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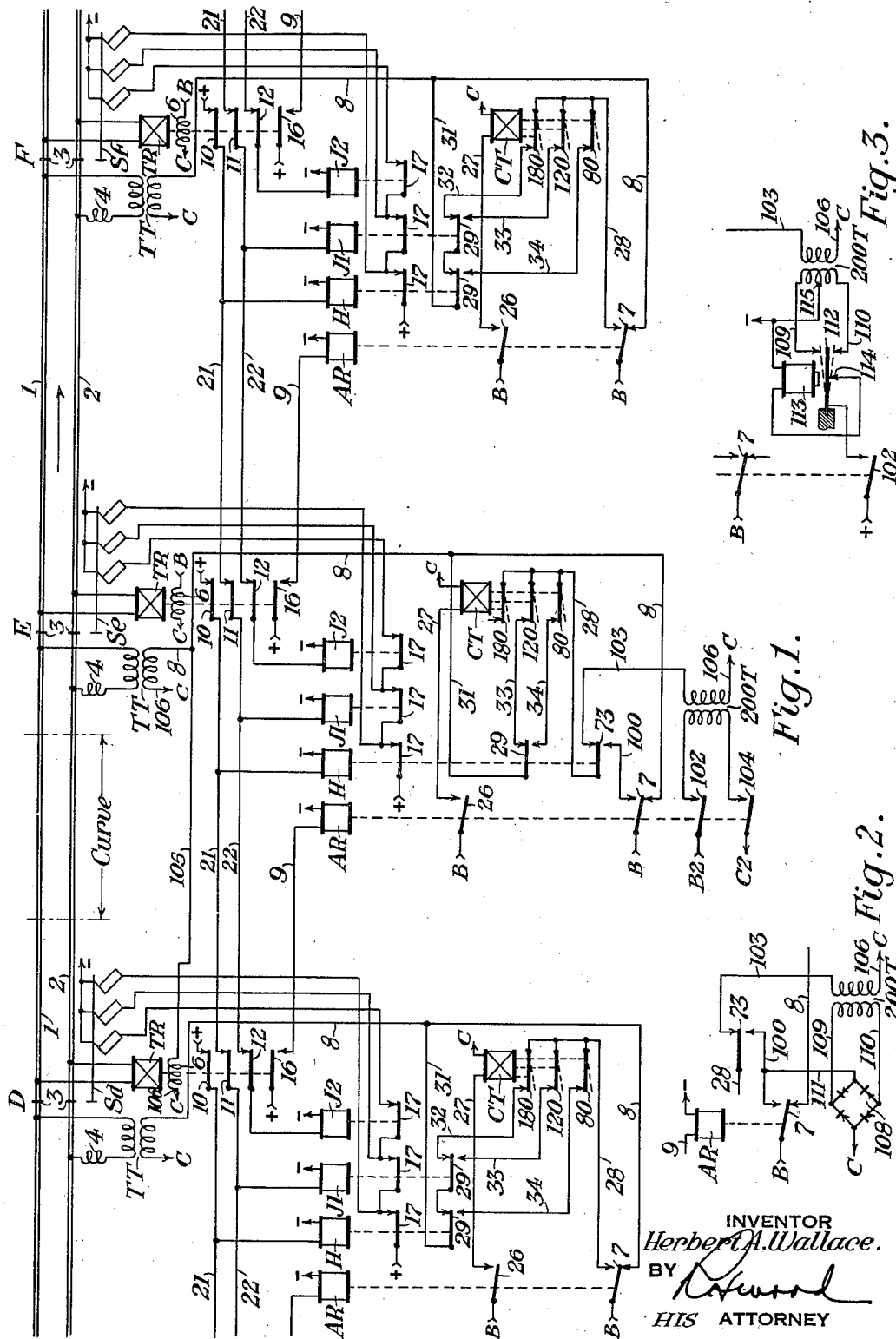
H. A. WALLACE

2,194,371

RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed May 20, 1938

6 Sheets-Sheet 1



INVENTOR
Herbert A. Wallace.
BY *Edward*
HIS ATTORNEY

March 19, 1940.

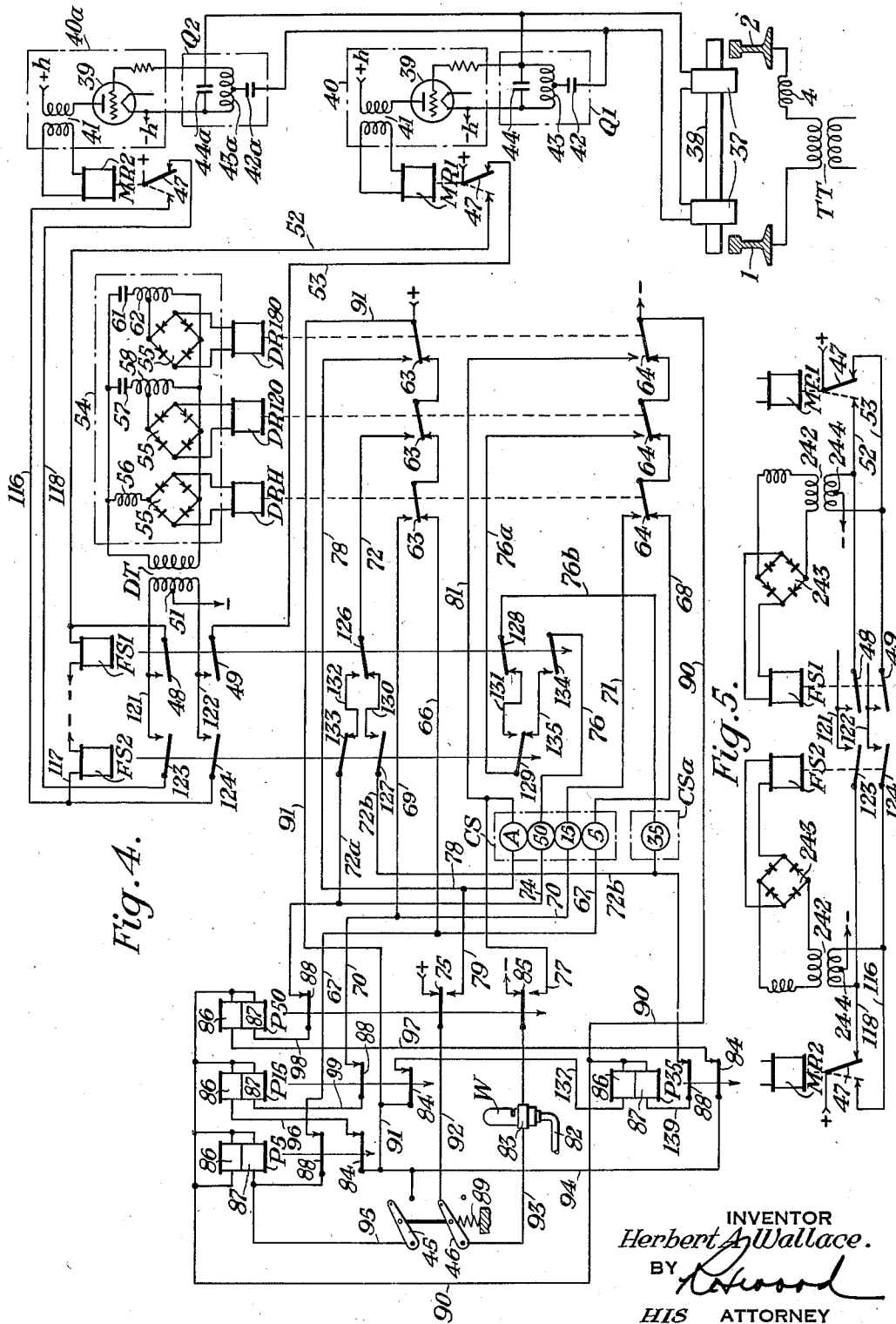
H. A. WALLACE

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RAILWAY TRAFFIC CONTROLLING APPARATUS

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6 Sheets-Sheet 2



INVENTOR
Herbert A. Wallace.
BY
His Attorney

March 19, 1940.

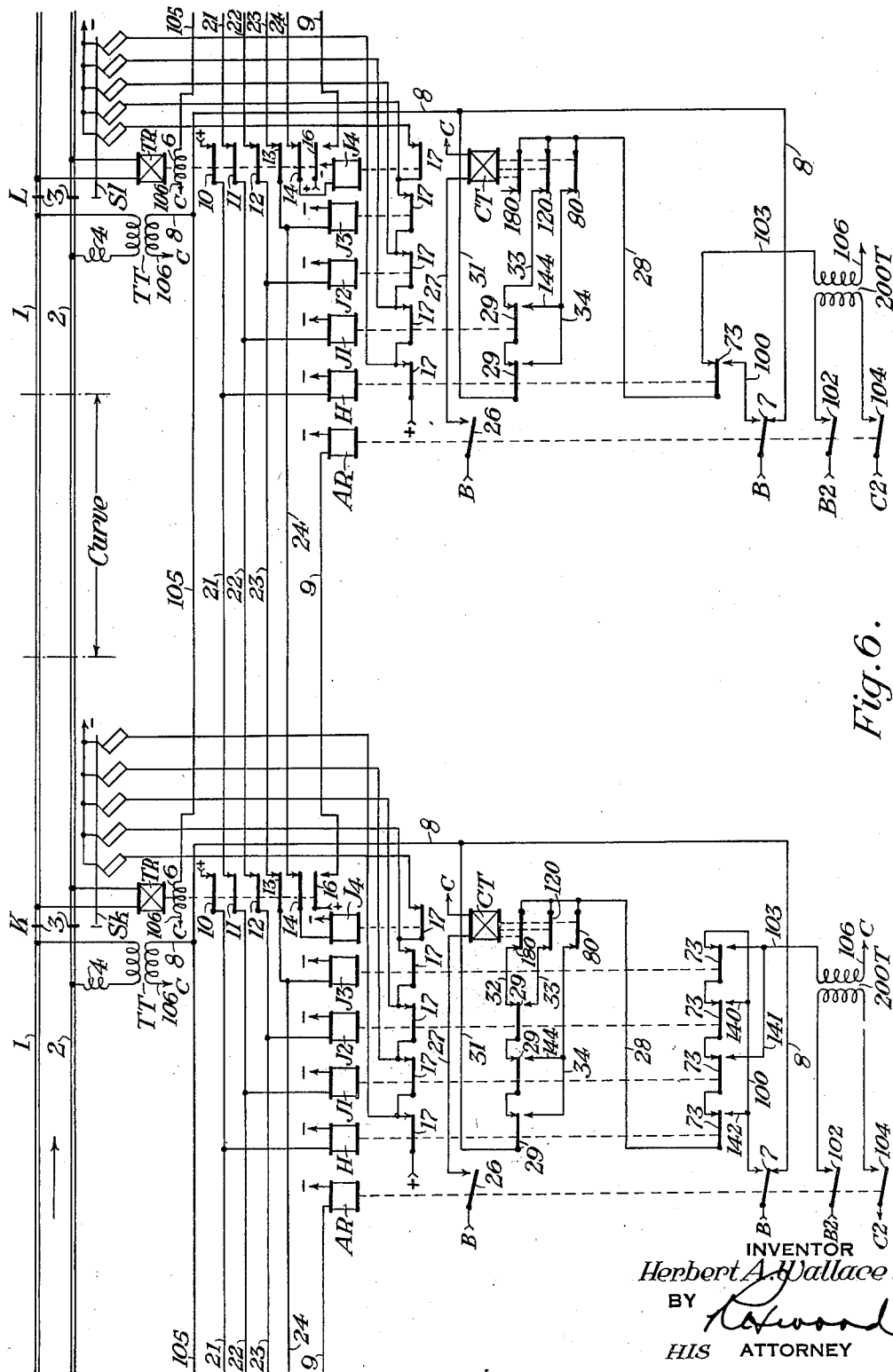
H. A. WALLACE

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RAILWAY TRAFFIC CONTROLLING APPARATUS

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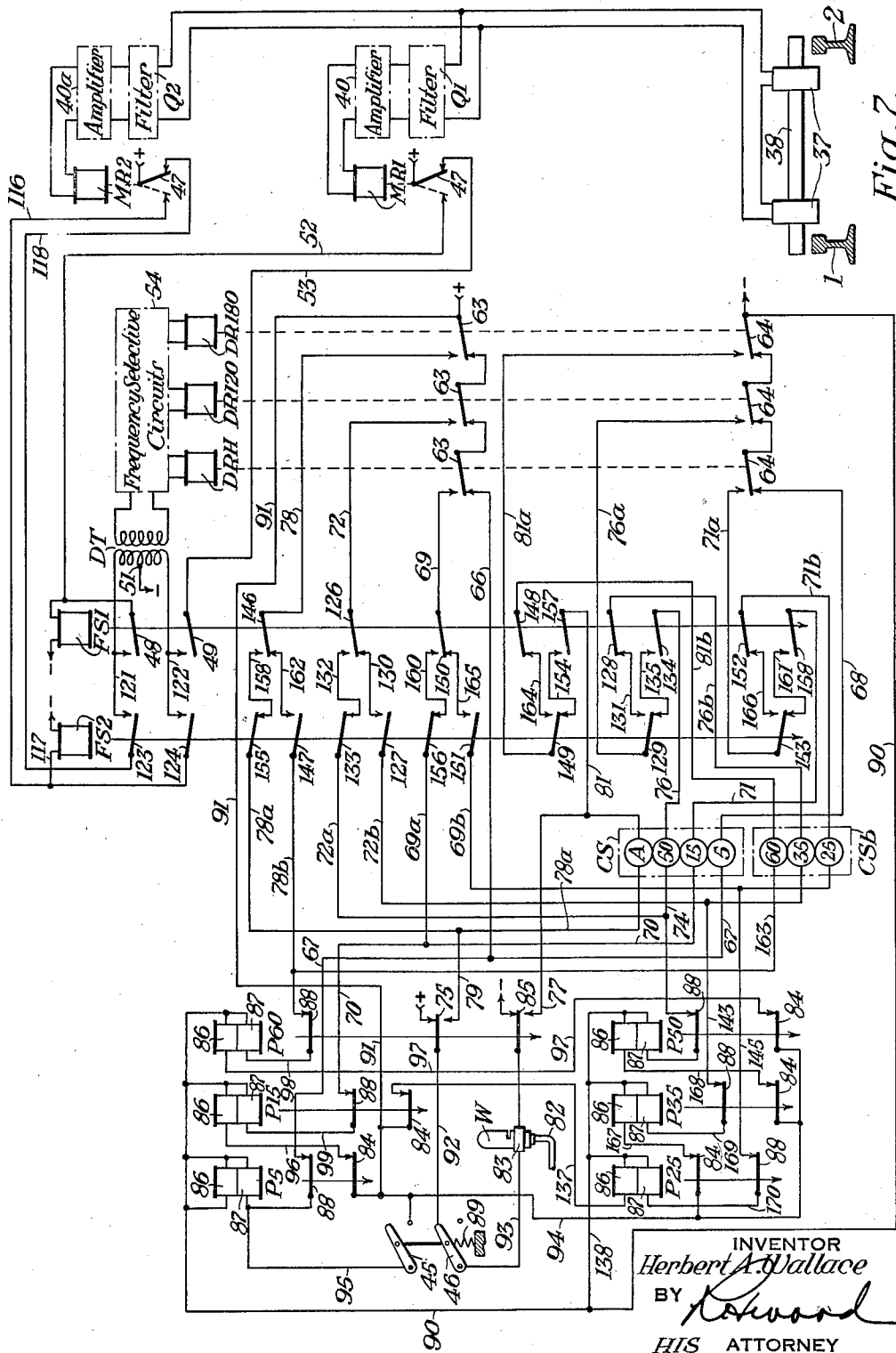
H. A. WALLACE

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RAILWAY TRAFFIC CONTROLLING APPARATUS

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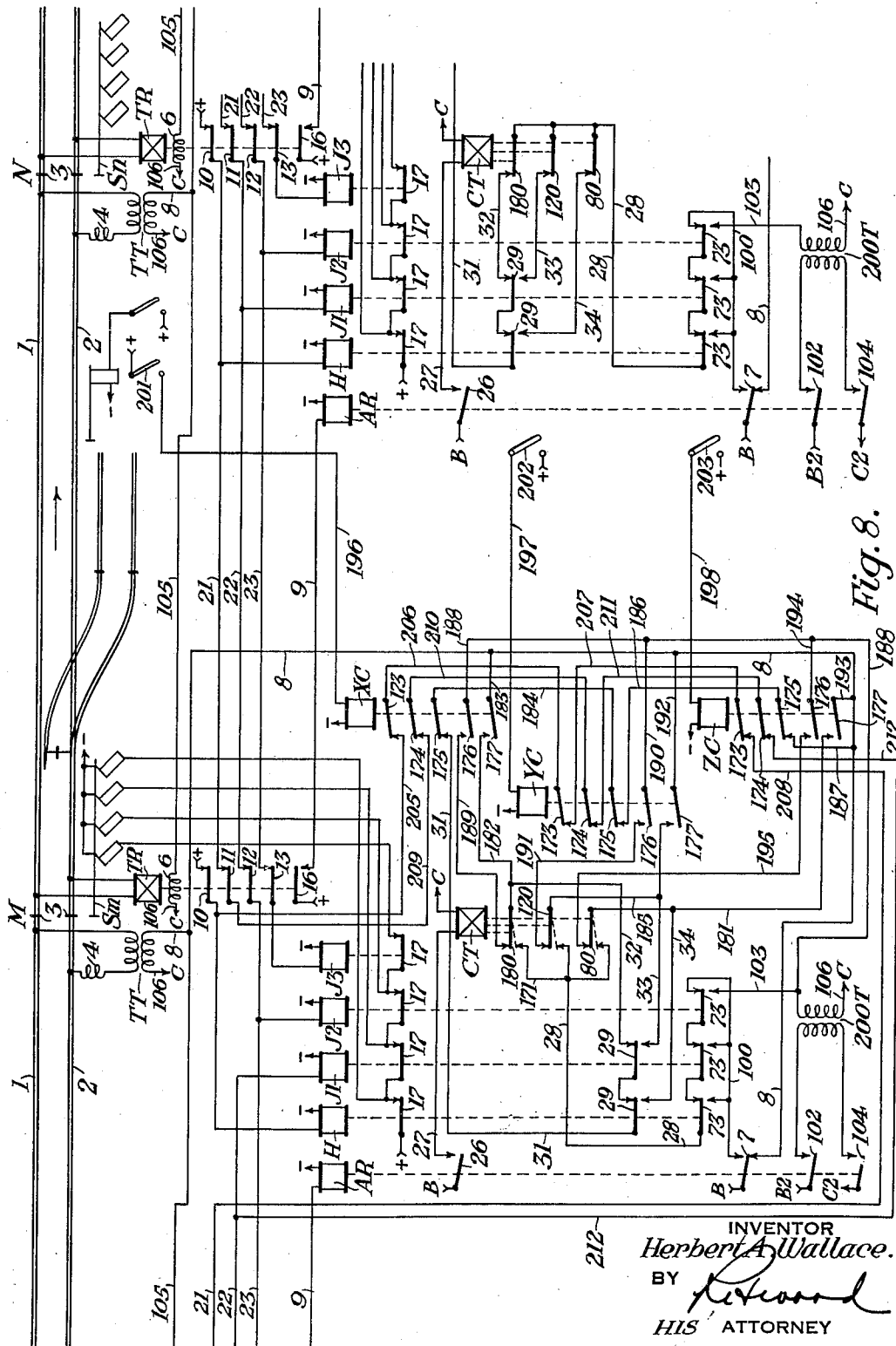
H. A. WALLACE

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RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed May 20, 1938

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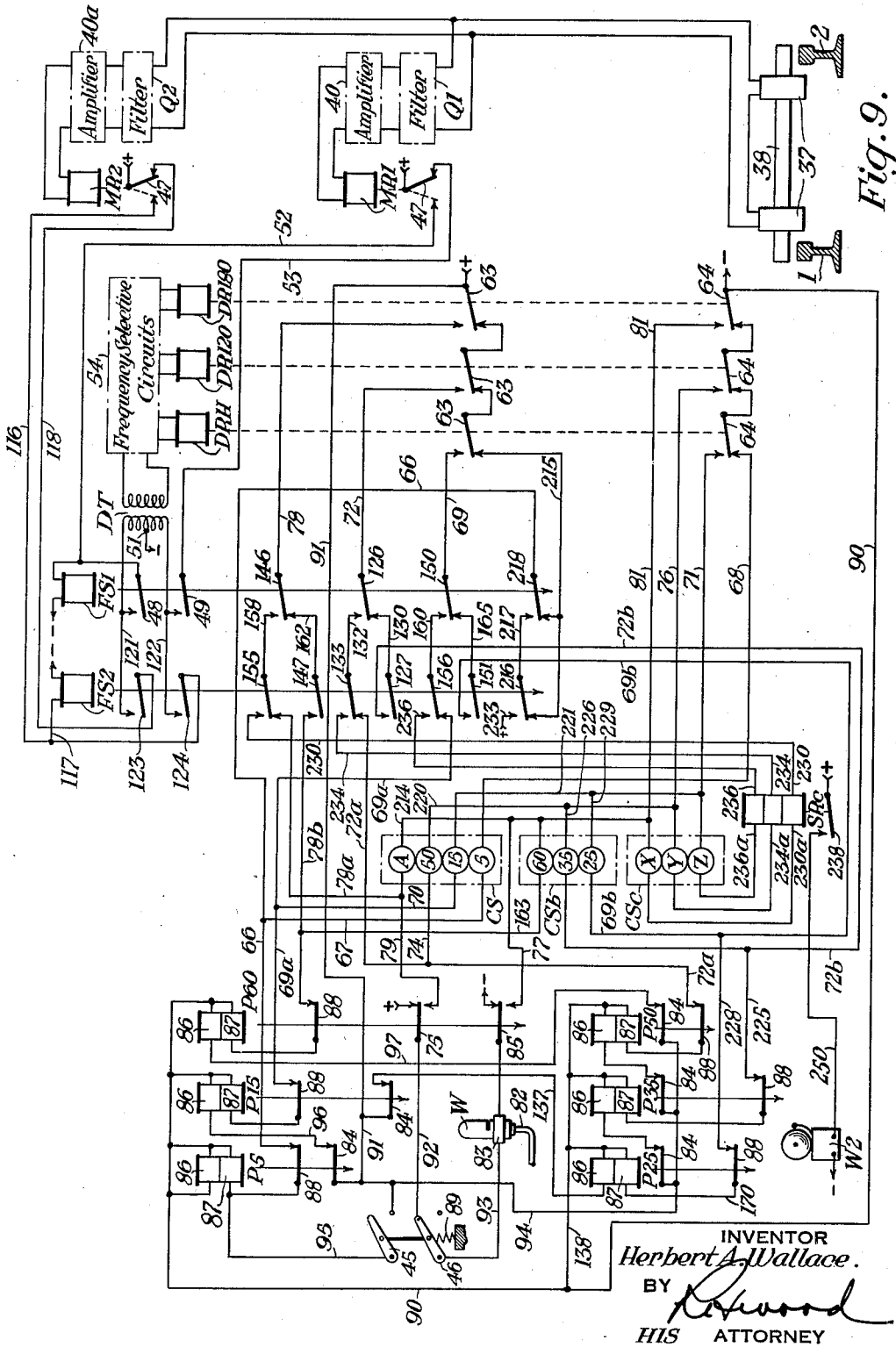
H. A. WALLACE

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RAILWAY TRAFFIC CONTROLLING APPARATUS

Filed May 20, 1938

6 Sheets-Sheet 6



UNITED STATES PATENT OFFICE

2,194,371

RAILWAY TRAFFIC CONTROLLING
APPARATUS

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

Application May 20, 1938, Serial No. 209,080

44 Claims. (Cl. 246—63)

My invention relates to railway traffic controlling apparatus and it has special reference to the organization of such apparatus into systems wherein cab signals or other governing devices carried aboard a train vehicle to indicate or enforce the permissible running speed are continuously controlled by energy coded in accordance with advance conditions and transmitted to the vehicle through the track rails.

One object of my invention is to provide a novel and improved form of such organization.

Another object is to increase the flexibility, comprehensiveness and range of application of train controlling systems of the class named.

An additional object is to extend the number of cab signal indications which are obtainable from a restricted variety of trackway current codes.

A further object is to accomplish the above by relatively simple additions to and without fundamental changes in the equipment of existing systems of coded cab signalling.

In practicing my invention, I attain the above and other objects and advantages by utilizing track circuit energy of one or another of a number of different carrier wave frequencies (such as 100 and 200 cycles per second), coding or modulating the energy of each of the frequencies so used at one or another of several different rates (such as 80, 120 and 180 supply circuit interruptions per minute) and providing train carried indicating means which respond distinctively to each different combination of frequency and coding of the trackway current.

I shall describe three representative forms of railway traffic controlling apparatus embodying my invention and shall then point out the novel features thereof in claims. These illustrative embodiments of my inventive improvements are disclosed in the accompanying drawings in which:

Fig. 1 is a diagrammatic representation of trackway apparatus incorporating my invention and arranged to supply the running rails with coded train control energy having a carrier wave frequency of one value under certain conditions and of a second value under other conditions;

Figs. 2 and 3 are simplified representations of alternative means for providing train control energy of the second carrier wave frequency which is employed in each of the wayside systems of Figs. 1, 6 and 8;

Fig. 4 is a diagrammatic view of train carried apparatus organized in accordance with my invention into a five indication cab signalling sys-

tem suitable for cooperation with and control by the trackway apparatus shown in Fig. 1;

Fig. 5 is a representation of a modified form of circuits for controlling the selector relays which are included in each of the train carried equipments of Figs. 4, 7 and 9;

Fig. 6 is a diagrammatic representation of trackway apparatus arranged to supply the running rails selectively with train control energy of two different carrier wave frequencies and extended to code the energy of each of these frequencies at three different rates of supply circuit interruption;

Fig. 7 is a diagrammatic view of train carried apparatus organized into a seven indication cab signalling system suitable for control by the trackway apparatus of Fig. 6;

Fig. 8 is a diagrammatic representation of a third form of trackway apparatus embodying my invention and arranged to supply the running rails with coded energy of one or the other of two different carrier wave frequencies or with coded composite energy of both of those frequencies; and

Fig. 9 is a diagrammatic view of a third form of train carried apparatus organized into a ten indication cab signalling system suitable for control by the trackway apparatus of Fig. 8.

Inasmuch as my invention contemplates an extension in the number of indications which can be provided by existing systems of coded cab signalling, it will be helpful first to consider the nature and mode of operation of the apparatus which a representative form of such an existing system comprises. Such apparatus is represented as being incorporated in each of the three cab signalling systems of my invention which are represented in Figs. 1-4, 6-7 and 8-9. As an introduction to my inventive improvements which are disclosed herein, description will first be given of the equipment of this illustrative form of existing system in which train control energy of but a single carrier wave frequency is utilized.

Considering first the trackway portions of this single frequency cab signalling equipment, these are included in the showings of each of Figs. 1, 6 and 8. In all of those figures, the reference characters 1 and 2 designate the rails of a track over which it will be assumed that traffic moves in the single direction indicated by the arrow, or from left to right in the diagrams. Insulated rail joints 3 divide the protected stretch of this track into the customary successive sections or blocks D-E, E-F, K-L, M-N, etc. and the rails of

each of these sections form a part of a track circuit of the usual character.

Each track circuit is supplied with alternating current operating energy impressed, through a track transformer TT and a current limiting reactor 4, between the rails of the section at a point adjacent the traffic leaving or exit end thereof. This energy is derived from any suitable source and distributed to the several locations of track circuit division D, E, F, etc. in conventional manner, as by the aid of a transmission circuit (not shown) extending along the right-of-way. In the diagrams, characters B and C designate power distributing terminals which are supplied from one such source. To facilitate explanation it will be assumed that the voltage of this source has a signal power frequency of 100 cycles per second.

Further included in each of the track circuits is the control winding of a track relay TR which is installed at the traffic entering end of the section. Each of these relays is of the alternating current type and, in addition to the control winding which is represented as being directly connected to the track rails, it is provided with a local or exciting winding 6 which receives alternating current energy from the same source as does the track transformer TT at the opposite or exit end of the associated section. When both windings of the relay are simultaneously energized, the contacts of the relay (represented therebeneath) are actuated to their uppermost or front positions. When, however, either of the two windings becomes deenergized, these contacts return to their lowermost or back positions.

As here shown, each of the track circuits normally receives steady energy from the source B—C through a circuit which includes a contact 7 of an approach control relay AR, a conductor 8, and the associated track transformer TT. As long as the track section is vacant, the rails 1 and 2 thereof transmit this energy to the track relay TR at the opposite end of the section and thereby maintain that relay actuated. When, however, a train occupies the section, the usual shunting action of its wheels and axles deprives the track relay of this steady energy and thereby initiates operations which cause coded energy, suitable for controlling cab signals or other train carried devices, to be impressed between the rails.

The approach control relays AR referred to above are installed at the locations of track section division and each is provided with an actuating circuit which includes a location interconnecting line conductor 9 and a contact 16 of the track relay TR at the opposite or entrance end of the associated section. Normally each of these relays AR is deenergized by virtue of track relay contact 16 being held in its front position. When, however, a train comes into the associated track section, the circuit just described supplies the relay with actuating current derived, in the particular arrangement shown, from a direct current control source which is designated by the terminals "plus" and "minus".

At such times the alternating current potential impressed between the rails of the track section is no longer steady but instead is "coded" by virtue of the rail supply circuit being interrupted at a definite rate according to the traffic or other conditions ahead. Such alternate opening and closing of the energy supply circuit is effected at each of the signal locations D, E, F, etc. by a code transmitter there represented

at CT. In the illustrative form shown, each of these transmitters is provided with three circuit making and breaking contacts 80, 120 and 180 arranged for selective inclusion in the energizing circuit of the associated track transformer. During operation of the transmitter these contacts are continuously actuated by a motor or other suitable mechanism (not shown in detail) at three different speeds which, for purposes of explanation, will be assumed to be such as respectively to provide codes of 80, 120 and 180 energy pulses per minute.

Operation of each transmitter is controlled by the associated approach control relay AR, the represented arrangement being such that the transmitter is brought into action only when a train occupies the track section to the rails of which the associated track transformer TT is connected. When the approach relay becomes actuated, as under conditions of section occupancy, a contact 26 thereof completes a circuit through which the transmitter driving mechanism is supplied with operating current from the source B—C and by way of a conductor 27. At the same time, contact 7 of the relay connects the coding contacts 80, 120 and 180 of the transmitter with the supply terminal B by way of a conductor 28 and thereby conditions these contacts for selective inclusion in the rail energizing circuit. As long, however, as the relay AR remains unactuated, as when the associated track section is vacant, the two connections named above are broken and contact 7 of that relay then maintains the track transformers TT continuously connected with the power source terminals B and C.

Further included in each of the trackway systems represented in Figs. 1, 6 and 8 are wayside signals S positioned in the customary manner adjacent the points of track section division D, E, F, etc. These signals are of a type suitable for indicating to an approaching train the nature of the traffic conditions in the track sections immediately ahead. As represented, each comprises a vertical standard supporting a plurality of semaphore arms one above the other. Elevation of the uppermost arm signifies that the track section immediately ahead of the signal location is clear; elevation of the second arm from the top indicates that there are two clear blocks ahead; elevation of the third arm from the top signifies that the three sections immediately ahead of the signal are unoccupied; and so on.

Control of each wayside signal S, and also selection of the character of the coded energy supplied to the track section to the rear of that signal, is effected by a plurality of traffic governing relays H, J1, J2, etc., installed at the associated section division location. These relays are provided with contacts 17 which are included in actuating circuits for the semaphore arms of the signal and also with contacts 29 which serve, when conditions so require, selectively to connect one or another of the contacts 80, 120 and 180 of the coding device CT in the rail supply circuit of the rear track section referred to above. As long as a particular traffic governing relay is unactuated the associated semaphore arm of the controlled signal S occupies its downward or traffic restricting position. When, however, the relay closes its front contacts, the signal circuit is completed by contact 17 and the controlled semaphore arm is then moved upwardly (by apparatus not shown) to an elevated

position which signifies that the associated track sections in advance is clear.

Thus, when all of the traffic governing relays H, J1, J2, etc. or energized, the controlled signal S holds all of its arms in the elevated positions and displays the "clear" indication which signifies that the several blocks immediately in advance are vacant. Likewise, when all of the relays are deenergized, the signal drops all of its arms and then displays the "stop" indication which signifies that the block which it directly protects is occupied. Furthermore, when relay H only is energized, the signal indicates that only one block ahead is clear; when relay J1 is also energized, the signal shows that there are but two clear blocks ahead; when relays H, J1 and J2 are energized, the controlled signal indicates that there are three clear blocks ahead; and so on.

The code selecting circuits at each signal location, which include contacts 29 of the traffic governing relays H, J1, J2, etc., are rendered effective only when the associated approach control relay AR is energized in response to the entrance of a train into the track section to the immediate rear. When, under this condition, relays H and J1 are energized, the associated track transformer TT receives energy through a circuit which includes conductor 28, contact 180 of the coding device CT, conductor 32, the relay contacts 29 and conductors 31 and 8. This causes the rails of the track section to the immediate rear to be supplied with energy of the 180 code. When relay H only is energized, the track transformer circuit includes coding contact 120 and conductor 33 and the track circuit is then supplied with energy of the 120 code. Finally, when relays H and J1 are deenergized, energy of the 80 code is supplied to the trackway through a circuit which includes coding contact 80 and conductor 34.

The represented actuating circuits for the traffic governing relays H, J1, J2, etc. at each signal location receive energization from the before referred to direct current source designated by terminals "plus" and "minus". Respectively included in all of these circuits are the contacts 10, 11, 12, etc. of the track relay TR at the same location. Further included in the circuit for relay J1 is a location interconnecting line conductor 21 and contact 10 of the track relay at the next location in advance; in that for relay J2 is a line conductor 22, contact 11 of the track relay at the first location in advance, the line conductor 21 extending forward from that location and contact 10 of the track relay at the second location ahead; and so on. Similarly, the actuating circuit for each of the relays J3 of Figs. 6 and 8 includes contact 13 of relay TR at the same location, line conductor 23, contact 12 of relay TR at the next location in advance, line conductor 22, contact 11 of relay TR at the second location in advance, line conductor 21, and contact 10 of relay TR at the third location in advance.

In operation of the wayside signal control and coded energy supply system which has just been described as forming a part of the trackway apparatus of each of Figs. 1, 6 and 8, when all of the sections of the protected stretch of track 1—2 are unoccupied, the track relay TR at each of the several signal locations is picked up, all of the relays H, J1, J2, etc. in each of the associated traffic governing groups are picked up, and all of the approach control relays AR are dropped out. In consequence, all of the wayside signals S give unrestrictedly "clear" indications which signify

that the several blocks immediately in advance of each are unoccupied and all of the track transformers TT receive steady energy from the supply source B—C.

As, now, a train advances through the stretch, the shunting action of its wheels and axles causes the track relay TR associated with each section occupied by it to release. This opens all of the traffic governing relay circuits which are carried through the contacts of that relay and also completes the circuit for the approach relay AR at the next location in advance. As a result, all of the relays H, J1, J2, etc. at the location of this unactuated track relay become deenergized, the associated wayside signal S indicates that the block which it directly protects is occupied, and the coding device CT at the advance location is brought into operation. It then codes the energy supplied to the rails of the occupied section at a rate which is determined by the condition of the associated traffic governing relays.

At the entrance of the first vacant block to the rear of the above-mentioned train, relay H only is energized, relays J1, J2, etc. are deenergized and the signal S controlled thereby indicates that there is only one clear block ahead; at the entrance of the second vacant block behind the occupied one, relay J2 and remaining J relays of higher numeral suffix are deenergized and the controlled signal indicates that there are two clear blocks ahead; and so on.

If the several sections ahead of the referred to train are vacant, the traffic governing relays H, J1, J2, etc. at the location immediately in advance of that train assume positions in which their selector contacts 29 include coding contact 180 in and exclude contacts 120 and 80 from the supply circuit of the associated track transformer TT. Under these conditions, the energy supplied from source B—C to the rails of the occupied track section is interrupted at the rate of 180 times per minute. In the event that a section comparatively close ahead is occupied by a second or advance train, the selector contacts 29 of the traffic governing relays just referred to include coding contact 120 in the track transformer supply circuit. This causes the energy which is transmitted to the rails of the section occupied by the following train to be interrupted at the rate of 120 times per minute. Finally, if a still closer section is occupied by the advance train, the contacts 29 include coding contact 80 in the trackway circuit, and the energy supplied to the rails of the section which the following train occupies is then interrupted at the rate of 80 times per minute.

Before considering the invention added portions of the trackway apparatus of Figs. 1, 6 and 8, the existing system portions of the cooperating train carried equipments of Figs. 4, 7 and 9 will first be described.

Each of these equipments converts a measure of the coded energy present in the track rails 1 and 2 into appropriate train controlling indications aboard the locomotive or other train vehicle which carries the equipment. In the representative form shown, the single frequency responsive portions of the apparatus of each of Figs. 4, 7 and 9 include a receiver 37—38, an amplifier 40, a master or code following relay 70 MRL, a decoding transformer DT, decoding relays DR, an indication giving cab signal CS, a warning whistle W, an acknowledging switch 45—46, and acknowledging relay P.

Control energy from the running rails 1—2 is

transmitted to the train carried apparatus by the receiver. In the form shown, it consists of a pair of windings 37 carried on a laminated iron bar 38 which is mounted ahead of the advance truck of the equipment carrying vehicle just above and spanning the two rails. These elements constitute the core and the secondary of a transformer of which the rails are the primary and when alternating current flows in the rails voltages are induced in and additively combined by these windings 37.

The amplifier 40 is controlled by the combined output potential of the receiver windings and it, in turn, delivers an appropriately increased amount of actuating energy to the master relay MR1. The simplified form of amplifier shown utilizes an electronic tube 39 and a master relay transformer 41. The secondary winding of this transformer is connected to the operating winding of relay MR1; the primary winding is included in a circuit through which a high voltage direct current source, designated by the terminals "+h" and "-h", passes current from the anode to the cathode of the tube; and the receiver output potential is impressed between the grid and cathode of the tube.

When no current is present in the track rails ahead of the equipment carrying vehicle, or when unvarying alternating current flows therein, the tube grid potential is such that the flow of unidirectional current through the primary of transformer 41 is constant. Under such circumstances no energy is transmitted to relay MR1. When, however, the rails carry coded or periodically interrupted alternating current, the tube 39 alters its impedance in step with the pulses of this trackway energy. This, in turn, causes the transformer 41 to impress an alternating potential of the code rate frequency (80, 120 or 180 cycles per minute for the apparatus shown) upon the actuating winding of the master relay.

Interposed between the receiver and the amplifier is an electrical filter Q1 represented as including a first capacitor 42, a reactor 43 and a second capacitor 44. The elements of this filter are so interconnected and proportioned as to suppress all frequencies except that of the 100 cycle or other selected carrier wave value. This makes it impossible for the master relay MR1 to respond to trackway energy having a carrier wave frequency differing substantially from the selected value above mentioned and thus renders the apparatus immune to interference from foreign currents.

The master relay MR1 follows the coding of the energy which the windings 37 receive from the track rails. As shown, it is of the direct current polarized type and has a contact 47 which shifts from one position to the other when the polarity of the relay energization changes and which, when the relay is unenergized, stays in the position to which it was moved by the last energization of the relay. In the particular arrangement represented, this contact is moved to its left-hand or "energy on" position (shown dotted) at the beginning of each pulse of trackway energy (at which time the operating winding of the relay receives a "positive" half cycle of current from transformer 41), and at the end of each trackway energy pulse (at which time the relay winding receives a "negative" half cycle of current) the contact is returned to its right-hand or "energy off" position (shown heavy) where it remains until another pulse of energy appears in the trackway. Thus, the contact

occupies its left-hand position during each "on" period of the trackway code and its right-hand position at all other times including the "off" code periods.

Energization of the decoding transformer DT is controlled by this contact 47 of the master relay. When following the trackway code, it pole changes a circuit from which the primary winding of the transformer receives pulses of direct current at code frequency. Ordinarily this current is supplied to the transformer energizing circuit from the 32 volt headlight generator of the locomotive or other suitable direct current source designated in the diagrams by the terminals "plus" and "minus". Also included in the particular circuit shown are contacts 48 and 49 of a selector relay FS1 later to be described. As long as the master relay MR1 is following a trackway code, these contacts continuously occupy their front positions (by virtue of controlling operations later to be explained) and through them the decoding transformer is maintained connected to the conductors 52 and 53 of the primary supply circuit.

When, now, the pole changing contact 47 of the master relay occupies its right-hand or "energy off" position, current from the positive supply terminal flows by way of conductor 53 upwardly through the lower half of the transformer winding and to the negative supply terminal by way of a mid tap connection 51. When, however, contact 47 is shifted to its left-hand or "energy on" position, the flow of current is by way of conductor 52 and then is downwardly through the upper half of the transformer primary.

The resulting code frequency pulses of primary current induce in the secondary winding of the decoding transformer DT an alternating current voltage of a frequency which is the same as is that of the trackway code by which the pulses are initiated. Thus, this secondary voltage will, in each of the particular systems disclosed, have a frequency of 80, 120 or 180 cycles per minute. It supplies actuating current to the three decoding relays DR through frequency selective circuits 54.

These decoding relays DR control the cab signal CS. As represented they are of the direct current type and each has a pair of signal control contacts 63 and 64 which are quick acting in both the pick-up and drop-out directions. When the relay is deenergized, these contacts occupy their lowermost or back positions and when the relay receives sufficient energizing current to effect its actuation they are biased to their uppermost or front positions.

In the arrangement shown, a full wave rectifier 55 is included in the circuit through which each of the relays DR receives energizing current from the decoding transformer DT. In the case of relay DRH, the rectified supply circuit includes a reactor 56 and is responsive to coded energizing pulses having frequencies corresponding to all three of the named 80, 120 and 180 trackway codes. In the case of relay DR120, the supply circuit includes a capacitor 57 and a reactor 58 which are so interrelated as to pass enough current to actuate the relay only when energizing pulses of the 120 code frequency are received from the transformer DT. In the case of relay DR180, the circuit includes a capacitor 61 and a reactor 2 designated to be resonant at the 180 code frequency and to energize the relay only when the

decoding transformer passes energy pulses at the rate of 180 per minute.

In operation of the decoding equipment just described, all three of the relays DR remain dropped out when the train carried apparatus receives uncoded steady energy or no energy at all; relay DRH only is picked up when the energy received from the trackway is of the 80 code; relays DRH and DR120 are both picked up when the received energy is of the 120 code; and relays DRH and DR180 are picked up and relay DR120 is dropped out when energy of the 180 code is received from the track rails.

A distinctive indication on the part of the cab signal CS is produced by each one of the four just described positional combinations of the decoding relays DR. This train carried signal may, of course, be of any suitable type adapted to indicate the track conditions ahead by means of color light, position light or other aspects within the engine cab. As illustratively shown at CS, it consists of four electric lights 5, 15, 50 and A arranged to be energized selectively. To facilitate description, it will be assumed that, when lighted, these lamps respectively display the characters by which they are marked in the diagrams and that the resulting signal aspects are interpreted by the engineman to mean that the maximum permissible running speed is 5, 15, 50 or an "Authorized" maximum number of miles per hour.

For supplying lighting current to the lamps, use is made of the locomotive headlight generator or other source designated in the diagrams by the terminals "plus" and "minus". Included in and serving to control the lamp energizing circuits are the previously mentioned contacts 63 and 64 of the decoding relays DR.

When all three of these decoding relays DR are dropped out, as when the signal carrying train goes into a track section already occupied by another train, cab signal lamp 5 is lighted. Its energizing circuit extends from the positive supply terminal, through the back contacts 63 of all three decoding relays in series, conductors 66 and 67, the lamp 5, conductor 68, and the back contacts 64 of all three relays DR in series back to the negative supply terminal.

When relay DRH only is actuated, as when the signal carrying train is in an otherwise vacant track section which is close behind a section occupied by another train ahead, cab signal lamp 15 is lighted. Its energizing circuit may be traced from the positive supply terminal, through back contacts 63 of relays DR120 and DR180 in series, front contact 63 of relay DRH, conductors 69 and 70, the lamp 15, conductor 71, front contact 64 of relay DRH, and back contact 64 of relays DR120 and DR180 in series back to the negative supply terminal.

When relay DR120 is actuated, as when the signal carrying train is in a track section further removed from an occupied section in advance, cab signal lamp 50 is lighted. Its energizing circuit extends from the positive supply terminal through back contact 63 of relay DR180, front contact 63 of relay DR120, conductors 72 and 74, the lamp 50, conductor 76, front contact 64 of relay DR120 and back contact 64 of relay DR180 back to the negative supply terminal.

Finally, when relay DR180 is actuated, as when the signal carrying train is in a track section so far removed from an occupied section in advance as to make full or authorized speed safe, cab signal lamp A is lighted. Its energizing circuit

may be traced from the positive supply terminal through front contact 63 of relay DR180, conductor 78, the lamp A, conductor 81, and front contact 64 of relay DR180 back to the negative supply terminal.

Further forming a part of each of the train carried equipments represented in Figs. 4, 7 and 9 are the customary means for supplementing the visual indications given by the cab signal CS by an audible warning which sounds whenever the signal indication changes in the more restrictive or speed reducing direction. In the arrangement shown, this warning is emitted by a whistle W which upon being placed in operation continues to blow until the engineman proves his alertness by acknowledging the change in indication which initiated the blowing. Such acknowledgement is effected through the agency of a switch 45—46 which, together with contacts of a group of acknowledging relays P, is included in circuits for controlling the whistle operation.

The particular whistle shown at W is sounded by compressed fluid, such as air from the usual brake operating pressure system, supplied thereto from a conduit 82 through an electrically operated valve 83. Normally this valve receives closing current, from the direct current terminals "plus" and "minus", through a circuit which includes front contacts 75 and 85 of the acknowledging relay P50 (P60 in Figs. 7 and 9) and blade 46 of the acknowledging switch. This current keeps the whistle silent. When, however, the circuit just described is interrupted, the valve opens and allows compressed air to pass into and operate the whistle.

The blades of the acknowledging switch 45—46 are normally held in the represented upwardly biased positions by a compression spring 89. To silence the whistle following a more restrictive indication change, the engineman depresses these blades and holds them in their downwardly biased positions for a short time interval. Blade 46 then opens the whistle control circuit while blade 45 initiates actuating operations on the part of the acknowledging relays P.

These acknowledging relays are arranged to be operated in a given sequence of which relay P5 marks the beginning and relay P50 (P60 in Figs. 7 and 9) the ending. As shown, each relay in the acknowledging group has a "pick-up" winding 86, a "stick" winding 87, and a contact 88 which controls the "stick" circuit of that relay. All relays except the highest sequence device also have a contact 84 which controls the "pick-up" circuit for the next relay in the operating sequence. In place of contact 84 that highest sequence relay is provided with the before referred to contacts 75 and 85 which form a part of the silencing circuit for the whistle W.

Current for energizing the referred to pick-up and stick circuits is obtained from the terminals "plus" and "minus" of the same direct current source that supplies lighting current to the cab signal lamps. In the case of each relay, when neither of its two windings 86 and 87 is energized, the relay contacts occupy their lowermost or unactuated positions. When, however, energizing current is supplied to either or both of the two windings, the relay contacts are picked up. All of these acknowledging relays P, moreover, are sufficiently slow releasing as not to drop out their contacts within the short interval of time which is required by the decoding relays DR to shift their contacts from one position to the other in effecting a change in cab signal indication.

In the particular arrangement of pick-up and stick circuits represented, relay P5 receives pick-up current (through its winding 87) when blade 45 of the acknowledging switch is depressed and stick current (also through its winding 87) by way of its own front contact 88 when closed if at that time signal lamp 5 is energized over conductor 67; relay P15 receives pick-up current (through its winding 86) by way of front contact 84 of relay P5 when closed and stick current (through its winding 87) by way of its own front contact 88 when closed if signal lamp 15 is at that time energized over conductor 70; and so on.

In operation of the acknowledging equipment, the whistle W normally remains inactive, as has already been pointed out, by virtue of its silencing circuit being completed through front contacts 75 and 85 and switch blade 46. In the event, however, of a change in indication in the more restrictive direction, this circuit becomes interrupted, the warning whistle is brought into action, and the switch 45—46 must be operated to restore the acknowledging relays P to a condition in which the circuit may again be completed to silence the whistle.

For example, assume that cab signal lamp A is lighted in response to decoding relay DR180 being actuated, which is the normal or clear advance track condition. In this situation, all of the acknowledging relays P are deenergized and released by virtue of all of their pick-up and stick circuits being interrupted, and the back contacts 75 and 85 of relay P50 (P50 in Figs. 7 and 9) complete the whistle silencing circuit. That circuit extends, under these conditions, from the positive supply terminal, through front contact 63 of relay DR180, the lamp energizing conductor 78, conductor 79, back contact 75, conductor 92, switch blade 46, conductor 93, the valve 83, back contact 85, conductor 77, the negative lamp energizing conductor 81, and front contact 64 of relay DR180 back to the negative supply terminal.

If in response to decoding relay DR180 dropping out and relay DR120 picking up lamp A goes out and lamp 50 is lighted, the whistle starts to operate. This results from a disconnection, at contacts 63 and 64 of relay DR180, of the energizing source from the circuit just traced. As the engineman depresses the acknowledging switch preparatory to silencing the whistle, blade 45 thereof completes the pick-up circuit for relay P5 and the acknowledging relays P5—15—50 are, as a result, actuated in the order named. (Also energized along with relays P5—15—50 is an added relay P35 which is included in the extended system of my invention that is represented in Fig. 4 and which is more fully described in a later portion of this specification.) Through "stick" current now received from the conductor 74 which energizes lamp 50, relay P50 locks itself in the picked-up position, and front contacts 75 and 85 of that relay now connect the whistle silencing circuit with the supply terminals "plus" and "minus" which are represented directly above these contacts. As the acknowledging switch later returns to its normal position, relay P5 drops out and causes the pick-up circuit of each of the other acknowledging relays to be opened. All of the acknowledging relays drop out except P50 the stick circuit of which is closed from conductor 74 and through its front contact 88. At the same time, blade 46 of the switch completes the whistle silencing circuit and thereby discontinues the warning sound.

If in response to decoding relay DR120 dropping out, lamp 50 goes out and lamp 15 is lighted, the whistle is again operated. This results from a breaking at contact 63 of relay DR120 of the stick circuit for relay P50 and the consequent disconnection, at contacts 75 and 85 of that relay, of the whistle silencing circuit from the energizing terminals above referred to. As the acknowledging switch 45—46 is depressed, relays P5—15—50 are again picked up in order. Relay P15 now locks itself in from "stick" current received from the conductor 70 which supplies energy to the lamp 15. Relay P50, in turn, is now also maintained actuated and contacts 75 and 85 thereof silence the whistle as soon as the switch 45—46 later returns to its normal position. At that time acknowledging relay P5 is allowed to drop out.

If in response to decoding relay DRH dropping out, lamp 15 goes out and lamp 5 is lighted, the whistle W once more operates. This results from a breaking, at contact 63 of relay DRH, of the stick circuit for relay P15; the dropping out of relays P15 and P50 which follows; and the before explained opening, at contacts 75 and 85 of relay P50, of the whistle silencing circuit. As the acknowledging switch is depressed, all of the relays P are once more picked up in order. Relay P5 now locks itself in, by connection with the conductor 67 which supplies current to the lamp 5, and thus holds the remaining acknowledging relays also picked up. Contacts 75 and 85 of relay P50 now set up the whistle silencing circuit and cause the whistle to cease operating when the switch 45—46 later returns to its normal position. Relay P5 does not, however, now drop out because its stick circuit is now completed by way of its front contact 88 and conductor 67.

Changes of cab signal indication in the speed increasing or less restrictive direction do not produce operations on the part of the warning whistle W. This is because each indication change of that character is accompanied by the completion of the stick circuit for the next relay P in the acknowledging sequence. As has been indicated, these relays are sufficiently slow releasing as not to drop out during the short interval of time that the decoding relays require to shift their contacts in effecting each less restrictive indication change. In consequence, each of such changes allows only the relays below it in the acknowledging sequence to drop out and keeps all of the acknowledging relays above it in the sequence picked up. As a result, contacts 75 and 85 of the whistle silencing circuit are maintained in their front positions during those changes and the whistle W is prevented from operating until a more restrictive indication occurs.

In the thus far described portions of each of the three cab signalling systems of Figs. 1-4, 6-7 and 8-9 use is made of track circuit energy of but one carrier wave frequency, assumed to be 100 cycles per second and shown as being supplied from source B—C. When coded at the illustrative rates of 180, 120 and 80 rail supply circuit interruptions per minute, this energy respectively causes the cab signal CS to display the indications of A, 50 and 15; when this energy is uncoded or is not present in the track circuit, the signal is caused to display indication 5.

The apparatus so far described thus corresponds to that used in a four indication system of conventional character. In many applications such

as a limited number of indications is not sufficient to take care of additional train control requirements which recently have come to be regarded as desirable. Typically the wayside portions of these existing installations made provision (including transmitters CT) for coding the trackway current at a limited number of rates only, such as the three above named, and the train carried portions thereof likewise provide correspondingly restricted decoding apparatus (including relays DR). Supplemental means for extending the cab signal indications obtainable from a restricted variety of trackway current codes to a number sufficient to meet all possible train control requirements are, therefore, needed.

In order to supply this particular need and generally to provide a cab signalling system of practically unlimited flexibility, comprehensiveness and range of application, I propose, as was stated at the beginning of this specification, to utilize trackway energy of more than one carrier wave frequency and to code or modulate the energy of each of the frequencies thus selectively used at one or another of the several different rates now customary or already provided for in existing installations. As will be seen presently, this proposal permits the present wayside coding devices CT and the present train carried decoders of existing installations to be used without fundamental modification and requires that supplements be made only to the apparatus and circuits of those wayside sections or blocks which must transmit the additional indications and only to the train carried equipments which need to receive them.

Three representative manners in which the above stated proposal may be carried into practice are disclosed by Figs. 1-4, 6-7 and 8-9. In all of these embodiments of my invention the added indications are obtained by the making of relatively simple additions to and without fundamental changes in the equipment of the conventional system of cab signalling already described as being of the four indication variety.

Five indication system of Figs. 1-4

The typical four indication cab signalling system just referred to as being controlled by single frequency trackway energy makes use of all of the wayside apparatus represented at locations D and F of Fig. 1. At location E, however, I have additionally shown supplemental trackway equipment by means of which one added indication may be provided for in the train carried apparatus of Fig. 4. The arrangement of this supplemental equipment is such that at certain times it supplies the track rails with coded train control energy of a carrier wave frequency which differs from the assumed 100 cycle value of source B—C.

The referred to energy of this second frequency may be derived from any suitable alternating current source and distributed to the various section dividing locations requiring it in any suitable manner, as by the aid of a second transmission circuit (not shown) extending along the right-of-way. In Fig. 1 (and in Figs. 6 and 8 also) characters B2 and C2 designate power distributing terminals which are supplied from one such source. If desired, the second frequency potential appearing between terminals B2 and C2 may also be generated locally by means of apparatus of the character shown in Figs. 2 and 3 (later to be described).

The frequency of this supplemental energy may be of any value which differs sufficiently from

that of the first source B—C and from interfering harmonics of commercial current frequencies to be clearly distinguishable therefrom by the train carried apparatus which it controls. One such frequency value suitable for the application under discussion is 200 cycles per second. To clarify description, it will be assumed, throughout the remainder of this specification, that the voltage appearing between terminals B2 and C2 has a frequency of that representative order.

In the organization of equipment shown at location E of Fig. 1, use is made of a transformer 200T to transmit energy from this second source B2—C2 to the trackway coding circuit under those preselected conditions already referred to. In the illustrative arrangement represented at location E, these particular conditions are reflected by the positions of a contact 73 of the traffic governing relay H and of contacts 102 and 104 of the approach control relay AR.

The traffic governing relay contact 73 is interposed between the coding contacts 80—126—130 of the transmitter CT and the two supply sources of train control energy. It serves to select whether coding circuit conductor 28 receives 100 cycle energy from source B—C through contact 7 of relay AR and a conductor 100, or 200 cycle energy from source B2—C2 through contacts 102 and 104 of relay AR, transformer 200T and conductor 103.

The former selection is made in accordance with those traffic conditions which involve occupancy by a train of one of the track sections beyond or in advance of location E. Depending upon the remoteness of such a train ahead, the rails of track section B—E are supplied, in the manner previously explained in detail, with 100 cycle energy coded at the rate of 130, 120 or 80 circuit interruptions per minute in the event that a train from the rear comes into the section named.

Selection of energy from source B2—C2 for supply to the trackway may, of course, be made in any additional special manner desired. For purposes of illustration, Fig. 1 shows this selection as being determined by a curve or other permanent speed restriction within track section D—E where it is there so marked on the diagram. To simplify explanation, it will be assumed that 35 miles per hour is the maximum speed at which a train may safely proceed through this particular portion of the section D—E.

In the further interests of description clarification, it will also be assumed that when only one section ahead of any of the non-curve containing blocks, such as E—F, is vacant, as reflected by traffic governing relay H only at the entrance thereof being actuated, the permissible running speed within that block is 50 miles per hour; and that when the section immediately in advance of any one of the sections of the protected track stretch of Fig. 1 is occupied, as reflected by relay H at the entrance thereof being dropped out, a speed of 15 miles per hour through that section should not be exceeded.

When, now, a train comes into section D—E the associated relay TR drops its contacts, thereby completing (at 16) the actuating circuit for the approach relay AR at location E, contact 26 of that relay places code transmitter CT in operation, contact 7 thereof interrupts the steady energizing circuit (which includes conductor 8) for the transformer TT at location E and connects conductor 100 with supply terminal B,

and contacts 102 and 104 connect transformer 200T to the supply source B2—C2.

If one or more track sections in advance of D—E is vacant, relay H at location E will be picked up. Contact 73 of that relay then connects coding circuit conductor 28 to 200 cycle supply conductor 103 and maintains it disconnected from 100 cycle supply conductor 100. Under these circumstances, transformer 200T supplies the rails of section D—E with 200 cycle energy derived from source B2—C2. Contact 120 of transmitter CT now codes this energy and track transformer TT transmits it to the rails in the usual manner. The circuit through which this thus coded 200 cycle energy is supplied to the track transformer now extends from one side of the secondary of transformer 200T, through conductor 103, front contact 73 of relay H, conductor 28, coding contact 120 of transmitter CT, conductor 23, front contact 29 of relay H, conductors 31 and 8, the primary winding of transformer TT, and conductor 106 (common to both of the transformers TT and 200T) back to the other side of the secondary of transformer 200T. In the cooperating apparatus of Fig. 4 (carried by the train within section D—E and presently to be described), this 200 cycle track circuit energy of the 120 code causes the lamp 35 of an added cab signal unit CSa to light and thereby indicate to the engineman that a speed of 35 miles per hour should not be exceeded.

As long as the train remains in the section D—E containing the curve or other permanent speed restriction, it is desired that neither of the lamps 50 or A of signal CS ever be lighted to authorize a higher speed even though the track ahead may be vacant for a long distance. For this reason no use is made at location E of the high speed authorizing coding contact 180 of the equipment there represented.

If the track section E—F immediately ahead of section D—E is occupied, traffic governing relay H will be dropped out. Contact 73 of this relay now connects coding circuit conductor 28 to 100 cycle supply conductor 100 and maintains it disconnected from 200 cycle supply conductor 103. When, now, a train is in section D—E, source B—C supplies the rails of that section with 100 cycle energy coded by contact 80 of the transmitter CT and through a circuit which may be traced from supply terminal B through front contact 7 of relay AR, conductor 100, back contact 73 of relay H, conductor 28, coding contact 80 of transmitter CT, conductor 34, back contact 23 of relay H, conductors 31 and 8, and the primary winding of transformer TT back to supply terminal C. In the manner previously explained, this 100 cycle track circuit energy of the 80 code causes the lamp 15 of cab signal CS to light and thereby indicate to the engineman that a speed of 15 miles per hour should not be exceeded.

When employing multi-frequency trackway energy in the manner represented at location E, provision is made for at all times supplying the local or exciting winding 6 of the track relay TR to the immediate rear, or at location D in the diagram of Fig. 1, with energy of the same character as is that impressed upon the track transformer TT which supplies the rails of the intervening section, or D—E in the diagram. This provision takes the form of a line conductor 155 which connects the relay winding directly with the transformer primary supply conductor 8 at location E.

Regardless now of whether the energy supplied

through transformer TT at that location to the rails of section D—E and by them to the control or track winding of relay TR at location E is of the 100 cycle variety from source B—C or of the 200 cycle variety from source B2—C2, the exciting winding 6 of that relay simultaneously receives energy of the same frequency through line conductor 105. This permits energy from either of the sources named to pick up the track relay at location D and otherwise assures the proper functioning of that relay under all possible operating conditions of the multi-frequency equipment at location E.

Further regarding the facilities for supplying energy of the second carrier wave frequency explained as appearing between terminals B2 and C2, it has already been mentioned that this energy may be generated locally at each of the track section division locations where required. When this second frequency is of the assumed value of 200 cycles per second, the apparatus of Fig. 2 may be employed with advantage for the purpose named.

In the arrangement of Fig. 2, the second frequency energy is obtained more or less directly from the 100 cycle supply source B—C, a full wave rectifier 108 being interposed between the transformer 200T and that source. When energized by this 100 cycle voltage the rectifier causes recurring pulsations of unidirectional voltage in the number of 200 per second to appear between its output terminals, with which conductors 109 and 110 are respectively connected. Each one of these pulsations is produced by each half wave of the rectifier supply potential and it, in turn, circulates through the primary winding of transformer 200T a unidirectional current which first builds up from zero to a maximum and then again decreases to zero.

In consequence, the alternating electromotive force induced in the secondary winding of that transformer has a frequency which is double that of the 100 cycle rectifier supply potential. This comes about from the fact that each build up of primary current in the transformer 200T produces a positive half cycle of secondary voltage and each decrease in primary current which follows similarly produces a negative half cycle of voltage in the secondary winding.

When the 200 cycle energy is supplied in the manner just described, the approach relay contacts 102 and 104, used by the arrangement of location E of Fig. 1, may be dispensed with and the control circuits shown in Fig. 2 for the rectifier 108 substituted therefor. These include the contact 7 of the approach relay AR and a conductor 111. As long as the track section with which the supply apparatus of Fig. 2 may be associated is vacant, the represented 200 cycle generating apparatus is unenergized. When, however, a train comes into that section, contact 7 connects the rectifier with source B—C and places transformer 200T in a condition for supplying the rails of that section with 200 cycle energy by way of relay contact 73 and conductor 28.

Energy of the second carrier wave frequency may also be generated locally by means of the tuned reed alternator shown in Fig. 3. In the arrangement of that figure transformer 200T receives primary energizing current, from a direct current source designated by the terminals "plus" and "minus," through a circuit which is periodically interrupted by a reed type vibrating member 112. Typically, this reed is of iron or other

magnetic material and one end thereof is rigidly fixed to a suitable stationary support. Moreover, the reed has a natural rate of vibration which corresponds to the desired frequency of the output voltage of transformer 200T.

Driving movement is imparted to the reed by an electromagnet 113 the energizing circuit of which is completed at point 114 each time that the reed approaches its lowermost position and thus the vibration is maintained as long as this driving circuit is supplied with energy. When in its lowermost position the reed sets up a circuit through which current flows by way of conductor 110 upwardly through the lower half of the primary winding of transformer 200T to mid tap 115; when in its uppermost position the reed completes a similar circuit through which current flows by way of conductor 109 downwardly through the upper half of the transformer primary and to the negative supply terminal, also by way of mid tap 115.

Each complete vibration of the reed thus causes a cycle of alternating current voltage to be induced in the secondary winding of the transformer and in this manner an electromotive force corresponding to that of source B2—C2 is generated whenever approach relay AR actuates its contact 102 to the upward or front closed position. Because of the greater flexibility, which permits energy of a frequency value which is not necessarily a multiple of that of source B—C to be produced, this tuned reed alternator will in many instances be found especially useful.

Comparable flexibility may, of course, also be obtained by employing a small motor generator set or other equivalent means to provide the second frequency energy now under consideration. Such means, as well as the expedients of Figs. 2 and 3, may be used to take the place of the supply source terminals B2 and C2 in each of the wayside systems of Figs. 1, 6 and 8.

Returning now to the complete system of wayside apparatus represented in Fig. 1, it will have become apparent that this equipment operates to supply the track rails selectively with train control energy derived either from source B—C (assumed to be of 100 cycle per second frequency) and coded at 180, 120 or 80 supply circuit interruptions per minute or derived from source B2—C2 (assumed to be of 200 cycle frequency) and coded at the rate of 120 circuit interruptions per minute. As has already been explained, the first frequency or 100 cycle energy causes the cab signal CS of the cooperating train carried equipment of Fig. 4 to give one or another of the four indications A, 50, 15 and 5. In order that this equipment may also respond to the second frequency or 200 cycle energy and thereby display a fifth indication, I supplement the conventional four indication portions thereof by certain additional apparatus which will now be described.

As shown in Fig. 4, this added apparatus comprises the before referred to cab signal CSa for displaying the fifth indication, an acknowledging relay P35 for that signal, a pair of selector relays FS1 and FS2 for at times transferring the control of decoding relays DR from the main cab signal CS to the added signal CSa, a master or code following relay MR2 for assisting master relay MR1 in controlling the two selector relays, and a filter Q2 for transmitting to master relay MR2 train control energy of the second carrier wave frequency only.

As represented, the added master relay MR2 is a duplicate of the first master relay MR1 which

follows the coding of 100 cycle trackway energy. Actuating current is delivered to this second relay by an associated amplifier 40a, which, like the first amplifier 40, is controlled by potential inductively picked up from the track rails 1 and 2 by the receiver windings 37. Such control potential, when of the proper character, is transmitted to the grid circuit of amplifier 40a by the filter Q2.

This second filter is represented as being of the same character as the filter shown at Q1 in association with relay MR1. It differs, however, in that its elements 42a, 43a and 44a are so proportioned as to suppress all frequencies except that of the 200 cycle or other selected second carrier wave value. In consequence, the master relay MR2 responds only to trackway energy having a carrier wave frequency of that second value.

Operation of the added master relay MR2 by 200 cycle trackway energy is the same as that of the first master relay MR1 by 100 cycle energy. During the "off" periods of the trackway code, contact 47 thereof occupies its right-hand or "energy off" position and during each "on" code period of 200 cycle trackway energy this contact is held in its left-hand or "energy on" position.

The selector or control transferring relays FS1 and FS2 are respectively associated with, and controlled by, the code following relays MR1 and MR2. Each is provided with contacts which are slow acting in the drop-out direction and quick acting in the pick-up direction. These contacts occupy their lowermost or back positions when the relay is deenergized and are moved to their uppermost or front positions when the relay is energized. The slowness of their release, moreover, is such that they remain continuously picked up when the relay is intermittently energized at the closely spaced intervals determined by the coded energy pulses which the apparatus of Fig. 1 supplies to the trackway.

Actuating current for these selector relays FS1 and FS2 is selectively transmitted to the operating windings thereof through circuits which are respectively controlled by the two master relays MR1 and MR2. In the arrangement shown, this current is supplied from the direct current source identified with the terminals "plus" and "minus". Included in the actuating circuit for relay FS1 is the contact 47 of relay MR1 and conductor 52 and in that for relay FS2 is the contact 47 of relay MR2 and a conductor 116.

Whenever the master relay MR1 shifts its contact to the left-hand position, as during each "on" period of coded 100 cycle trackway energy, selector relay FS1 thus receives actuating current through a circuit which extends from the positive supply terminal, through left biased contact 47 of relay MR1, conductor 52, and the winding of relay FS1 back to the negative supply terminal. When, and as long, however, as master relay MR1 holds its contact in the right-hand position, selector relay FS1 remains unenergized and unactuated.

Likewise, whenever master relay MR2 shifts its contact to the left-hand position, as during each "on" period of coded 200 cycle trackway energy, selector relay FS2 receives actuating current through a comparable circuit extending from the positive supply terminal, through left-biased contact 47 of relay MR2, conductors 116 and 117, and the winding of the relay FS2 back to the negative supply terminal. As long, however, as the contact of master relay MR2 occupies

its right-hand position, selector relay FS2 also remains unactuated.

Accordingly, whenever master relay MR1 is following a trackway code, the spaced pulses of energizing current supplied to the first selector relay FS1 through the circuit first traced above act to maintain the contacts of that selector relay continuously in their picked-up positions, this uninterrupted actuation being made possible by the before mentioned slow releasing characteristics of the relay. Once effected it continues as long as code following operation on the part of relay MR1 continues.

When thus picked up, contacts 48 and 49 of relay FS1 establish the earlier mentioned connection of the decoding transformer DT with the primary supply conductors 52 and 53, contact 47 of master relay MR1 then pole changes the direct current supply circuit for the primary winding of transformer DT, and the decoding relays DR now selectively pick up in accordance with whether the trackway energy which operates master relay MR1 is of the 80, 120 or 180 coding. Under such conditions, the contacts 63 and 64 of these decoding relays complete the energizing circuit for one or another of lamps A, 50, 15 and 5 of the cab signal CS.

Likewise, whenever the master relay MR2 is following a trackway code, as when the energy supplied by the apparatus of Fig. 1 has a carrier wave frequency of 200 cycles per second, the second selector relay FS2 maintains its contacts continuously picked up in response to the spaced pulses of energized current which then are received by its winding. Under these conditions, contacts 123 and 124 of relay FS2 connect the decoding transformer DT to the supply conductors 116 and 118 which are controlled by the master relay MR2, and the direct current supply circuit for the primary winding of transformer DT now is pole changed by the contact 47 of relay MR2 in a manner comparable to that previously explained in connection with relay MR1.

That is, when contact 47 of the master relay MR2 occupies its right-hand or "energy off" position, current flows downwardly through the upper half of the transformer primary by way of a circuit which extends from the positive supply terminal, through the right-biased contact 47 of relay MR2, conductor 118, front contact 123 of relay FS2, conductor 121, the upper portion of the transformer primary and the mid tap 51 to the negative supply terminal. When, however, the above referred to contact 47 is biased to its left-hand or "energy on" position, current flows upwardly through the lower half of the transformer primary by way of a circuit which may be traced from the positive supply terminal, through the left-biased contact 47, conductor 116, front contact 124 of relay FS2, conductor 122, the lower portion of the transformer primary, and the mid tap 51 back to the negative supply terminal.

From the foregoing it will be seen that when the decoding transformer DT receives pulses of primary current which are pole changed at code frequency by master relay MR2 in response to 200 cycle energy in the trackway, the action of the decoding relays DR is exactly the same as when these relays are controlled by master relay MR1 in response to 100 cycle trackway energy. In both instances the primary current pulses induce in the decoding transformer secondary an alternating current voltage having a frequency which is the same as that of the trackway code which initiated the pulses. Regardless, therefore, of

whether this secondary voltage results from coded trackway energy of the 200 cycle carrier wave frequency or of the 100 cycle frequency, it supplies actuating current to the decoding relays DR through the previously described frequency selective circuits 54 and in either instance relay DRH responds to coded energizing pulses determined by all three of the named 80, 120 and 180 trackway codes, relay DR120 responds only to pulses determined by the 120 code, and relay DR180 responds only to pulses determined by the 180 code.

If desired, the selector relays FS1 and FS2 of the train carried equipment of Fig. 4 (and of Figs. 7 and 9 also) may also be rendered selectively responsive to code following operations on the part of master relays MR1 and MR2 by use of energizing circuits of the modified form represented in Fig. 5. In the scheme of that figure, the direct current winding of each of the named selector relays is connected with the secondary winding of a transformer 242 through the medium of a rectifier 243. The primary winding of this transformer is, in turn, connected across the conductors of the pole changing circuit which the associated master relay MR controls and is also provided with a mid tap 244 joined to the negative terminal of the direct current source from which the transformer DT of the decoding apparatus is energized through the master relay contacts 47.

As long as the master relay is inactive, unvarying current flows through one of the primary halves of the transformer 242 and no energy is by it transferred to the controlled selector relay FS. Under such conditions that relay accordingly remains unactuated. In the event, however, that the master relay is following a trackway code, the transformer primary receives code frequency pulses of direct current which induce an alternating voltage of the same frequency in the secondary. Through rectifier 243, that voltage energizes the winding of the selector relay and causes it to pick up its contacts. The circuits shown being untuned, selector relay FS1 thus responds to 100 cycle trackway energy of all three of the 80, 120 and 180 codes and selector relay FS2 likewise responds to 200 cycle train control energy of all three of the named codings.

Further considering now the added cab signal CSa of Fig. 4, it is there shown as being provided with but a single lamp 35. To facilitate description it will be assumed that when lighted this lamp displays the character by which it is marked and that the resulting signal aspect is interpreted by the engineman to mean that the maximum permissible running speed is 35 miles per hour. In the illustrative arrangement represented, this signal CSa is controlled by contacts 63 and 64 of the decoding relays DR120 and DR180 through a circuit which is routed through transfer contacts 126—127 and 128—129 of the selector relays FS1 and FS2.

Current for lighting the signal lamp 35 is supplied by way of this circuit from the same direct current source as energizes the lamps of the main cab signal CS. This lamp energizing circuit is set up by the transfer contacts just referred to whenever the selector relay FS2 is picked up and relay FS1 is dropped out, as when coded 200 cycle control energy is being received from the trackway and is completed by the actuation of decoding relay DR120 and the dropping out of relay DR180, a positional combination which takes place when the received trackway energy has a carrier wave frequency of 200 cycles per second and is coded at

the rate of 120 supply circuit interruptions per minute. The circuit extends from the positive supply terminal, through back contact 63 of relay DR/80, front contact 63 of relay DR/20, conductor 72, back contact 126 of relay FS1, conductor 130, front contact 127 of relay FS2, conductor 72b, the lamp 35, conductor 76b, back contact 128 of relay FS1, conductor 131, front contact 129 of relay FS2, conductor 76a, front contact 64 of relay DR/20 and back contact 64 of relay DR/80 back to the negative supply terminal.

The energizing circuit for lamp 50 of cab signal CS, completed under conditions of 100 cycle trackway energy reception, is carried through transfer contacts 126—133 and 134—129 of the selector relays FS1 and FS2. This circuit is set up by the contacts named when relay FS1 is actuated and relay FS2 is unactuated and is completed when decoding relay DR/20 is actuated and relay DR/80 is unactuated. It may be traced from the positive supply terminal through back contact 63 of relay DR/80, front contact 63 of relay DR/20, conductor 72, front contact 126 of relay FS1, conductor 132, back contact 133 of relay FS2, conductors 72a and 74, the lamp 50, conductor 76, front contact 134 of relay FS1, conductor 135, back contact 129 of relay FS2, conductor 76a, front contact 64 of relay DR/20 and back contact 64 of relay DR/80, back to the negative supply terminal.

In the arrangement represented in Fig. 4 (and Fig. 7 also), the control circuit assigning contacts 126—127—133 and 128—129—134 of the two selector relays FS1 and FS2 are self checking, that is, each circuit carried through a front contact of one relay is also carried through a back contact of the other, and vice versa. This requires that both relays must operate in the manner intended before the circuit can be completed and constitutes a precaution which safeguards against the giving of false indications on the part of the cab signal lamps in the event of improper relay operation.

The added acknowledging relay P35 associated with the lamp of cab signal CSa is represented as being a duplicate of the slow releasing acknowledging relays P5, P15 and P50 which are associated with the lamps of the signal CS. It aids in controlling the whistle W and causes it to supplement the visual indication given by the signal CSa whenever a change involving that indication is in the more restrictive or speed reducing direction.

In the particular arrangement of acknowledging relays shown in Fig. 4, relay P35 is included between relays P15 and P50 in the actuating sequence previously described and its "pick-up" and "stick" windings 86 and 87 are energized through circuits comparable to those already described for relays P5—15—50. That is, the pick-up circuit for this added relay P35 is completed by contact 84 of relay P15 when picked up while the stick circuit therefor is completed when contact 88 of relay P35 is picked up if added cab signal lamp 35 is at that time energized over conductor 72b.

The operation of the five indication acknowledging equipment shown in Fig. 4 will now be explained. Normally, as has been pointed out, the warning whistle W remains inactive by virtue of its silencing circuit being completed through front contacts 75 and 85 of relay P50 and blade 46 of the acknowledging switch. If signal lamp A is lighted, all of the relays P5—15—35—50 are dropped out and the whistle silencing circuit (previously described as including back contacts

75 and 85 of relay P50) then is connected across the lamp energizing conductors 78 and 81. If, however, any one of the remaining lamps 50, 35, 15 and 5 is lighted, the acknowledging relay P50 is picked up and the silencing circuit then is energized from the positive and negative supply terminals shown as being connected to the front points of contacts 75 and 85.

If lamp A, assumed originally to be active (relays FS1—DRH—DR/80 picked up; FS2—DR/20 dropped out), goes out and lamp 50 is lighted (relays FS1—DRH—DR/20 picked up; FS2—DR/80 dropped out), the supply of silencing energy first referred to above is interrupted at contacts 63 and 64 of the decoding relay DR/80 and the whistle starts to operate. Depression of the acknowledging switch 45—46, preparatory to silencing the whistle, first picks up relay P5 over a circuit which extends from the positive supply terminal, through conductors 91 and 94, the switch blade 45, conductor 95, the relay winding 87 and conductor 90 back to the negative supply terminal.

Relay P5 then picks up relay P15 over a circuit which extends from the positive supply terminal, through conductors 91 and 94, front contact 84 of relay P5, conductor 96, winding 86 of relay P15 and conductor 90 back to the negative supply terminal. Relay P15, in turn, now picks up relay P35 over a circuit which extends from the positive supply terminal, through conductor 91, front contact 84 of relay P15, conductor 137, the winding 86 of relay P35 and conductor 90 back to the negative supply terminal. Finally, relay P35 picks up relay P50 over a circuit which extends from the positive supply terminal, through conductors 91 and 94, front contact 84 of relay P35, conductor 97, the winding 86 of relay P50 and conductor 90 back to the negative supply terminal.

Relay P50 locks itself in over a stick circuit which may be traced from the positive supply terminal, through back contact 63 of relay DR/80, front contact 63 of relay DR/20, conductor 72, front contact 126 of relay FS1, conductor 132, back contact 133 of relay FS2, conductors 72a and 74, front contact 88 of relay P50, conductor 98, the winding 87 of that relay and conductor 90 back to the negative supply terminal. Contacts 75 and 85 of relay P50 now connect the whistle silencing circuit directly with the associated positive and negative energizing supply terminals. This circuit is completed and the whistle silenced when blade 46 of the acknowledging switch returns to its upward or normal position. At that time blade 45 breaks the pick-up circuit for relay P5, that relay releases relay P15 by breaking its pick-up circuit at contact 84, and relay P15, in turn, releases relay P35 by interrupting its pick-up circuit.

If lamp 50 goes out and lamp 35 is lighted (relays FS2—DRH—DR/20 picked up; FS1—DR/80 dropped out), relay P50 drops out, as a result of its stick circuit having been interrupted at contacts 130 and 133 of the selector relays FS, and once more places the whistle W in operation. As the acknowledging switch 45—46 is depressed, relays P5—15—35—50 are again picked up in order. Relay P35 locks itself in over a stick circuit which extends from the positive supply terminal, through back contact 63 of relay DR/80, front contact 63 of relay DR/20, conductor 72, back contact 126 of relay FS1, conductor 130, front contact 127 of relay FS2, conductor 72b, front contact 88 of relay P35, 71

conductor 139, the winding 87 of relay P35, and conductor 90 back to the negative supply terminal. Contact 84 of relay P35 maintains relay P50 picked up and the contacts 75 and 85 of that relay now connect the whistle silencing circuit directly with its special energizing terminals. This circuit is completed and the whistle silenced when the acknowledging switch returns to its normal position. At that time relays P5 and P15 drop out.

If lamp 35 goes out and lamp 15 is lighted (relays FS1—DRH picked up; FS2—DR120—DR180 dropped out), relay P50 once more drops out, as a result of the stick circuit for relay P35 having been interrupted at contacts 126 and 127 of the selector relays and at contact 63 of relay DR120, and again places the whistle W in operation. As the acknowledging switch is depressed, relays P5—15—35—50 are once more picked up in order. Relay P15 now locks itself in by connection, through its own contact 88 and conductor 99, with the conductor 70 over which lamp 15 is energized. Its contact 84 maintains relay P35 picked up which, in turn, holds relay P50 picked up. Contacts 75 and 85 of that relay now connect the whistle silencing circuit with its energizing terminals. This circuit is completed and the whistle silenced when the acknowledging switch returns to its normal position, at which time relay P5 drops out.

Finally, if lamp 15 goes out and lamp 5 is lighted (relays FS1—FS2—DRH—DR120—DR180 dropped out), relays P15—35—50 drop out in the order named, as a result of the stick circuit for relay P15 having been broken at contact 63 of relay DRH, and the whistle is again placed in operation. As the acknowledging switch is depressed, relays P5—15—35—50 are again picked up in order. Relay P5 now locks itself in by a connection of its winding 87, through its own contact 88, with the conductor 67 over which the lamp 5 is energized, and thus holds the remaining acknowledging relays also picked up. Contacts 75 and 85 of relay P50 then cooperate with the acknowledging switch, when returned to its normal position, to discontinue action on the part of the whistle.

Changes of cab signal indication in the speed increasing or less restrictive direction do not, as has been mentioned, bring the warning whistle into action. Each indication change of this character is accompanied by the completion of the stick circuit for the next relay F above the associated one in the acknowledging sequence and all of these relays are sufficiently slow releasing as not to drop out during those short intervals of time in which the decoding relays DR and the selector relays FS shift their contacts from one position to the other in effecting indication changes. Upon the occasion of each less restrictive change, therefore, only the relays below the associated one in the acknowledging sequence are allowed to drop out while all those above it are maintained picked up until a more restrictive indication takes place.

The various component parts of the first embodiment of my improved cab signalling apparatus having been described, attention will now be directed to the manner in which this complete system of Figs. 1 and 4 operates to provide five distinctive indications aboard a locomotive or other train vehicle.

Assume first that all of the sections of the protected stretch of track represented at 1—2 in Fig. 1 are unoccupied. Under such a condi-

tion the track relay TR at each wayside signal location D, E, F, etc. is picked up, the approach relay AR at each of these locations is dropped out and the rails of each of the sections are supplied with uninterrupted 100 cycle energy. Assume next that a train propelled by a locomotive equipped with the apparatus represented in Fig. 4 proceeds through the stretch of track protected by the apparatus shown in Fig. 1.

The wheels and axles of this train shunt the track-way potential from between the rails of each occupied section and cause the track relay TR associated with that section to drop out. At the exit end of the section approach relay AR now places the code transmitter CT in operation, disconnects the track transformer TT from its steady energy supply circuit, and sets up a coding circuit therefor with B—C as the supply source. The several advance track sections being vacant, all of the traffic governing relays H, J1 and J2 at the next signal location ahead of the train are picked up, contacts 29 thereof include the coding contact 180 in the supply circuit for the associated track transformer TT, this transformer impresses 100 cycle energy of the 180 coding between the rails of the occupied section at the exit end thereof, and current of a corresponding character now circulates through the portions of those rails which are ahead of the equipment-carrying vehicle.

On this vehicle, this 100 cycle track circuit current of the 180 code induces corresponding voltages in the pick-up windings 37 of the receiver and filter Q1 passes a measure of these induced pulses of 100 cycle voltage to amplifier 40 which delivers code following energy to master relay MR1. Filter Q2, however, prevents the named voltages from reaching the amplifier 40a which is associated with the second master relay MR2. Under the control of code following relay MR1 selector relay FS1 picks up and connects decoding transformer DT to the pole changing circuit of relay MR1. Transformer DT now supplies energy which picks up decoding relays DRH and DR180 and these relays complete the lighting circuit for lamp A of cab signal CS. The resulting signal aspect indicates to the engineman that the train may proceed at unrestricted or full authorized speed. As the train comes into a section, such as that shown at D—E in Fig. 1, containing a curve or other permanent speed restriction, the trackway apparatus supplies the rails with 200 cycle energy derived from sources B2—C2 and coded at the 120 rate. This comes about when relay TR at location D drops out and picks up relay AR at location E thereby placing the associated code transmitter CT in operation, connecting transformer 200T with source B2—C2 and periodically connecting track transformer TT to transformer 200T through the coding contact 120.

On the train within section D—E, the picked up measure of this 200 cycle trackway energy of the 120 code is passed by filter Q2 to amplifier 40a, which, in turn, supplies code following energy to master relay MR2. Filter Q1 now prevents this 200 cycle potential from reaching amplifier 40 and thus prevents master relay MR1 from operating. In following the trackway code, contact 47 of relay MR2 supplies actuating energy to selector relay FS2 which picks up its contacts connecting decoding transformer DT to the supply circuit controlled by relay MR2 and transferring the control of decoding relays DR120 and DR180 from lamp 50 of cab signal CS to lamp 75

35 of added signal CSa. Transformer DT now supplies energy which picks up relays DRH and DR120, and these relays complete the lighting circuit for cab signal lamp 35, which, in turn, advises the engineman that 35 miles per hour is the maximum safe speed permissible.

As the train leaves section D—E and advances into another section, such as E—F, which contains no curves or other permanent speed restrictions, it again encounters 100 cycle trackway energy of the 180 code which causes lamp 35 of cab signal CSa to be extinguished and lamp A of signal CS again to be lighted.

Upon departure of the train from section D—E the rails thereof transmit 200 cycle energy from the transformer TT to the control winding of the track relay TR at location D, winding 6 of that relay receives energy of identical character through line conductor 105, and the relay picks up and breaks the actuating circuit for relay AR at location E. That relay now drops out, shuts down the code transmitter CT, disconnects transformer 200T from source B2—C2 and reconnects the track transformer TT directly with the 100 cycle supply source B—C. Until another train comes into the section D—E, track relay TR at location D is maintained actuated by this uninterrupted 100 cycle energy which is supplied to both windings of the relay by way of the track rails and line conductor 105 respectively.

Assume now that while proceeding through territory having no curves or other permanent speed restrictions the cab signal equipped train closes in on another train ahead which also is going along track equipped at each wayside signal location with apparatus which is a duplicate of that shown at D and F in Fig. 1.

As the train carrying the apparatus represented in Fig. 4 comes into the second track section behind that occupied by the advance train, the rails of that section receive 100 cycle energy of the 120 code. This is because traffic governing relays J1 and J2 at the exit end of that section are both dropped out due to their energizing circuits being broken by the track relay TR at the entrance of the advance occupied section. Contact 29 of relay J1 now includes coding contact 120 of transmitter CT in the primary circuit of the associated transformer TT and this circuit is connected with 100 cycle source B—C as soon as approach relay AR picks up in response to the entry of the signal carrying train into the section in question. On the train this energy causes relay MR1 to follow the code, relay FS1 to be picked up, and relays DRH and DR120 also to be actuated. Lamp 50 is accordingly lighted to indicate that the maximum safe running speed is 50 miles per hour.

As the signal equipped train comes into the first track section behind the one occupied by the advance train the rails of that section receive 100 cycle energy of the 80 code. This results from all of the traffic governing relays H, J1 and J2 at the exit end of the rear occupied block dropping out as a result of their actuating circuits being broken by the track relay TR at the entrance end of the advance occupied section. Contact 29 of relay H now includes coding contact 80 of transmitter CT in the primary winding circuit of the associated track transformer TT. This circuit is connected with source B—C when approach relay AR picks up its contacts upon the entry of the signal equipped train into the section in question. On this train the 100 cycle 80 code energy received from the trackway causes

master relay MR1 to operate, selector relay FS1 to be actuated, decoding relay DRH to be picked up and cab signal lamp 15 to be lighted, thereby indicating that the maximum safe speed is 15 miles per hour.

If now the train in the rear advances into the rear portion of the block through which the train ahead is traveling, no energy at all will be present in the portions of the rails which are immediately ahead of the rear train, due, of course, to the by-passing action of the wheels and axles of the advance train. On the signal equipped train in the rear both of the master relays MR1 and MR2 accordingly remain inactive, selector relays FS1 and FS2 are dropped out, the decoding transformer DT is deenergized and all three of the decoding relays DR likewise are dropped out. Under these conditions, the energizing circuit for lamp 5 of cab signal CS is completed and that lamp lights to indicate that the maximum safe running speed is 5 miles per hour.

The foregoing description of the operations which take place when the cab signal equipped train approaches sufficiently close to another train ahead to require that its speed be reduced to 15 or 5 miles per hour apply not only to track sections, such as E—F of Fig. 1, the equipment of which responds to advance occupancy conditions only, but also to the section D—E containing the curve or other permanent speed restriction with which the assumed limit of 35 miles per hour has been identified.

Thus when the signal carrying train is within section D—E and the next section immediately ahead, or E—F, is occupied, the track relay TR at location E is dropped out and all of the traffic governing relays H, J1 and J2 are also dropped out. Contact 29 of relay H now includes coding contact 80 of transmitter CT in the primary circuit of track transformer TT while contact 73 of the same relay connects this circuit with the 100 cycle supply source B—C. The actuation of approach relay AR which accompanies the presence of the train within the section D—E now places the transmitter in operation and thereby causes 100 cycle energy of the 80 code to be supplied to the rails of section D—E. On the train, this causes lamp 15 to light in the manner already explained. Likewise, when the rear portion of the advance train is in the exit end of section D—E and shunts the energy from transformer TT from between the rails, the rear or signal carrying train responds to the absence of this energy by causing lamp 5 to light, also in the manner previously explained.

As the manner in which the warning whistle W, the acknowledging relays P and the acknowledging switch 45—46 function under all more restrictive changes of cab signal indications has previously been explained rather fully, no further description of the operation of those portions of the improved cab signalling system disclosed in Figs. 1—4 need here be given.

Seven indication system of Figs. 6—7

The seven indication system of cab signalling disclosed in Figs. 6—7 is basically similar to the just described five indication system of Figs. 1—4. It incorporates the apparatus of, and is built around, the conventional four indication system described in the first part of this specification as operating on coded energy of a single carrier wave frequency, assumed to be 100 cycles per second and shown as being derived from source B—C. Likewise, the seven indication system now about to be described also makes use, under

certain conditions, of trackway energy of a second or additional carrier wave frequency, again assumed to be 200 cycles per second and shown as being derived from source B2—C2.

5 Whereas, however, the system of Figs. 1-4 codes this second frequency energy at but the single rate of 120 supply circuit interruptions per minute and thereby operates only one added cab signal lamp 35, the trackway portions of the system of
10 Figs. 6-7 include provision for coding the second frequency energy at any one of the three rates of 80, 120 and 180 interruptions per minute and the train carried portions of this system likewise includes three added lamps 25, 35 and 60, re-
15 spectively arranged to respond to energy of the three distinctive characters just named. As will be seen, a total of seven indications is in this manner made available.

In the illustrative arrangement of trackway
20 apparatus shown in Fig. 6, the 80 and 180 codings of the second frequency or 200 cycle energy correspond to two added speed indications, while the 120 coding of this energy is identified with a curve indication analogous to that described in
25 connection with track section D—E of Fig. 1. As represented, this curve (which again typifies permanent speed restrictions of all kinds) is within the confines of block K—L and the two added speed indications just referred to are included
30 in an extended arrangement of the illustrative form of automatic block signalling equipment which has previously been described generally and the special features of which will now be considered.

35 In Fig. 6, each of the wayside signals Sk and Sl, and so on, has a total of five semaphore arms which provide aspects of a meaning previously explained. That is, elevation of the uppermost arm signifies that the track section immediately
40 ahead of the signal location is clear; elevation of the second arm from the top indicates that there are two clear track blocks ahead; elevation of the third arm shows that three blocks ahead are clear; elevation of the fourth arm
45 shows that four blocks ahead are clear; and the elevation of the fifth or bottom arm signifies that the five blocks immediately ahead of the signal are unoccupied.

For controlling each of these signals a total
50 of five traffic governing relays H, J1, J2, J3 and J4 are provided. Each of these relays is associated with one of the signal arms, it causing that arm to be elevated when the relay is actuated and allowing the arm to occupy its downward
55 or traffic restricting position when the relay is dropped out. In the manner represented and already explained, the actuating circuits for the traffic governing relays are carried through the contacts of the associated and advance location
60 track relays TR. Thus, when the section immediately ahead of a particular location is occupied all of the traffic governing relays at that location are dropped out; when there is but one vacant section ahead relay H only is picked up;
65 when there are but two vacant sections in advance relays H and J1 are picked up; when there are but three vacant sections ahead relays H, J1 and J2 are picked up; when there are only four vacant sections ahead relays H, J1, J2 and J3
70 are energized; and finally, when five or more sections ahead of the location are unoccupied all five of the traffic governing relays are picked up.

In the case of all of the track sections of the wayside system of Fig. 6, the contacts 25 of the
75 traffic governing relays select which one of the

three coding contacts 80, 120 and 180 of the device CT is included in the train control energy supply circuit, and the contacts 73 of the same relays select which one of the two sources B—C and B2—C2 is connected in power supplying re-
5 lation with that circuit.

When all of the so equipped sections of the protected stretch of track 1—2 are unoccupied, all of the track relays TR are picked up, all of the wayside signals S signify that the five blocks
10 in advance of each signal are clear, all of the approach relays AR are dropped out and source B—C supplies steady 100 cycle energy to the rails of each section. Under these conditions the trackway supply circuit includes back contact 7
15 of the approach relay AR, conductor 8 and the associated track transformer TT. When, however, a train occupies one of these sections the track relay TR at the entrance end thereof drops out, the approach relay AR at the exit end picks
20 up, the associated code transmitter CT receives operating energy through the front contact 26 of that relay, and the transformer 200T is connected by contacts 102 and 104 to supply source B2—C2.

If four or more sections ahead of that exit end
25 location are vacant, as reflected by the there installed traffic governing relays H, J1, J2 and J3 being energized, source B—C supplies the rails of the track section in question with 100 cycle energy of the 180 code. This supply is through
30 the track transformer TT and by way of a primary energizing circuit which extends from supply terminal B through front contact 7 of relay AR, conductor 100, front contacts 73 of relays
35 J3, J2, J1 and H in series, conductor 28, coding contact 180 of transmitter CT, conductor 32, front contacts 29 of relays J2, J1 and H in series, conductors 31 and 8 and the primary of transformer TT back to supply terminal C.

If only three track sections ahead of the occu-
40 pied one under discussion are vacant, as reflected by traffic governing relay J3 being unactuated, source B2—C2 supplies the rails of that section with 200 cycle energy of the 180 code. The track transformer energizing circuit may now be traced
45 from one side of the secondary of transformer 200T through conductor 103, back contact 73 of relay J3, front contacts 73 of relays J2, J1 and H in series, conductor 28, coding contact 180, con-
50 ductor 32, front contacts 29 of relays J2, J1 and H in series, conductors 31 and 8, the primary winding of transformer TT, and conductor 106, back to the other side of the secondary of trans-
former 200T.

If only two track sections ahead of the occupied
55 one are vacant, as reflected by traffic governing relays J2 and J3 being unactuated, source B—C supplies the rails of that section with 100 cycle energy of the 120 code. The track transformer energizing circuit now extends from supply
60 terminal B through front contact 7 of relay AR, conductors 100 and 140, back contact 73 of relay J2, front contacts 73 of relays J1 and H in series, con-
ductor 28, coding contact 120 of device CT, con-
65 ductor 33, back contact 29 of relay J2, front con-
tacts 29 of relays J1 and H, conductors 31 and 8, and the primary of transformer TT back to supply terminal C.

If only one track section ahead of the occupied
70 one is vacant, as reflected by relay H only of the traffic governing group being actuated, source B2—C2 supplies the rails of that occupied section with 200 cycle energy of the 80 code. The track transformer energizing circuit may now be traced
75 from one side of the secondary of transformer

200T through conductors 103 and 141, back contact 73 of relay J1, front contact 73 of relay H, conductor 28, coding contact 80 of device CT, conductors 34 and 144, back contact 29 of relay J1, front contact 29 of relay H, conductors 31 and 8, the primary of transformer TT and conductor 106 back to the other side of the secondary of transformer 200T.

Finally, if the next section ahead of the occupied one under discussion is also occupied, as reflected by relay H being unactuated, source B—C supplies the rails thereof with 100 cycle energy of the 80 code. The track transformer energizing circuit now extends from supply terminal B through front contact 7 of relay AR, conductors 100 and 142, back contact 73 of relay H, conductor 28, coding contact 80, conductor 34, back contact 29 of relay H, conductors 31 and 8 and the primary winding of transformer TT back to supply terminal C.

In order to clarify certain description later to follow, it will here be assumed that when the next section immediately ahead of a train proceeding through the protected stretch of track represented in Fig. 6 is occupied the permissible running speed through any of the sections equipped with the wayside apparatus of that figure is 15 miles per hour; when there is but one vacant block ahead, a speed of 25 miles per hour should not be exceeded; when there are but two clear blocks ahead the maximum rate of speed should not exceed 50 miles per hour; when there are three clear blocks ahead speeds up to 60 miles per hour are permitted; and when there are four or more vacant blocks in advance, operation of the train at full authorized speed is permissible.

The equipment shown at location L in association with the curve containing track section of Fig. 6 will next be considered. Still further to simplify explanation, it will be assumed, as in the case of section D—E of Fig. 1, that 35 miles per hour is the maximum speed at which the train may safely proceed through the portion of the section K—L marked "curve". Since it is not desired that speeds above that value ever be authorized through the section, even though the track ahead may be vacant for a long distance, the equipment at location L makes no use of the high speed authorizing coding contact 180.

When a train comes into this section K—L, track relay TR at location K drops out, approach relay AR at location L picks up, code transmitter CT at the same location is placed in operation, the steady energizing circuit for the associated track transformer TT is interrupted, and transformer 200T is connected to the supply source B2—C2.

If two or more track sections in advance of K—L are vacant, traffic governing relays H and J1 at location L will be actuated. Contact 73 of relay H now connects coding circuit conductor 28 to 200 cycle supply conductor 103 and contacts 29 of these relays include coding contact 120 of device CT in the trackway supply circuit. Under these circumstances, transformer 200T supplies 20 cycle energy, contact 120 codes this energy at the rate of 120 interruptions per minute and transformer TT transmits it to the rails of section K—L. The energizing circuit for transformer TT now extends from one side of the secondary of transformer 200T, through conductor 103, front contact 73 of relay H, conductor 28, coding contact 120 of transmitter CT, conductor 33, front contacts 29 of relays J1 and H in series, conductors 31 and 8, the primary winding of transformer TT, and conductor 106 back to the

other side of the secondary of transformer 200T.

If only one track section ahead of K—L is vacant, traffic governing relay J1 at location L will be unactuated and relay H will be actuated. Contact 73 of relay H still connects coding circuit conductor 28 to 200 cycle supply conductor 103. Contacts 29, however, now include coding contact 80 in the trackway supply circuit. Under these circumstances the rails of section K—L receive 200 cycle energy of the 80 code through an energizing circuit which may be traced from one side of the secondary of transformer 200T, through conductor 103, front contact 73 of relay H, conductor 28, coding contact 80 of device CT, conductors 34 and 144, back contact 29 of relay J1, front contact 29 of relay H, conductors 31 and 8, the primary of transformer TT and conductor 106 back to the other side of the secondary of transformer 200T.

Finally, if the track section immediately ahead of K—L is occupied, all of the traffic governing relays at location L will be unactuated. Under these circumstances the rails of section K—L receive 100 cycle energy of the 80 code. The track transformer energizing circuit now extends from supply terminal B, through front contact 7 of relay AR, conductor 100, back closed contact 73 of relay H, conductor 28, coding contact 80, conductor 34, back contact 29 of relay H, conductors 31 and 8 and the primary of transformer TT back to the supply terminal C.

From the foregoing, it will be seen that the wayside equipment of Fig. 6 operates to supply the track rails selectively with train control energy derived either from source B—C and coded at 180, 120 or 80 supply circuit interruptions per minute or derived from source B2—C2 and also coded at one or another of the rates of 180, 120 and 80 circuit interruptions per minute. As in the case of the system of Figs. 1-4, the first frequency or 100 cycle energy causes the cab signal CS of the cooperating train carried equipment of Fig. 7 to give one or another of the four indications of A, 50, 15 or 5.

In order that this equipment may also respond to the second frequency or 200 cycle energy and thereby display three additional indications, I supplement the four indication portions thereof by certain added apparatus which will now be described. As shown in Fig. 7, this added apparatus comprises a cab signal CSb for displaying the three extra indications, acknowledging relays P25, P35 and P50 associated with the three lamps of that signal, a pair of selector relays FS1 and FS2 for at times transferring the control of the decoding relay from the main cab signal CS to the added signal CSb, a master or code following relay MR2, and a frequency selective filter Q2 associated therewith.

The two master or code following relays MR1 and MR2 of Fig. 7 and their associated amplifiers and filters 40 and Q1 and 40a and Q2 are duplicates of the correspondingly identified pieces of apparatus already described in connection with the equipment of Fig. 4. That is, filter Q1 passes to the amplifier 40 only those alternating current potentials from the receiver 37—38 which result from trackway energy having a carrier wave frequency of 100 cycles per second and filter Q2 similarly passes to amplifier 40a only those receiver voltages which result from trackway energy having a carrier wave frequency of 200 cycles per second.

Master relays MR1 and MR2 thus selectively follow the coding of trackway energy of the two different carrier wave frequencies named. In a

manner identical to that explained in connection with the apparatus of Fig. 4, these two code following relays selectively control the actuation of the two selector relays FS1 and FS2 of Fig. 7.

Except for the fact that these selector relays are provided with a greater number of contacts in Fig. 7, they also are duplicates of the correspondingly identified devices of Fig. 4. Their contacts are sufficiently slow acting in the drop out direction as to remain continuously picked up when the relay is intermittently energized at the closely spaced intervals determined by the coded energy pulses which the apparatus of Fig. 6 supplies to the trackway. As in the case of the equipment of Fig. 4, selector relay FS1 of Fig. 7 continuously holds its contacts in their front positions whenever master relay MR1 is following a trackway code and selector relay FS2 similarly is picked up continuously whenever master relay MR2 is following a code.

Accordingly, the decoding transformer DT receives code frequency pulses of primary energizing current pole change by relay MR1 when trackway energy of the 100 cycle carrier wave frequency is picked up by receiver windings 37 and energizing pulses pole changed by code following relay MR2 when the received energy is of the 200 cycle carrier wave frequency. In either instance, the three decoding relays DR selectively respond to the secondary voltage of transformer TT in the usual manner. That is, when the pulses are determined by the 120 code relays DRH and DR120 are actuated; when determined by the 120 code relays DRH and DR120 actuate; when determined by the 80 code relay DRH only actuates; and when the trackway energy is zero or uninterrupted all three of the decoding relays DR are unactuated.

The added cab signal shown at CS5 in Fig. 7 is provided with three lamps previously referred to and identified by the characters 25, 35 and 60. To facilitate description it will again be assumed that when lighted each of these lamps displays the character by which it is marked and that the resulting signal aspect is respectively interpreted by the engineman to mean that the maximum permissible running speed is 25, 35 or 60 miles per hour.

In the arrangement of Fig. 7 each of these added lamps is controlled by the contacts 63 and 64 of the decoding relay DR through a circuit which is routed through transfer contacts of the selector relays FS1 and FS2. In the case of lamp 35 this circuit includes contacts 126—127 and 128—129 and is identical with the circuit shown and described for lamp 35 in the apparatus of Fig. 4. In the case of lamp 60, it includes corresponding selector relay contacts 146—147 and 148—149. Similarly, the circuit for lamp 25 includes added selector relay contacts 150—151 and 152—153.

In the event that selector relay FS1 is actuated and relay FS2 is unactuated, as when 100 cycle control energy is being received from the trackway, the control of the decoding relays is assigned to the lamps of the cab signal CS. Aiding in this assignment are contacts 155, 133 and 156 of selector relay FS2 and contacts 157, 134 and 158 of relay FS1. Under these conditions lamps A, 50, 15 and 5 of signal CS have selectively completed, by the decoding relays DR, energizing circuits which will now respectively be traced.

Lamp A is lighted when decoding relays DRH and DR180 are actuated. Its circuit extends from the positive supply terminal through front contact

63 of relay DR180, conductor 73, front contact 146 of relay FS1, conductor 156, back contact 155 of relay FS2, conductor 73a, the lamp A, conductor 81, front contact 157 of relay FS1, conductor 154, back contact 149 of relay FS2, conductor 81a, and front contact 64 of relay DR180 back to the negative supply terminal.

Lamp 50 is lighted when decoding relays DRH and DR120 are actuated. Its energizing circuit may be traced from the positive supply terminal, through back contact 63 of relay DR180, front contact 63 of relay DR120, conductor 72, front contact 126 of relay FS1, conductor 132, back contact 133 of relay FS2, conductors 72a and 74, the lamp 50, conductor 76, front contact 134 of relay FS1, conductor 135, back contact 129 of relay FS2, conductor 76a, front contact 64 of relay DR120 and back contact 64 of relay DR180 back to the negative supply terminal.

Lamp 15 of signal CS is lighted when decoding relay DRH only is actuated. Its energizing circuit extends from the positive supply terminal, through back contacts 63 of relays DR180 and DR120 in series, front contact 63 of relay DRH, conductor 60, front contact 150 of relay FS1, conductor 160, back contact 156 of relay FS2, conductors 63a and 70, the lamp 15, conductor 71, front contact 159 of relay FS1, conductor 161, back contact 153 of relay FS2, conductor 71a, front contact 64 of relay DRH, and back contacts 64 of relays DR120 and DR180 in series, back to the negative supply terminal.

Lamp 5 of signal CS is lighted when all three of the decoding relays DR are unactuated. Its energizing circuit does not include any transfer contacts of the selector relays and is the same as previously traced in the earlier portion of this specification and again described in connection with the train carried apparatus of Fig. 4.

In the event that selector relay FS2 is actuated and relay FS1 is unactuated, as when 200 cycle control energy is being received from the trackway, the control of the three decoding relays DR is transferred from the lamps of signal CS to the lamps of the added signal CSb. Under these conditions, the usual selective actuation of the decoding relay completes the lighting circuit for one or another of the added signal lamps 60, 35 and 25. These circuits will now be traced.

Lamp 60 is lighted when decoding relays DRH and DR180 are actuated. Its energizing circuit extends from the positive supply terminal, through front contact 63 of relay DR180, conductor 78, back contact 146 of relay FS1, conductor 162, front contact 147 of relay FS2, conductors 78b and 163, the lamp 60, conductor 81b, back contact 148 of relay FS1, conductor 164, front contact 149 of relay FS2, conductor 81a, and front contact 64 of relay DR180 back to the negative supply terminal.

Lamp 35 is lighted when decoding relays DRH and DR120 are actuated. Its energizing circuit may be traced from the positive supply terminal, through back contact 63 of relay DR180, front contact 63 of relay DR120, conductor 72, back contact 126 of relay FS1, conductor 130, front contact 127 of relay FS2, conductor 72b, the lamp 35, conductor 76b, back contact 123 of relay FS1, conductor 131, front contact 129 of relay FS2, conductor 76a, front contact 64 of relay DR120 and back contact 64 of relay DR180 back to the negative supply terminal.

Lamp 25 of the added signal CSb is lighted when relay DRH only of the decoding group is actuated. Its energizing circuit extends from the

positive supply terminal through back contacts 63 of relay DR/80 and DR/20 in series, front contact 63 of relay DRH, conductor 69, back contact 150 of relay FS1, conductor 165, front contact 151 of relay FS2, conductor 69b, the lamp 25, conductor 71b, back contact 152 of relay FS1, conductor 166, front contact 153 of relay FS2, conductor 71a, front contact 64 of relay DRH, and back contacts 64 of relays DR/20 and DR/80 in series back to the negative supply terminal.

The added acknowledging relays P25, P35 and P60 associated with the lamps of the added cab signal CSb are represented as being duplicates of the acknowledging relays P5, P15 and P50 which are associated with the lamps of the original cab signal CS. These relays aid in causing the whistle W to supplement the visual indications given by the signals CS and CSb by an audible warning which sounds whenever a change in indication is in the more restrictive or speed reducing direction. In the particular arrangement of acknowledging relays shown in Fig. 7 the operating sequence is relay P5 followed by P15, by P25, by P35, by P50 and finally by relay P60.

The operation of the seven indication acknowledging equipment of Fig. 7 will now be explained. As in the case of the five indication apparatus of Fig. 4, the whistle W normally is maintained inactive by virtue of its silencing circuit being completed through blade 46 of the acknowledging switch and contacts 75 and 85 of relay P60. That is, when any one of the cab signal lamps 5, 15, 25, 35, 50 and 60 is lighted, relay P60 is picked up and the silencing circuit then is energized from the supply terminals which are connected to the front points of the contacts 75 and 85. When, however, the signal lamp A is lighted, the silencing circuit receives current from the lamp energizing conductors 78a and 81 by way of the conductors 79 and 77 which are connected to the back points of the relay contacts above named.

If lamp A, which will be assumed originally to be active (relays FS1—DRH—DR/80 picked up; FS2—DR/20 dropped out), is extinguished and lamp 60 is lighted (relays FS2—DRH—DR/80 picked up; FS1—DR/20 dropped out), the supply of silencing energy last referred to above is interrupted at contacts 146 and 155 of the selector relays FS1 and FS2 and the whistle W starts to blow. Depression of the acknowledging switch 45—46, preparatory to silencing the whistle, first picks up relay P5 over a circuit, including conductor 95, which has already been traced in describing the acknowledging apparatus of Fig. 4. Relay P5 then picks up relay P15 over a circuit including conductor 96, which also was previously traced in connection with Fig. 4.

Relay P15 now picks up relay P25 over a circuit which extends from the positive supply terminal, through conductor 91, front contact 84 of relay P15, conductor 137, winding 86 of relay P25, and conductors 138 and 90 back to the negative supply terminal. Relay P25 picks up relay P35 over a circuit which extends from the positive supply terminal, through conductors 91 and 94, front contact 84 of relay P25, conductor 167, the winding 86 of relay P35 and conductors 138 and 90 back to the negative supply terminal. Relay P35, in turn, picks up relay P50 over a circuit which extends from the positive supply terminal, through conductors 91 and 94, front closed contact 84 of relay P35, conductor 168, the winding 86 of relay P50 and conductors 138 and

90 back to the negative supply terminal. Finally, relay P50 picks up relay P60 over a circuit which extends from the positive supply terminal, through conductors 91 and 94, front contact 84 of relay P50, conductor 97, the winding 86 of relay P60 and conductor 90 back to the negative supply terminal.

Relay J60 now locks itself in over a stick circuit which may be traced from the positive supply terminal, through front contact 63 of relay DR/80, conductor 72, back contact 146 of relay FS1, conductor 162, front contact 147 of relay FS2, conductor 72b, front contact 88 of relay P60, conductor 98, the winding 87 of relay P60 and conductor 90 back to the negative supply terminal. Contacts 75 and 85 of relay P60 now connect the whistle silencing circuit directly with the supply terminals which are associated with their front points. When the acknowledging switch returns to its normal position, blade 46 completes this circuit and silences the whistle while blade 45 breaks the pick-up circuit for relay P5. That relay now drops out and releases relay P15 by breaking its pick-up circuit at contact 84, relay P15 similarly releases relay P25, relay P25 releases relay P35 and, finally, relay P35 releases relay P50.

If lamp 60 goes out and lamp 50 is lighted (relays FS1—DRH—DR/20 picked up; FS2—DR/80 dropped out), relay P60 drops out, as a result of its stick circuit having been broken at contacts 146—147 of selector relays FS and at contact 63 of relay DR/80, and its contacts 75 and 85 once more allow the whistle W to come into operation. As the acknowledging switch 45—46 is depressed, relays P5—15—25—35—50—60 are again picked up in order. Relay P50 now locks itself in over a stick circuit which extends from the positive supply terminal, through back contact 63 of relay DR/80, front contact 63 of relay DR/20, conductor 72, front contact 126 of relay FS1, conductor 132, back contact 133 of relay FS2, conductors 72a and 74, front contact 88 of relay P50, the winding 87 of that relay, and conductors 138 and 90 back to the negative supply terminal. Contact 84 of relay P50 maintains relay P60 picked up and the contacts 75 and 85 of that relay now connect the whistle silencing circuit directly with the supply terminals which are associated with the front points of those contacts. As the acknowledging switch returns to its normal position, blade 46 completes this circuit, thereby silencing the whistle, while blade 45 allows relays P5—15—25—35 to drop out in the order named.

If lamp 50 goes out and lamp 35 is lighted (relays FS2—DRH—DR/20 picked up; FS1—DR/80 dropped out), relays P50 and P60 drop out, as a result of the stick circuit for relay P50 having been interrupted at contacts 126 and 133 of the selector relays, and contacts 75 60 and 85 of relay P60 again place the whistle in operation. As the acknowledging switch is depressed, relays P5—15—25—35—50—60 are once more picked up in order. Relay P35 now locks itself in over a stick circuit which extends from the positive supply terminal through back contact 63 of relay DR/80, front contact 63 of relay DR/20, conductor 72, back contact 126 of relay FS1, conductor 130, front contact 127 of relay FS2, conductors 72b and 143, front contact 88 of relay P35, conductor 169, the winding 87 of relay P35 and conductors 138 and 90 back to the negative supply terminal. Contact 84 of relay P35 maintains relay P50 picked up which, in turn, holds relay P60 picked up. Contacts 75 75

and 85 of that relay now connect the whistle silencing circuit with its above referred to energizing terminals. As the acknowledging switch returns to its normal position, it completes this circuit, thereby silencing the whistle, and also allows relays P5—15—25 to drop out.

If lamp 35 goes out and lamp 25 is lighted (relays FS2—DRH picked up; FS1—DR120—DR180 dropped out), relays P35—50—60 drop out, as a result of the stick circuit for relay P35 having been interrupted at contact 63 of relay DR120, and contacts 75 and 85 of relay P60 once more place the whistle in operation. As the acknowledging switch 45—46 is depressed, relays P5—15—25—35—50—60 are again picked up in order. Relay P25 now locks itself in over a stick circuit which extends from the positive supply terminal through back contacts 63 of relays DR180 and DR120 in series, front contact 63 of relay DRH, conductor 69, back contact 150 of relay FS1, conductor 165, front contact 151 of relay FS2, conductors 69b and 145, front contact 88 of relay P25, conductor 170, the winding 87 of relay P25 and conductors 138 and 90 back to the negative supply terminal. Through contact 84, relay P25 maintains relays P35—50—60 picked up and through contacts 75 and 85 relay P60 connects the whistle silencing circuit with its energizing terminals. As the acknowledging switch returns to its normal position, it completes this circuit thereby silencing the whistle W, and it also allows relays P5 and P15 to drop out.

If lamp 25 goes out and lamp 15 is lighted (relays FS1—DRH picked up; FS2—DR120—DR180 dropped out), relays P25—35—50—60 drop out, as a result of the stick circuit for relay P25 having been interrupted at contacts 150 and 151 of the selector relays FS, and relay P60 again places the whistle W in operation. As the acknowledging switch is depressed, relays P5—15—25—35—50—60 are once more picked up in order. Relay P15 now locks itself in over a stick circuit which extends from the positive supply terminal, through back contacts 63 of relays DR180 and DR120 in series, front contact 63 of relay DRH, conductor 69, front contact 150 of relay FS1, conductor 160, back contact 156 of relay FS2, conductors 69a and 70, front contact 88 of relay P15, conductor 99, the winding 87 of relay P15 and conductor 90 back to the negative supply terminal. Through its contact 84, relay P15 maintains relays P25—35—50—60 picked up and relay P60 again connects the whistle silencing circuit with its special energizing terminals. As the acknowledging switch returns to its normal position, it completes this circuit, thereby silencing the whistle, and it also allows relay P5 to drop out.

If lamp 15 goes out and lamp 5 is lighted (relays FS1—FS2—DRH—DR120—DR180 all dropped out), relays P15—25—35—50—60 drop out in the order named, as a result of the stick circuit for relay P15 having been broken at contact 63 of relay DRH, and the whistle W is again placed in operation. As the acknowledging switch 45—46 is depressed, relays P5—15—25—35—50—60 are again picked up in order. Relay P5 now locks itself in by a connection of its winding 87, through its own contact 88, with the conductor 67 over which the lamp 5 is energized, and thus holds the remaining acknowledging relays also picked up. Contacts 75 and 85 of relay P60 cooperate with the acknowledging switch, when re-

turned to its normal position, to discontinue action on the part of the whistle W.

For the same reasons as were pointed out in connection with the acknowledging apparatus of Fig. 4, changes in cab signal indications in the speed increasing or less restrictive direction do not, in the system of Fig. 7, bring the warning whistle W into action. To illustrate, suppose that lamp 5 is extinguished and lamp 15 is lighted. Reference to the diagram of Fig. 7 will show that the same shift of control relay contacts which interrupts the stick circuit for acknowledging relay P5 also completes the stick circuit for acknowledging relay P15. This occurs before slow release relay P15 has time to drop its contacts and in consequence relays P15—25—35—50—60 are maintained actuated, the whistle silencing circuit remains intact, and only relay P5 drops out.

Likewise when the indication changes from 20 lamp 15 to lamp 25 the stick circuit for relay P25 is completed and only relay P15 drops out; when the indication changes from lamp 25 to lamp 35 the stick circuit for relay P35 is completed and only relay P25 drops out; when the change is from lamp 35 to lamp 50 the stick circuit P50 is completed and only relay P35 drops out; when the change is from lamp 50 to lamp 60 the stick circuit for relay P60 is completed and only lamp P50 drops out. Finally, when the change is from lamp 60 to lamp A, the stick circuit for relay P60 is interrupted and that relay drops out. The whistle W does not blow, however, as under this condition the contacts 75 and 85 of relay P60 connect the silencing circuit to the now positively and negatively energized conductors 79 and 77.

Both the trackway and the train carried equipments of the improved seven indication cab signalling system of Figs. 6-7 having been described, consideration will now be given to the manner in which that complete system operates.

First let it be assumed that all of the sections of the protected stretch of track 1—2 represented in Fig. 6 are unoccupied. Under this condition, as in the case of the previously described system of Figs. 1-4, the track relay TR at each of the several signal locations K, L, etc., is maintained picked up by steady energy received from the location ahead, the approach relay AR at each of these locations is dropped out and the rails of the track section immediately behind each of these locations are supplied, from source B—C, with uninterrupted 100 cycle energy through a circuit which includes back closed contact 7 of relay AR, conductor 8 and the track transformer TT.

As a train proceeds through this otherwise unoccupied protected stretch of track, the shunting action of its wheels and axles initiates the following operations on the part of the equipment associated with each of the sections occupied: The track relay TR at the entrance end drops out. The approach relay AR at the exit end picks up, the associated code transmitter CT is placed in operation, the supply of steady energy to the associated track transformer TT is discontinued, the traffic governing relays H, J1, J2 and J3 at the exit end of this occupied section are all picked up, the 186 coding contact of device CT is included in the trackway supply circuit and this circuit is connected to receive 100 cycle energy from source B—C.

On the train equipped with the cab signalling equipment represented in Fig. 7 the following operations take place: From the trackway the

receiver windings 37 pick up this 100 cycle energy of the 180 code, filter Q2 prevents master relay MR2 from being influenced thereby, while filter Q1 passes a measure thereof to amplifier 40 which, in turn, causes master relay MR1 to follow the 180 trackway code. Selector relay FS1 picks up and connects the decoding transformer DT to the pole changing circuit which relay MR1 operates and aids dropped-out relay FS2 in assigning the control of the decoding relays DR to the cab signal CS. Transformer DT now causes decoding relays DRH and DR180 to pick up and thereby completes the lighting circuit for lamp A. This produces a signal indication authorizing full or unrestricted speed and signifying that at least four track sections ahead of the train are vacant.

Assume now that the train equipped with the cab signalling apparatus of Fig. 7 enters the section K—L of Fig. 6 which contains the curve or other permanent speed restriction of 35 miles per hour. This causes the trackway apparatus at location L to supply the rails of that section with 200 cycle energy of the 120 code. Incident to this supply are the following actions: Track relay TR at location K drops out, approach relay AR at location L picks up, the associated code transmitter CT is placed in operation, transformer 200T is connected to supply source B2—C2, all of the traffic governing relays H, J1, J2 and J3 remain picked up, the associated track transformer TT is connected with transformer 200T through the coding contact 120 of device CT, and the track rails are supplied with energy of the character above named.

On the train the picked up measure of this 200 cycle 120 code energy is prevented from influencing master relay MR1 by filter Q1 and is passed by filter Q2 to amplifier 40a by means of which it causes master relay MR2 to follow the trackway code. In consequence, selector relay FS2 picks up, thus assigning the control of the decoding relays to added cab signal CSb and connecting the decoding transformer DT to the primary supply circuit of which the contact 47 of relay MR2 forms a part. The decoding transformer now passes energy which causes decoding relays DRH and DR120 to pick up and thereby completes the lighting circuit for signal lamp 35. The resulting aspect signifies that 35 miles per hour is the maximum safe speed.

As the train leaves the curve containing section K—L of Fig. 6 and goes into protected territory having no permanent speed restriction, it is again subjected to control energy in the running rails of the 100 cycle 180 code variety. Cab signal lamp 35 accordingly goes out and lamp A is again lighted to indicate that at least four track sections ahead are unoccupied.

Assume now that the signal equipped train closes in on another train ahead. As long as the following train is spaced from the advance one by five or more blocks it is subjected to control energy in the running rails of the 100 cycle 180 code variety and lamp A of its cab signalling apparatus continues to remain lighted.

When, however, it comes into the fourth block behind that occupied by the advance train it is subjected to control energy in the running rails of the 200 cycle 180 code variety and cab signal lamp 60 accordingly lights to signify that the maximum safe running speed is 60 miles per hour. This lighting is caused by master relay MR2 following the trackway code, selector relay FS2 being actuated, decoding transformer DT

supplying energy which actuates decoding relays DRH and DR180, the lighting circuit for lamp 60 being set up by the contacts of the two selector relays and this circuit being completed by the contacts of the decoding relays. The named control energy of the 200 cycle 180 code is supplied to the rails of the section occupied by the rear train as a result of the track transformer TT at the exit end thereof being periodically connected (through contacts 29 of actuated relays H, J1 and J2, coding contact 180 of transmitter CT, and contacts 73 of actuated relays H, J1 and J2 and unactuated relay J3) with the secondary of transformer 200T which now is connected with 200 cycle source B2—C2.

As the signal equipped train comes into the third block behind that occupied by the first train it comes under the control of 100 cycle energy of the 120 code in the trackway and cab signal lamp 50 is thereby caused to light. On the train this results from code following operation by master relay MR1, actuation of selector relay FS1, transmission by decoding transformer DT of energy which picks up relays DRH and DR120, assignment by the two selector relays FS of the decoding relay control to cab signal CS, and completion by the contacts of the decoding relays DR of the energizing circuit for lamp 50. The named train control energy is supplied to the rails of the block occupied by the rear train as a result of the track transformer TT at the exit end thereof being periodically connected with the 100 cycle supply source B—C through contacts 29 of actuated relays H and J1 and unactuated relay J2, the coding contact 120 and contacts 73 of actuated relays H and J1 and unactuated relay J2.

As the signal equipped train comes into the second block behind that occupied by the first train, it receives from the running rails control energy of the 200 cycle 80 code variety, which energy causes lamp 25 to light and signify that the maximum running speed is now 25 miles per hour. This lighting results from code following operation by relay MR2, actuation of selector relay FS2, the setting up by the two selector relays of the circuits for the lamps of cab signal CSb, transmission by decoding transformer DT of energy which actuates decoding relay DRH and completion by the decoding relay contacts of the lighting circuit for lamp 25. The named train control energy is supplied to the rails of the section occupied by the rear train as a result of the track transformer TT at the exit and thereof being periodically connected (through contacts 29 of actuated relay H and unactuated relay J1, coding contact 80 of device CT and contacts 73 of actuated relay H and unactuated relay J1) with transformer 200T which receives 200 cycle energy from source B2—C2.

When in the first section behind that occupied by the advance train, the signal equipped or following train receives control energy of the 100 cycle 80 code from the trackway. This causes cab signal lamp 15 to light as a result of code following operation on the part of master relay MR1, actuation of selector relay FS1, a setting up by the contacts of the two selector relays of the circuits for the lamps of signal CS, transmission by decoding transformer DT of energy which actuates decoding relay DRH, and completion by the decoding relay contacts of the energizing circuit for lamp 15. At the exit end of the section occupied by the rear train the named train control energy is supplied to the rails as a result

of transformer TT being periodically connected with the 100 cycle supply source B—C through contact 29 of unactuated relay H, coding contact 30 of device CT and back closed contact 73 of relay H.

As the signal equipped train enters the rear portion of the particular block already occupied by the advance train no energy is received from the running rails and lamp 5 lights, signifying that the permissible running speed is exceedingly low. This lighting results from inactivity on the part of both of the master relays MR¹ and MR², no transmission of energy by decoding transformer DT and all three of the decoding relays DR occupying their unactuated positions in which the energizing circuit for lamp 5 is completed.

If while the signal equipped train is within the curve containing section K—L of Fig. 6 the advance traffic conditions are such that the train speed should be limited to some value less than the 35 mile per hour rate assumed for the curve, the contacts 29 and 73 of the signal control relays H and J¹ at location L make appropriate selections in the character of train control energy supplied to the rails of the section through transformer TT. Thus, if there is only one clear block ahead, relay J¹ will be dropped out and will connect the track transformer to the 200 cycle supply conductor 103 through coding contact 80. On the train this causes cab signal lamp 25 to light in the manner already explained. Likewise, if the next track section ahead of K—L is occupied, relay H will also be dropped out and will connect the track transformer TT with the 100 cycle supply conductor 100 through coding contact 80. On the train, lamp 15 now lights.

During the various changes of cab signal indications just described the six acknowledging relays P of the train carried equipment of Fig. 7 operate in the manner already explained in connection with the description of that apparatus. Their effect, of course, is to allow the warning whistle W to operate upon each indication change in the more restrictive or speed reducing direction and to prevent whistle operation upon the occasion of all changes which are in the less restrictive or speed increasing direction.

Ten indication system of Figs. 8-9

In its basic arrangement and mode of operation the ten indication cab signalling system disclosed in Figs. 8-9 is similar to the five and seven indication systems of Figs. 1-4 and 6-7. Like them, it incorporates the apparatus of, and is built around, the conventional four indication equipment described in the first part of this specification. Like them, also, it selectively employs coded train control energy of two different carrier wave frequencies (supplied from sources B—C and B²—C² and again assumed to be 100 and 200 cycles per second) respectively to control a four indication cab signal unit CS and an added cab signal unit CS^b providing three indications.

In addition to this equipment, the system of Figs. 3-9 includes still further provision for controlling a third cab signal unit CSc. As represented in Fig. 9 this third unit is equipped with three lamps X, Y and Z which when lighted respectively display distinctive aspects differing from those provided by units CS and CS^b. As will be seen, these three new indications made available by signal unit CSc increase from seven

to ten the total number of indications which may be displayed within the vehicle cab.

For controlling the lamps of cab signal CSc use is made of trackway energy having three distinctive characters each of which may be distinguished by the train carried equipment from the coded trackway energy of the 100 cycle and of the 200 cycle carrier wave frequencies. These three supplemental characters of train control energy are provided by compounding the already available 100 and 200 cycle electromotive forces from sources B—C and B²—C² and then employing the already available coding devices CT to modulate this compounded energy at one or another of the usual three rates of 80, 120 and 180 supply circuit interruptions per minute.

In the wayside apparatus shown in Fig. 8, the named compounding is effected by supplying the running rails with energy from source B—C (100 cycle) during what corresponds to each "off" period of the conventional trackway code and with energy from source B²—C² (200 cycle) during what corresponds to each "on" period of such a code. As in the trackway or wayside apparatus of the first two embodiments of my invention, the contacts 29 and 73 of the traffic governing relays H, J¹, J², etc. cooperate in selecting which one of the three coding contacts 80, 120 and 180 of the device CT is included in the circuit through which this compound energy is supplied to the trackway.

For assisting in this selection and determining when the compound energy instead of straight 100 or 200 cycle energy is to be utilized, use is made of three special indication initiating relays XC, YC and ZC. In the arrangement represented, these relays are identified with the lamps X, Y and Z of the third cab signal unit CSc of Fig. 9 and when selectively actuated these relays respectively condition the trackway apparatus of Fig. 8 to supply the running rails with compound 100—200 cycle energy coded at the rate of 180, 120 and 80 supply circuit interruptions per minute.

As represented, each of the relays XC, YC and ZC is provided with an actuating winding of the usual character and with five contacts 173 to 177. As long as the winding is unenergized these contacts occupy their lowermost or back positions. When, however, actuating current is supplied to the winding the contacts are moved upwardly to their actuated or front positions and there held until the supply of energizing current is cut off.

Control of these relays may, of course, be effected in any manner desired, as through the medium of circuits shown as respectively including line conductors 196, 197 and 198 and switches or other circuit completing devices 201, 202 and 203. Depending upon the character of the information which it is desired that the signal lamps X, Y and Z aboard the train transmit to the engineman these devices may take the form of switches operated by train order or other wayside signals, manually operable control buttons or the like.

In the particular arrangement represented in Fig. 8 they are identified with train order giving means of typical well-known type, the details of which are not pertinent to a disclosure of the present invention. For present purposes it will be sufficient to state that the orders with which the transmission initiating relays XC, YC and ZC are identified bear such a relation to the represented and previously described automatic block signalling apparatus associated with track

1—2 that the control line conductors 21 and 22 therefor extending back from wayside signal location M to the contacts 11 and 12 of the track relay TR at the next location to the rear are routed through the contacts 173 and 174 of these relays.

Thus, in the case of line conductor 21 the connection of track relay contact 19 thereto is effected through a conductor 205, contact 173 of relay XC, conductor 206, contact 173 of relay YC, conductor 207, contact 173 of relay ZC and a conductor 208. Likewise, in the case of line conductor 22, the connection of track relay contact 11 thereto is effected through a conductor 209, contact 174 of relay XC, conductor 210, contact 174 of relay YC, conductor 211, contact 174 of relay ZC, and conductor 212.

As long as all three of the relays under discussion remain unactuated, the connections above traced are maintained intact and the traffic governing relays at the first location to the rear of track section M—N are controlled in the normal automatic block system manner already described. When, however, any one of these three relays actuates in response to an operation of the device 201, 202 or 203, and for the purpose of lighting one of the cab signal lamps X, Y or Z, both of the line conductor connections are interrupted. In such event, relay J1 at location M will drop its contacts to their back positions as will also relays H and J1 at the next signal location to the rear.

The manner in which the wayside equipment shown at location M in Fig. 8 operates to supply the rails of the track section to the immediate rear of location M with coded train control energy of the 100 cycle, the 200 cycle and the composite 100—200 cycle variety will now be described. Considering first the circuits through which energy of the 100 cycle carrier wave frequency is transmitted from source B—C to the running rails for the purpose of controlling the lamps of cab signal CS, these circuits are rendered effective when all three of the special control relays XC, YC and ZC are unactuated and when approach relay AR is actuated in response to the presence of the train in section L—M.

The 180 coding of this 100 cycle energy is selected when all of the traffic governing relays H, J1, J2 and J3 are actuated. Under this condition, the primary energizing circuit for the track transformer TT extends from supply terminal B through front contact 7 of relay AR, conductor 100, the front contacts 73 of relays J2, J1 and H in series, conductors 28 and 171, coding contact 180 (in its back position) of device CT, conductors 182 and 32, front contacts 29 of relays J1 and H in series, conductor 31, back contact 175 of relay XC, conductor 184, back contact 175 of relay YC, conductor 186, back contact 175 of relay ZC, conductors 187 and 8 and the primary of track transformer TT back to supply terminal C. This circuit is completed each time that the coding contact 180 is in its downward or back position.

The 100 cycle train control energy of the 120 code is supplied to the trackway when relays AR and H are actuated and relays J1, XC, YC and ZC are unactuated. Under these conditions the primary energizing circuit for the track transformer TT may be traced from the supply terminal B, through front contact 7 of relay AR, conductor 100, back contact 73 of relay J1, front contact 73 of relay H, conductor 28, coding

contact 120 (in its back position) of device CT, conductors 185 and 33, back contact 29 of relay J1, front contact 29 of relay H, conductor 31, back contact 175 of relay XC, conductor 184, back contact 175 of relay YC, conductor 186, back contact 175 of relay ZC, conductors 187 and 8 and the primary winding of transformer TT back to supply terminal C. This circuit likewise is completed each time that the coding contact 120 is in its downward or back position.

The 100 cycle train control energy of the 80 code is supplied to the trackway when relay AR is actuated and relays H, J1, XC, YC and ZC are unactuated. Under this condition, the primary energizing circuit for the transformer TT extends from supply terminal B, through front contact 7 of relay AR, conductor 100, back contact 73 of relay H, conductors 28 and 171, coding contact 80 (when in its back position) of device CT, conductors 181 and 34, back contact 29 of relay H, conductor 31, back contact 175 of relay XC, conductor 184, back contact 175 of relay YC, conductor 186, back contact 175 of relay ZC, conductors 187 and 8 and the primary of transformer TT back to supply terminal C. As in the case of the two circuits previously described, the circuit just traced is completed each time that the coding contact 80 is in its downward or back position.

The 100 cycle trackway supply circuits having been described, consideration will now be given to the circuits through which energy of the 200 cycle carrier wave frequency is transmitted from source B2—C2 to the running rails for the purpose of controlling cab signal CSb. These also are rendered effective when all three of the special control relays XC, YC and ZC are unactuated and when the approach relay AR is actuated in response to the presence of a train in section L—M.

The 200 cycle train control energy of the 180 code is supplied to the trackway when relays AR, H and J1 are actuated and relays J2, XC, YC and ZC are unactuated, as already mentioned. Contacts 102 and 104 of relay AR now connect transformer 200T with the supply source B2—C2. Under the condition just stated, the primary energizing circuit for the track transformer TT extends from one side of the secondary winding of transformer 200T, through conductor 103, back closed contact 73 of relay J2, front contacts 73 of relays J1 and H in series, conductors 28 and 171, coding contact 180 (in its back position) of device CT, conductors 182 and 32, front contacts 29 of relays J1 and H in series, conductor 31, back contact 175 of relay XC, conductor 184, back contact 175 of relay YC, conductor 186, back contact 175 of relay ZC, conductors 187 and 8, the primary winding of transformer TT, and conductor 106 back to the other side of the secondary of transformer 200T. This circuit is completed each time that the coding contact 180 is in its downward or back position.

The particular equipment represented at location M of Fig. 8 does not include provision for supplying the trackway with 200 cycle energy of either the 120 or the 80 code. In cases where such supply may be desirable, the apparatus of Fig. 8 may readily be modified to include the arrangement disclosed at locations K and L of the wayside equipment of Fig. 6 in order to supply the coding circuit conductor 28 with the 200 cycle energy from transformer 200T under conditions when the coding contacts 120 and 80 are included

in the trackway supply circuit. In that event, operation of the 200 cycle supply circuits during conditions of 120 and 80 coding will be identical with those already explained in the case of the 120 and 80 codings of 100 cycle energy with the single exception that the energy supply will be from 200 cycle source B2—C2 instead of from source B—C.

Consideration will now be given to the circuits through which energy of the composite 100—200 cycle carrier wave frequency is transmitted from sources B—C and B2—C2 to the running rails for the purpose of controlling cab signal CSc. These circuits are set up by the actuation of one or another of the special control relays XC, YC and ZC and are rendered effective when approach relay AR is actuated in response to the presence of a train in section L—M. The action last named interrupts the steady energizing circuit for transformer TT and connects transformer 200T with the 200 cycle supply source B2—C2.

Composite 100—200 cycle energy of the 180 code is supplied to the trackway when relays AR, H, J1 and J2 are actuated and when special control relay XC is actuated and relays YC and ZC are unactuated. Under these conditions, coding contact 180 of device CT alternately completes two circuits through which the primary winding of track transformer TT receives energy. The first of these circuits connects the winding with the 100 cycle source B—C each time that the coding contact is in its back position, while the second of these circuits connects the transformer primary with the secondary of the 200 cycle transmitting transformer 200T each time that the coding contact 180 occupies its front position.

The referred to 100 cycle supply circuit may be traced from supply terminal B, through front contact 7 of relay AR, conductor 100, front contacts 73 of relays J2, J1 and H in series, conductors 28 and 171, coding contact 180 (in its down position) of device CT, conductor 182, front contact 177 of relay XC, conductors 183 and 8 and the primary winding of transformer TT, back to supply terminal C. The referred to 200 cycle supply circuit extends from one side of the secondary of transformer 200T, through conductor 188, front contact 176 of relay XC, conductor 189, coding contact 180 (in its front position) of device CT, conductor 182, front contact 177 of relay XC, conductors 183 and 8, the primary winding of transformer TT and conductor 106 back to the other side of the secondary of transformer 200T.

Composite 100—200 cycle train control energy of the 120 code is supplied to the trackway when relays AR and H are actuated, relay J1 is unactuated, special control relay YC is actuated, and relays XC and ZC are unactuated. As in the preceding instance, two separate energizing circuits for the primary of track transformer TT are now set up, which circuits are alternately completed by the coding contact 120 of device CT, the 100 cycle circuit when the contact is in its back position and the 200 cycle circuit when the coding contact is in its front position.

The referred to 100 cycle supply circuit may be traced from supply terminal B, through front contact 7 of relay AR, conductor 100, back closed contact 73 of relay J1, front contact 73 of relay H, conductor 28, coding contact 120 (in its back position) of device CT, conductors 185 and 33, front contact 177 of relay YC, conductors 192

and 8, and the primary of transformer TT back to supply terminal C. The referred to 200 cycle supply circuit extends from one side of the secondary of transformer 200T, through conductors 188 and 190, front contact 176 of relay YC, conductor 191, coding contact 120 (in its front position) of device CT, conductors 185 and 33, front contact 177 of relay YC, conductors 192 and 8, the primary of transformer TT, and conductor 106 back to the other side of the secondary winding of transformer 200T.

Composite 100—200 cycle train control energy of the 80 code is supplied to the trackway when special control relay ZC is actuated and when relays XC, YC, H and J1 are unactuated and relay AR is actuated. Again two separate circuits are set up which are alternately completed by the coding contact 80 of device CT. The 100 cycle circuit may be traced from supply terminal B, through front contact 7 of relay AR, conductor 100, back contact 73 of relay H, conductors 28 and 171, coding contact 80 (in its back position) of device CT, conductor 181, front contact 177 of relay ZC, conductors 193 and 8, and the primary winding of transformer TT back to the supply terminal C. The 200 cycle supply circuit extends from one side of the secondary of transformer 200T, through conductors 188 and 194, front contact 176 of relay ZC, conductor 195, coding contact 80 (in its front position) of device CT, conductor 181, front contact 177 of relay ZC, conductors 193 and 8, the primary winding of transformer TT, and conductor 106 back to the other side of transformer 200T.

The trackway portions of the ten indication cab signalling system of Figs. 8-9 having been described, attention will now be directed to the cooperating train carried apparatus represented in Fig. 9. Basically, this equipment is similar to that shown in, and described in connection with, Fig. 7. It differs therefrom, however, in including the previously referred to third signal unit CSc and in being modified to respond to energy not only of the 100 cycle and 200 cycle coded trackway energy when received individually but also to the composite 100—200 cycle train control energy which the equipment of Fig. 8 at times supplies to the running rails.

As in the previously explained embodiments of my invention, the train carried equipment of Fig. 9 utilizes two master relays MR1 and MR2 arranged to respond selectively to coded trackway energy of the 100 cycle and the 200 cycle carrier wave frequencies, a pair of cooperating selector relays FS1 and FS2 arranged to actuate selectively in response to code following operations on the part of relays MR1 and MR2 to connect the decoding transformer DT with the supply circuit pole changed by the active master relay, and the conventional decoding relays DR which are selectively responsive to the code frequency actuating currents transmitted thereto by transformer DT. Whereas, however, the transfer contacts of the selector relays FS utilized in the first two embodiments of my invention assigned the control of the decoding relay contacts 63 and 64 from one to the other of two cab signal units CS and CSb (CSa in Fig. 4) the extended arrangement of Fig. 9 is set up in a manner that the decoding relay control is at times additionally assigned to the third cab signal unit CSc.

That is, when the received trackway energy is of the 100 cycle carrier wave frequency, the decoding relay control is assigned to signal unit

CS; when of the 200 cycle frequency the control is assigned to signal unit CSb; and when the train control energy received from the trackway is of the composite 100—200 cycle variety the decoding relay contacts are included in energizing circuits for the lamps X, Y and Z of the third signal unit CSb. In the particular scheme represented, the acknowledging circuits, including relays P and switch 45—46, are not similarly extended to include the lamps of the third signal unit CSc in the conventional acknowledging set up.

The nature of the three way assigned control circuits represented in Fig. 9 may best be explained by tracing: first the circuits through which the lamps of cab signal CS receive energy when coded pulses of 100 cycle carrier wave frequency energy are picked up from the trackway; then the circuits through which the lamps of signal unit CSb are supplied with lighting current when the carrier wave frequency of the received trackway energy is 200 cycles per second; and finally the circuits through which the lamps of the third cab signal unit CSc are supplied with lighting current when the coded train control energy received from the running rails is of the compound 100—200 cycle variety supplied by wayside apparatus of the character represented in the previously described Fig. 8.

The manner in which signal CS is controlled by 100 cycle trackway energy will first be considered. When this energy is coded at the rate of 180 supply circuit interruptions per minute, lamp A of signal CS is lighted. This results from master relay MR1 following the trackway code, selector relay FS1 being actuated and relay FS2 being unactuated, and decoding relays DRH and DR180 being actuated and relay DR120 being unactuated. The lamp energizing circuit which is completed under these conditions may be traced from the positive supply terminal through front contact 63 of relay DR180, conductor 78, front contact 146 of relay FS1, conductor 158, back contact 155 of relay FS2, conductor 78a, the lamp A, conductors 214 and 81, and front contact 64 of relay DR180 back to the negative supply terminal.

Lamp 50 of signal CS is lighted when the 100 cycle trackway energy is coded at the 120 rate. Under this condition, master relay MR1 follows the code, selector relay FS1 is actuated and relay FS2 is unactuated, decoding relays DRH and DR120 are actuated, and relay DR180 is unactuated. The lamp lighting circuit now extends from the positive supply terminal through back contact 63 of relay DR180, front contact 63 of relay DR120, conductor 72, front contact 126 of relay FS1, conductor 132, back contact 133 of relay FS2, conductors 72a and 74, the lamp 50, conductors 220 and 76, front contact 64 of relay DR120, and back contact 64 of relay DR180 back to the negative supply terminal.

Lamp 15 of signal unit CS is lighted when the 100 cycle trackway energy is coded at the 80 rate. Under this condition, master relay MR1 follows the code, selector relay FS1 is actuated and relay FS2 is unactuated, decoding relay DRH is actuated and relays DR120 and DR180 are unactuated. The lamp circuit now completed may be traced from the positive supply terminal, through back contacts 63 of relays DR180 and DR120, front contact 63 of relay DRH, conductor 69, front contact 150 of relay FS1, conductor 160, back contact 156 of relay FS2, conductors 69a and 70, the lamp 15, conductors 221 and 71, front contact 64 of relay DRH, and back contacts 64

of relays DR120 and DR180 back to the negative supply terminal.

The manner in which the lamps of the second cab signal unit CSb are controlled by the coded trackway energy of the 200 cycle carrier wave frequency will next be considered. When this energy is of the 180 coding, lamp 60 of signal CS is lighted. Under the condition stated, master relay MR2 follows the trackway code, selector relay FS2 is actuated and relay FS1 is unactuated, decoding relays DRH and DR180 are actuated, and relay DR120 is unactuated. The now completed lamp circuit extends from the positive supply terminal, through front contact 63 of relay DR180, conductor 78, back contact 146 of relay FS1, conductor 162, front contact 147 of relay FS2, conductors 78b and 163, the lamp 60, conductors 214 and 81, and front contact 64 of relay DR180 back to the negative supply terminal.

Lamp 35 of signal CSb is lighted when the 200 cycle trackway energy is coded at the 120 rate. Under this condition master relay MR2 follows the code, selector relay FS2 is actuated and relay FS1 is unactuated, decoding relays DRH and DR120 are actuated, and relay DR180 is unactuated. The now completed lamp circuit may be traced from the positive supply terminal, through back contact 63 of relay DR180, front contact 63 of relay DR120, conductor 72, back contact 126 of relay FS1, conductor 130, front contact 127 of relay FS2, conductor 72b, the lamp 35, conductors 226, 220 and 76, front contact 64 of relay DR120, and back contact 64 of relay DR180 back to the negative supply terminal.

Lamp 25 of signal CSb is lighted when the 200 cycle trackway energy is coded at the rate of 80 supply circuit interruptions per minute. Under this condition, the master relay MR2 follows the code, selector relay FS2 is actuated and relay FS1 is unactuated, decoding relay DRH is actuated, and relays DR120 and DR180 are unactuated. The now completed lamp circuit extends from the positive supply terminal, through back contacts 63 of relays DR180 and DR120, front contact 63 of relay DRH, conductor 69, back contact 150 of relay FS1, conductor 155, front contact 151 of relay FS2, conductor 69b, the lamp 25, conductors 229, 221 and 71, front contact 64 of relay DRH, and back contacts 64 of relays DR120 and DR180 in series back to the negative supply terminal.

From the foregoing, it will be seen that except for minor differences the circuits through which the lamps are supplied with lighting current, the control of cab signals CS and CSb is effected in the same manner as in the previously explained train carried equipments of Figs. 4 and 7. The differences referred to include an elimination from conductors 81, 76 and 71 leading from the lamps to the contacts 64 of the decoding relays DR of the self-checking control transferring contacts of the selector relays FS1 and FS2.

The manner in which compound 100—200 cycle trackway energy operates the train carried equipment of Fig. 9 to control the lamps of the third cab signal unit CSc will now be explained. Whenever coded energy of this compound character is received from the running rails, master relay MR1 follows the spaced pulses of the 100 cycle energy while master relay MR2 follows the intervening pulses of the 200 cycle carrier wave frequency energy. Under such conditions, both of the selector relays FS1 and FS2

are picked up and the primary winding of the decoding transformer DT is connected to the pole changing circuits identified with both of the master relays MR.

In so far as operation of the decoding transformer is concerned, the effect, in the particular form of connection shown, is the same as when but one of the master relays is following the trackway code. In part, this is because when the contact 47 of relay MR1 is in its left-biased or "energy on" position, the contact 47 of relay MR2 occupies its right-biased or "energy off" position and vice versa. This reversed relation of contact positions is due to the fact that the pulses of 100 cycle and of 200 cycle trackway energy supplied by the wayside apparatus of Fig. 8 are noncoincident and follow each other in regular alternating order.

In order that both of the pole changing circuits will simultaneously supply energizing current to the same half of the decoding transformer primary for each of the two combinations of master relay contact positions encountered during the code following operations above described, the two pole changing circuits are carried to the primary circuit in relatively reversed manner. Thus, when relay MR1 is left-biased and relay MR2 is right-biased, conductors 52 and 118 both feed positive current to conductor 121 connected to the upper end of the primary of transformer DT. Likewise, when relay MR1 is right-biased and relay MR2 is left-biased, conductors 53 and 115 similarly feed positive energizing current to conductor 122 joined with the lower end of the transformer primary.

The lamp lighting circuits for cab signal CSC which are completed by the compound 100—200 cycle trackway energy will now be described. If the coding of this compound energy is of the 180 rate, lamp X will be lighted. Under the condition named, relays MR1 and MR2 both follow the trackway code, selector relays FS1 and FS2 are both picked up, decoding relays DRH and DR180 are actuated and relay DR120 is unactuated. The now completed lamp lighting circuit extends from the positive supply terminal through front contact 63 of relay DR180, conductor 78, front contact 146 of relay FS1, conductor 158, front contact 155 of relay FS2, conductor 233, the lamp X, conductor 81, and front contact 64 of relay DR180 back to the negative supply terminal.

If the 100—200 cycle composite trackway energy is coded at the 120 rate, lamp Y of the cab signal CSC will be lighted. Under the condition stated, both master relays MR1 and MR2 follow the trackway code, both selector relays FS1 and FS2 are actuated, decoding relays DRH and DR120 are actuated and relay DR180 is unactuated. The now completed lamp energizing circuit may be traced from the positive supply terminal, through back contact 63 of relay DR180, front contact 63 of relay DR120, conductor 72, front contact 126 of relay FS1, conductor 132, front contact 133 of relay FS2, conductor 234, the lamp Y, conductor 76, front contact 64 of relay DR120, and back contact 64 of relay DR180 back to the negative supply terminal.

If the composite 100—200 cycle trackway energy is coded at the 80 rate, lamp Z of cab signal CSC will be lighted. Under the condition stated, both of the master relays MR1 and MR2 follow the trackway code, both of the selector relays FS1 and FS2 are actuated, decoding relay DRH is actuated and relays DR120 and DR180 are

unactuated. The lamp lighting circuit now completed extends from the positive supply terminal, through back contacts 63 of relays DR180 and DR120, front contact 63 of relay DRH, conductor 69, front contact 159 of relay FS1, conductor 160, front contact 156 of relay FS2, conductor 236, the lamp Z, conductor 71, front contact 64 of relay DRH and back contacts 64 of relays DR120 and DR180 in series back to the negative supply terminal.

In the event that the energy is uncoded or that there is no energy in the running rails, lamp 5 of cab signal CS will be lighted as a result of a conditioning of the train carried apparatus which is identical to that explained in connection with the first two embodiments of my invention. That is, both of the master relays MR1 and MR2 will remain inactive, both of the selector relays FS1 and FS2 will be unactuated and all of the decoding relays DRH, DR120 and DR180 will also be unactuated. Lamp 5 now receives lighting current through a circuit which may be traced from the positive supply terminal, through back contacts 63 of relays DR180, DR120 and DRH in series, conductor 215, back contact 218 of relay FS1, conductors 66 and 67, the lamp 5, conductor 68, and back contacts 64 of relays DRH, DR120 and DR180 in series back to the negative supply terminal.

The acknowledging equipment represented as forming a part of the train carried apparatus of Fig. 9 will now be described. Both in arrangement and in operation it is comparable to that shown in the diagram of Fig. 7. Six acknowledging relays P5, P15, P25, P35, P50 and P60 are associated with the two cab signal units CS and CSb in conventional manner. Upon the occasion of each more restrictive indication change which involves the lamps of these two units, the whistle W sounds and can be silenced only by the usual operation of the acknowledging switch 45—46.

In the illustrative form shown, moreover, the acknowledging circuits of Fig. 9 are so set up that a change in indication from either of the first two signal units CS and CSb to any one of the lamps X, Y and Z of the special or third signal unit CSC is also announced by a blast from whistle W. Each of these special indication blasts can be silenced by operating the acknowledging switch 45—46. In addition, a special warning device, shown in the form of a bell W2, is provided for further advising of a lighting of the lamps of the signal unit CSC. As represented, this bell is arranged to operate during the full continuance of each of the special indications X, Y and Z and it produces a sound readily distinguishable from that given by the whistle. It is controlled by a relay SRc more fully to be described presently.

The apparatus of both the trackway and the train carried portions of my improved ten indication cab signalling system of Figs. 8—9 having been described, attention will now be directed to the manner in which the equipments of Figs. 8—9 cooperate during operation of the complete cab signalling system.

In this system the lamps of the two cab signal units CS and CSb are controlled by coded trackway energy of the 100 cycle and the 200 cycle carrier wave frequency in a manner fully equivalent to that already explained in connection with the first two embodiments of my invention. As long as all three of the special indication relays XC, YC and ZC of the wayside apparatus of Fig. 8 are released that apparatus supplies the running rails with coded energy of

either the 100 cycle or the 200 cycle frequency. On the train, one or another of the lamps of the cab signal CS of Fig. 9 lights in response to the 100 cycle energy and one or another of the lamps of the signal unit CSb similarly lights in response to the 200 cycle energy. The selection of the lamp is, in both cases, determined by the rate at which the trackway energy is coded by one or another of the contacts 80, 120 and 180 of the device CT.

The manner in which the lamps of the third cab signal unit CSc of Fig. 9 are caused to light in response to an operation of one or another of the relays XC, YC and ZC of Fig. 8 will now be described. Assume first that it becomes desirable to effect the lighting of lamp X aboard the train and that control device 201 of the trackway apparatus of Fig. 8 is closed to initiate that operation.

Relay XC now picks up, contacts 176 and 177 thereof connect the coding contact 180 of device CT with the track transformer supply circuit in a manner permitting it to feed 100 cycle and 200 cycle energy alternately thereto, and contacts 173 and 174 disconnect line conductors 21 and 22 extending rearwardly from location M from the track relay contacts 10 and 11 at that location. This allows traffic governing relay J1 to release and complete, through contact 73, the connection between coding circuit conductor 28 and 100 cycle supply conductor 100. Contact 175 of relay XC disconnects the traffic governing relay contacts 29 from the track transformer supply conductor 8.

As the train comes into the track section of which location M marks the exit, relay AR at that location picks up. This places coding device CT in operation, connects supply conductor 100 with the 100 cycle supply terminal B and also connects transformer 200T with the 200 cycle supply source B2—C2. In moving up and down at the rate of 180 times per minute, coding contact 180 now connects the track transformer TT with the 200 cycle supply source each time that the contact is in its upward position and connects the track transformer with the 100 cycle supply source B—C each time that the contact is in its downward position. In consequence, the rails of the track section receive compound 100—200 cycle energy of the 180 code.

On the train, master relay MR1 follows the pulses of the 100 cycle energy thus supplied to the running rails and master relay MR2 follows the intervening pulses of the 200 cycle energy. As a result, selector relays FS1 and FS2 are both picked up and the decoding transformer DT receives pulses of primary energizing current pole changed by the contacts 47 of the relays MR1 and MR2 acting in parallel at the rate of 180 times per minute. In consequence, decoding relays DRH and DR180 are picked up and relay DR120 remains released. Contacts 63 and 64 of these relays now complete the circuit, set up by contacts 146 and 155 of the selector relays, through which energizing current is supplied to the lamp X of cab signal CSc. Lamp X remains lighted as long as the train remains in the section L—M and indication initiating relay XC remains picked up.

Assume next that it becomes desirable to cause the lighting of the cab signal lamp Y. First, control device 201 is opened thereby allowing relay XC to release. Then, device 202 is closed to initiate the new cab signal indication Y. This picks up relay YC. Contacts 176 and 177

of that relay now set up circuits through which contact 120 of the coding device CT may alternately supply the trackway with energy of the 100 cycle and the 200 cycle frequency, contacts 173 and 174 interrupt the circuits of which line conductors 21 and 22 form a part and thereby assure that traffic governing relay J1 occupies its unactuated position, and contact 175 disconnects the traffic governing relay contacts 29 from the track transformer supply conductor 8.

As the train comes into the section L—M, approach relay AR at location M picks up and places the code transmitter CT in operation, connects supply terminal B to conductor 28 through back contact 73 of relay J1, and connects the transformer 200T with the 200 cycle supply source B2—C2. In oscillating between its back and front positions at the rate of 120 times per minute coding contact 120 now alternately connects the transformer TT at location M with the 100 cycle supply source B—C and the 200 cycle supply source B2—C2. In consequence, the rails of section L—M receive compound 100—200 cycle energy of the 120 coding.

On the train, both of the master relays MR1 and MR2 of the equipment of Fig. 9 now follow the trackway code, both of the selector relays FS1 and FS2 are again picked up and the decoding transformer DT receives primary energizing pulses pole changed at the rate of 120 times per minute. This picks up decoding relays DRH and DR120 and allows relay DR180 to remain released. Contacts 63 and 64 of these relays now complete the circuit, previously set up by contacts 126 and 133 of the selector relays FS, through which the lamp Y of cab signal CSc receives lighting current.

Assume now that it becomes desirable to effect the lighting of lamp Z aboard the train. This may be done by opening control device 202 and then closing the control device 203 which picks up relay ZC. Contacts 176 and 177 of that relay now set up circuits through which the contact 80 of the coding device CT may supply the trackway with alternate pulses of 100 cycle and 200 cycle energy, contacts 173 and 174 break the connection of line conductors 21 and 22 and thereby assure that traffic governing relay J1 is released, and contact 175 disconnects the traffic governing relay contacts 29 from the track transformer supply conductor 8.

As the train comes into the section L—M, approach relay AR at location M picks up, places the code transmitter CT in operation, joins coding circuit conductor 28 with the supply terminal B (through back contact 73 of relay J1), and connects the transformer 200T with the 200 cycle supply terminal B2—C2. In oscillating between its back and front positions at the rate of 80 times per minute, coding contact 80 now alternately connects the track transformer TT with the 100 cycle supply source B—C and the 200 cycle supply source B2—C2. In consequence, the rails of the track section L—M receive compound 100—200 cycle energy of the 80 coding.

On the train, each of the two master relays MR1 and MR2 follows the particular component of this code to which it is responsive, both of the selector relays FS1 and FS2 are picked up and the decoding transformer DT receives primary energizing pulses pole changed at the rate of 80 times per minute. As a result, decoding relay DRH is picked up and relays DR120 and DR180 remain released. Contacts 63 and 64 of these relays now complete the circuit, set up

by contacts 150 and 156 of the selector relays, through which the lamp Z of cab signal CSC receives lighting current.

It has been seen that the two selector relays FS1 and FS2 of the train carried equipment of Fig. 9 are provided with contacts 216 and 218 which are additional to the transfer contacts in the lighting circuits of the cab signal lamps. These added contacts 216 and 218 are included in the supply circuit of lamp 5 of signal unit CS and in the stick circuit of acknowledging relay P5 and one of their functions is to cause this most restrictive lamp 5 to light simultaneously with the display of any one of the special indications X, Y and Z of signal unit CSc.

As has been pointed out, both of the selector relays FS1 and FS2 are picked up at all times that any of the lamps of the special indication unit CSc is lighted. Under this condition, lamp 5 of unit CS also receives lighting current over a circuit which may be traced from the positive supply terminal through conductor 233, front contact 216 of relay FS2, conductor 217, front contact 218 of relay FS1, conductors 66 and 67, the lamp 5, conductor 68, and back contacts 64 of relays DRH, DR120 and DR180 in series back to the negative supply terminal.

The manner in which the train carried acknowledging equipment of Fig. 9 operates will now be described. Regarding the actions which accompany indication changes involving the lamps of signal units CS and CSb only, it will suffice to say that these are identical with the corresponding operations which have already been explained in connection with the train carried apparatus of Fig. 7. That is, when the change is in the less restrictive or speed increasing direction, no operation of the whistle W results while upon the occasion of each more restrictive change the whistle sounds and the acknowledging switch 45—46 must be operated to silence it.

Regarding indication changes which involve the lamps X, Y and Z of the third or special cab signal unit CSc, it has been seen that the circuits of Fig. 9 are so set up that each special indication X, Y and Z is accompanied by a sounding of the bell W2. In the illustrative arrangement shown, the relay SRc which controls this bell is provided with three electrically separate actuating windings which are respectively connected in series with the conductors 230, 234 and 236 through which energizing current is supplied to the lamps X, Y and Z. When any one of these windings passes lamp lighting current, it biases relay contact 238 upwardly and completes for the bell an operating circuit which extends from the positive supply terminal, through front contact 238 of relay SRc, conductor 250 and device W2 back to the negative supply terminal. As long, however, as all of the windings remain deenergized, this contact is released and the bell is inactive.

In addition, as has likewise been mentioned, each change in indication from either of the signal units CS and CSb to the special unit is accompanied by a blast from the whistle W, which blast continues until the acknowledging switch 45—46 is operated. This blast is initiated by those contacts of the selector relays FS1 and FS2 which form a part of the circuits through which lighting current is supplied to the signal lamps and through which stick current is supplied to the acknowledging relays.

In examining the acknowledging actions, assume first that the indication change is from

one of the lamps of signal unit CS to any one of the lamps of the unit CSc. As selector relay FS2 picks up incident to this change, the contact thereof which breaks the active lamp lighting circuit also opens the silencing circuit for whistle W. If lamp A was originally lighted, this opening is directly made at contact 155; if lamp 50 or 15 was originally lighted, this opening results from the release of acknowledging relay P60 which follows the break (at contact 133 or 156) in the stick circuit of relay P50 or P15. However, if lamp 5 was originally lighted, it so continues and the stick circuit for relay P5 is merely shifted from the back to the front point of selector relay contact 216.

The whistle W, having been placed in operation as described above, can be silenced by depressing the acknowledging switch 45—46. This picks up relay P5 (over a circuit which includes conductor 91 and switch blade 45) and then acknowledging relays P15—25—35—50—60 in order. Relay P5 now locks itself in over a circuit which extends from the positive supply terminal through conductor 233, front contact 216 of relay FS2, conductor 217, front contact 218 of relay FS1, conductor 66, front contact 88 of relay P5, the winding 87 of that relay, and conductor 90 back to the negative supply terminal. Contacts 75 and 85 of relay P60 now set up the silencing circuit and cause the whistle to cease operating as soon as the switch 45—46 later returns to its normal position.

The above sequence of operations applies to changes in indication from any one of lamps A, 50 and 15 of signal unit CS to any one of the lamps X, Y and Z of unit CSc. Lamp 5 of unit CS is, as has been noted, lighted along with the active lamp of signal unit CSc. If lamp 5 was lighted before the indication change, the whistle does not operate on the occasion of the change because, as has been pointed out, the stick circuit for acknowledging relay P5 is then transferred from the back to the front point of contact 216 of selector relay FS2 before relay P5 has time to drop out.

Assume next that the indication change is from any one of the lamps of signal unit CSb to any one of the lamps of unit CSc. As selector relay FS1 picks up incident to this change, the contact thereof which breaks the active lamp lighting circuit likewise opens the silencing circuit for whistle W.

In all cases this opening results from the release of acknowledging relay P60 which follows a break in the originally active stick circuit. If lamp 60 was originally lighted, this break is at contact 148 of relay FS1 and in the stick circuit of relay P60; if lamp 35 was originally lighted, the break is at contact 126 and in the stick circuit of relay P35; and if lamp 25 was originally lighted, the break is at contact 150 and in the stick circuit of relay P25.

The whistle W, having been placed in operation as described above, again can be silenced by depressing the acknowledging switch 45—46. This picks up all six of the acknowledging relays P5—60 in order, relay P5 locks itself in over the stick circuit previously traced (as including front contacts 216 and 218 of the selector relays), and contacts 75 and 85 of relay P60 once more set up the silencing circuit which causes the whistle to cease operating as soon as the acknowledging switch returns to its normal position. Again it will be noted that lamp 5 of unit CS is lighted along with the active lamp of signal unit CSc.

If the indication change is from one to another of the lamps of the special signal unit CSc no response on the part of the whistle W is produced. This is because both of the selector relays FS1 and FS2 remain picked up and the stick circuit which their contacts 216 and 218 complete for relay P5 is maintained intact during such a change. As has been pointed out, a lighting of any one of the lamps X, Y or Z is under all conditions accompanied by a ringing of the auxiliary alarm bell when that bell is arranged as shown at W2 in Fig. 9.

An indication change from signal unit CSc back to either of the units CS or CSb is accompanied by a blast from the warning whistle W and this requires the usual operation of the acknowledging switch for silencing. Under the stated conditions, the blast is produced when one of the two selector relays FS1 or FS2 releases incident to the indication change and breaks (at contact 218 or 216) the stick circuit for the acknowledging relay P5.

From the foregoing description of the apparatus utilized in and the manner of operation of each of the three cab signalling systems disclosed herein, the many features of practical advantage which these improved systems possess will have become apparent. Special attention, however, may well be called to certain of these advantages in their relation to the requirements of present day railway signalling practice.

As has been pointed out, the trend of these requirements is toward a greater number of indications within the engine cab than the previously known systems of train control and cab signalling which have been installed (over 20,000 miles of track and more than 9,000 locomotives so equipped were in operation in the United States during 1936) during past years are capable of providing. Because of its inherent complexity this apparatus is comparatively expensive and each installation thereof represents a large outlay of capital. Railroads are, therefore, reluctant to scrap their present equipment even in favor of new and differently designed systems which do provide the larger number of indications now desirable in the light of high speed train operation and other comparable factors.

A definite need, accordingly, exists for means whereby existing coded cab signal systems can be used without fundamental or expensive changes to satisfy the various added requirements that are now being placed upon them. As has been seen, the herein disclosed expedients of my invention meet this need in a very practical and satisfactory manner.

Thus, to expand, in accordance with them, the conventional four indication system (described at the beginning of this specification) into a five (Figs. 1-4), seven (Figs. 6-7), or even ten (Figs. 8-9) indication system the only changes required are relatively simple additions to the existing engine and wayside circuits. In the wayside apparatus the existing coders CT are used without fundamental change while on the engine the decoding relays DR and other related equipments are similarly employed. Moreover, such relatively minor changes as are occasioned by the added indications need be made only in those wayside blocks which must transmit the additional indications and only on those engines which need to receive them.

In addition, the number of cab signal indica-

tions which are obtainable from a restricted variety of trackway current codes may be extended almost without limitation. That is, through the use of only the three coding rates of 80, 120 and 180 supply circuit interruptions per minute my improved systems of Figs. 1-4, 6-7, and 8-9, respectively provide five, seven and ten signal indications aboard the train. In each case the herein disclosed extension is effected by the use of energy of only one added carrier wave frequency. Were, however, two or more added carrier wave frequencies to be employed in comparable manner, as it will be apparent that they might readily be (such as 150, 200 and 250 cycles per second in addition to the existing 100 cycle variety), the three trackway current codings could then be caused to provide corresponding further increases in the total number of indications in the locomotive cab.

Moreover, the expedients of my invention greatly increase the flexibility, comprehensiveness and range of application of train controlling systems of the class under consideration. They at once make available a sufficient number of indications to take care of even the most unusual requirements, they are so flexible as to be suited to practically all conceivable applications, and locomotives equipped to give one number of indications may be operated over tracks provided with wayside equipment for giving not only the corresponding number of indications but also a greater or a lesser number.

Although I have described my invention as being combined with the apparatus of an existing type of four indication train control system wherein energy of only three codes is supplied to the trackway, it will be understood that my improved organization and the equipment employed therein may also be used in original installations or with apparatus which includes code transmitters arranged to interrupt the trackway supply circuit at either more or less than the three representative rates of 80, 120 and 180 times per minute. Moreover, while I have restricted my disclosure to train control systems wherein trackway energy of but two different carrier wave frequencies is utilized, it will likewise be apparent that the expedients of my invention also make possible further extended systems wherein selective use is made of coded train control energy of any one of an unrestricted number of different carrier wave frequencies.

Hence, although I have shown and described herein only three forms of railway traffic controlling apparatus embodying my invention, it will be understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In combination, a section of railway track, a plurality of sources of alternating current differing in carrier wave frequency, means along the wayside for selectively connecting one or another of said sources with the rails of said section at the exit end thereof, other wayside means for periodically interrupting said connection at one or another of a plurality of different rates of coding, and train carried signalling means controlled by the said periodically interrupted current which is received from said rails and arranged to give a distinctive indication for each different combination of carrier wave frequency and coding of that current.

2. Railway traffic controlling apparatus comprising a section of track, wayside means at the exit end of said section for there supplying the rails of the section with alternating current of one or another of a plurality of different carrier wave frequencies, other wayside means for periodically interrupting said current at one or another of a plurality of different code rates, further wayside means controlled by traffic conditions in advance of said section for selecting both the carrier wave frequency and the coding of said rail supplied current, and train carried governing means controlled by said current which is received from said section rails and arranged to give a distinctive response for each combination of carrier wave frequency and coding of that received current.

3. In combination, a section of railway track, wayside means at the exit end of said section for there supplying the rails of that section with alternating current of one or another of a plurality of different carrier wave frequencies, other wayside means for interrupting the supplied current at one or another of a plurality of different rates of coding, train carried means for receiving from said rails energy determined by the flow of said coded current therein, a plurality of train carried relays controlled by said received energy, some of said relays being selectively responsible to the frequency of the received energy and others being selectively responsible to the coding thereof, and a plurality of train carried signals jointly controlled by said frequency responsive and said coding responsive relays and selectively energized in accordance with various conditions of actuation of those relays.

4. In a railway traffic controlling system, the combination of a section of track, a plurality of sources of alternating current energy of different carrier wave frequencies, a coding device having a plurality of circuit making and breaking contacts which operate at different rates, wayside means responsive to traffic conditions in advance of said section for connecting one or another of said energy sources to the rails of the section at the exit end thereof and for including one or another of said coding device contacts in said connection, and traffic governing apparatus controlled by the said periodically interrupted energy which is received from said section rails and responsive both to the carrier wave frequency and to the coding of that received energy.

5. In a railway traffic controlling system, the combination of a section of track, a wayside circuit through which trackway energy may be supplied to the rails of said section at the exit end thereof, a plurality of sources of alternating current energy of different carrier wave frequencies, a coding device having a plurality of circuit making and breaking contacts which operate at different rates, a group of wayside relays controlled in accordance with advance traffic conditions, means including contacts carried by said relays for selectively including one or another of said coding contacts in said rail supply circuit, means including other contacts also carried by said relays for selectively connecting one or another of said energy sources to said circuit, and traffic governing apparatus controlled by the said trackway energy which is received from said rails and responsive both to the carrier wave frequency and to the coding of that received energy.

6. In a railway traffic controlling system, the combination of a section of track, a wayside

circuit through which trackway energy may be supplied to the rails of said section at the exit end thereof, two sources of alternating current energy of different carrier wave frequencies, a coding device having a pair of circuit making and breaking contacts which operate at different rates, a wayside relay controlled in accordance with advance traffic conditions, means including a contact carried by said relay for selectively including one or the other of said coding contacts in said rail supply circuit, means including another contact carried by said relay for selectively connecting one or the other of said energy sources to said circuit, and traffic governing apparatus controlled by the said trackway energy which is received from said rails and responsive both to the carrier wave frequency and to the coding of that received energy.

7. In combination: adjoining forward and rear sections of track; a wayside signal for guarding said forward section; a wayside circuit through which trackway energy may be supplied to the rails of said rear section at the exit end thereof; a plurality of sources of alternating current energy of different carrier wave frequencies; a coding device having a plurality of circuit making and breaking contacts which operate at different rates; a group of wayside relays controlled in accordance with advance traffic conditions and provided with contacts for governing said wayside signal, other contacts for selectively including one or another of said coding contacts in said rail supply circuit, and still additional contacts for selectively connecting one or another of said energy sources to said circuit, and traffic governing apparatus controlled by the said trackway energy which is received from said rails and responsive both to the carrier wave frequency and to the coding of that received energy.

8. In a railway traffic controlling system, the combination of a section of track, a circuit through which trackway energy may be supplied to the rails of said section, a plurality of sources of alternating current energy of different carrier wave frequencies, a coding device having a plurality of circuit making and breaking contacts which operate at different rates, means effective when said section is vacant for connecting said rail supply circuit directly to a given one of said energy sources, means effective when said section is occupied and responsive to advance traffic conditions of said track for selectively connecting said rail supply circuit to one or another of said energy sources and for including one or another of the contacts of said coding device in said circuit, and traffic governing apparatus controlled by the said trackway energy which is received from said rails and responsive both to the carrier wave frequency and to the coding of that received energy.

9. In a railway traffic controlling system, the combination of a section of track, a wayside circuit through which trackway energy may be supplied to the rails of said section at the exit end thereof, a plurality of sources of alternating current energy of different carrier wave frequencies, a coding device having a plurality of circuit making and breaking contacts which operate at different rates, an approach controlled relay effective when said section is vacant to connect said rail supply circuit directly to a given one of said sources and effective when the section is occupied to interrupt said direction connection and to include one or another of the contacts of said coding device in the rail supply circuit, ad-

vance traffic controlled relays also effective when said section is occupied to connect said rail supply circuit selectively with one or another of said energy sources and to determine which of said coding contacts then is included in that circuit by said approach controlled relay, and traffic governing apparatus controlled by the said trackway energy which is received from said rails and responsive both to the carrier wave frequency and to the coding of that received energy.

10. In combination: a section of railway track; a wayside circuit through which energy may be supplied to the exit end of said section; two sources of alternating current of different carrier wave frequencies; a coding device having a plurality of circuit making and breaking contacts adapted to operate at different rates; an approach controlled relay effective when the section is vacant to connect said rail supply circuit directly to one of said sources and effective when the section is occupied to interrupt said direct connection, place said coding device in operation and include one or another of its contacts in the rail supply circuit; advance traffic controlled relays also effective when the section is occupied to connect said rail supply circuit with one or the other of said energy supply sources and to determine which of said coding contacts then is included in that circuit by said approach controlled relay; and traffic governing apparatus controlled by the said trackway energy which is received from said rails and responsive both to the carrier wave frequency and to the coding of that received energy.

11. In a railway traffic controlling system, the combination of a section of track, a circuit through which trackway energy may be supplied to the rails of said section, two sources of alternating current of different carrier wave frequencies, a coding device having a plurality of circuit making and breaking contacts operating at different rates, means responsive to advance traffic conditions for connecting said rail supply circuit selectively to one or the other of said energy sources through one or another of the contacts of said coding device whereby to produce code cycles of individual frequency energy, means responsive to other predetermined conditions for causing the coding contact which is included in said rail supply circuit alternately to connect that circuit first to one and then to the other of said energy sources during each cycle of trackway code whereby to produce code cycles of composite frequency energy, and traffic governing apparatus controlled by the said trackway energy which is received from said rails and selectively responsive to each individual frequency coding of that received energy and also to each composite frequency coding thereof.

12. In combination, a section of track, a circuit through which trackway energy may be supplied to the exit end of said section, two sources of alternating current of different carrier wave frequencies, a coding device having a contact which periodically moves between a front position and a back position, an approach controlled relay effective when said section is vacant to connect said rail supply circuit directly to one of said sources and effective when the section is occupied to interrupt said direct connection and include said coding contact in the rail supply circuit, relays selectively controlled by advance traffic and other predetermined conditions and also effective when the section is occupied to connect said contact including circuit selectively

to one or the other of said energy sources individually whereby to produce recurring code cycles of individual frequency energy or to both sources in an alternate or composite manner which causes the coding contact to pass to the trackway energy from one source when in its front position and energy from the other source when in its back position whereby to produce recurring code cycles of composite frequency energy, and traffic governing apparatus controlled by the said trackway energy which is received from said rails and selectively responsive to each of said two individual frequency codings of that received energy and also to said composite frequency coding thereof.

13. In a railway traffic controlling system, the combination of a section of track, a circuit through which trackway energy may be supplied to the rails of said section, two sources of alternating current energy of different carrier wave frequencies, a coding device having a plurality of contacts each of which periodically moves at a distinctive rate between a front position and a back position, advance traffic controlled relays which selectively include one or another of said coding contacts in said rail supply circuit whereby to produce code cycles of individual frequency energy, other relays, circuits controlled by said other relays through which the thus included contact connects said rail supply circuit with one of said sources when in its front position and with the other of said sources when in its back position whereby to produce code cycles of composite frequency energy, and traffic governing apparatus controlled by said trackway energy which is received from said rails and selectively responsive to each individual frequency coding of that received energy and also to each composite frequency coding thereof.

14. In combination, a section of railway track, a circuit through which trackway current may be supplied to the rails of said section, two sources of alternating current of different carrier wave frequencies, a coding device having a plurality of contacts each of which periodically moves at a distinctive rate between a front position and a back position, one group of relays controlled by advance traffic conditions and arranged selectively to include one or another of said coding contacts in said rail supply circuit whereby to produce recurring code cycles of individual carrier wave frequency current, a second group of relays controlled by other conditions, circuits governed by the relays of said second group through which the thus included coding contact connects said rail supply circuit with one of said sources when in its front position and with the other of said sources when in its back position, whereby to produce recurring code cycles of composite carrier wave frequency current, and traffic governing apparatus controlled by said trackway current which is received from said rails and selectively responsive to each individual carrier wave frequency coding of that received current and also to each composite carrier wave frequency coding thereof.

15. In a railway traffic controlling system, the combination with a section of track of wayside means at the exit end of said section for there supplying the rails of that section with alternating current having one or another of a plurality of different carrier wave frequencies and periodically interrupted at one or another of a plurality of different rates of coding, train carried means for receiving from said rails energy

determined by the flow of said coded current therein, a plurality of train carried code following relays, means responsive to the carrier wave frequency of said received energy for selectively energizing one or another of said relays in step with the code pulses of that received energy, and train carried governing means controlled by operation of said relays and selectively responsive to whichever one of them follows the received trackway code and to the rate at which such following operation takes place.

16. In combination, a section of railway track, wayside means at the exit end of said section for there supplying the rails of that section with alternating current which is periodically interrupted at one or another of a plurality of different rates of coding and which has one carrier wave frequency under certain conditions and a second carrier wave frequency under other conditions, train carried means for receiving from said rails energy determined by the flow of said coded current therein, a pair of train carried code following relays each of which is provided with a separate operating circuit, a separate amplifier included in each of said operating circuits, a first filter connecting said receiving means with one of said amplifiers and adjusted to transmit thereto control energy of said first carrier wave frequency only, a second filter connecting the receiving means with the other of said amplifiers and adjusted to transmit thereto control energy of said second carrier wave frequency only, and train carried governing means controlled by operation of said two relays and selectively responsive to whichever one of them follows the received trackway code and to the rate at which said following operation takes place.

17. The combination with a stretch of railway track of means for supplying the rails of said stretch with coded alternating current of one carrier wave frequency under certain conditions, of a second carrier wave frequency under other conditions, and of both of said frequencies alternately applied under still other conditions; train carried means for receiving from said rails energy determined by the flow of said coded current therein; a pair of train carried code following relays; means responsive to the carrier wave frequency of said received energy for selectively energizing one or the other of said relays in step with the code pulses of that received energy; and train carried governing means selectively responsive to individual operation of each of said two relays and to joint operation of both.

18. In combination with a section of railway track which contains a permanent speed restriction, apparatus at the exit end of said section comprising a circuit through which current may be supplied to the rails thereof, first and second sources of alternating current differing in frequency, a coding device having first and second contacts which operate at different rates, and a relay controlled by advance traffic conditions and arranged to include said first coding contact in and connect said first current source to said rail supply circuit at certain times and to include said second coding contact in and connect said second current source to said circuit at all other times.

19. In combination with a section of railway track which contains a permanent speed restriction, apparatus at the exit end of said section comprising a circuit through which current may

be supplied to the rails thereof, first and second sources of alternating current differing in frequency, a coding device having first and second contacts which operate at different rates, a first relay controlled by advance traffic conditions and arranged to connect said first current source to said rail supply circuit at certain times and to connect said second current source to the circuit at all other times, and a second relay also controlled by advance traffic conditions but arranged to include said first coding contact in said rail supply circuit at certain times and to include said second coding contact in the circuit at all other times.

20. In combination with a stretch of trackway which is selectively supplied with current of a first carrier wave frequency coded at a first, second or third rate of modulation or with current of a second carrier wave frequency coded at said second rate only, train carried apparatus comprising a receiver for picking up energy from said trackway, a first master relay which follows the coding of said received energy when that energy is of said first carrier wave frequency, a second master relay which follows the coding of said energy when that energy is of said second carrier wave frequency, three decoding relays governed by said master relays and selectively responsive to the rate at which either of them operates, a first cab signal unit consisting of four indicating devices, a second cab signal unit made up of one indicating device, an energizing circuit for each device in both of said units, contacts carried by said decoding relays for controlling the said circuits of either of said units, a pair of selector relays selectively responsive to operation of said first and second master relays, and contacts carried by said selector relays for selectively including said decoding relay contacts in the four circuits of said first signal unit or in the single circuit of said second signal unit.

21. In combination with a stretch of trackway which is selectively supplied with current of a first carrier wave frequency coded at a first, second or third rate of modulation or with current of a second carrier wave frequency coded at one or another of said three rates, train carried apparatus comprising a receiver for picking up energy from said trackway, first and second master relays which respectively follow the coding of said received energy when that energy is of said first and said second carrier wave frequency, three decoding relays governed by said master relays and selectively responsive to the rate at which either of them operates, a first cab signal unit consisting of four indicating devices, a second cab signal unit made up of three indicating devices, an energizing circuit for each device in both of said units, contacts carried by said decoding relays for controlling the said circuits of either of said units, a pair of selector relays selectively responsive to operation of said first and second master relays, and contacts carried by selector relays for selectively including said decoding relay contacts in the four circuits of said first signal unit or in the three circuits of said second signal unit.

22. In the train carried portion of a coded system of cab signalling, the combination of a first group of visual signals for indicating clear and restrictive conditions of the track, a second group of visual signals for indicating special train orders, energy supply circuits for the signals of each group, decoding relays selectively energized under the control of coded energy received from

the trackway and having contacts for controlling the said energy supply circuits for either of said signal groups, a pair of selector relays also selectively energized under the control of received trackway energy and arranged to assign said decoding relay control to one of said groups of signal supply circuits under certain conditions and to the other of said groups of signal supply circuits under other conditions, and contacts carried by said selector relays for causing the most restrictive of said track condition signals to be energized at all times that a special train order signal is energized.

23. In the train carried portion of a coded system of cab signalling, the combination of a first group of visual signals for indicating clear and restrictive conditions of the track, a second group of visual signals for indicating special train orders, energy supply circuits for the signals of each group, decoding relays selectively energized under the control of coded energy received from the trackway and having contacts for controlling the said energy supply circuits for either of said signal groups, a pair of selector relays also selectively energized under the control of received trackway energy and arranged to assign said decoding relay control to one of said groups of signal supply circuits under certain conditions and to the other of said groups of signal supply circuits under other conditions, an audible warning signal, means including a chain of acknowledging relays associated with the signals of said first or track condition indicating group for causing said audible warning signal to sound whenever the indication displayed by said track condition signals changes in the more restrictive direction, means including a manually operable acknowledging switch for silencing said warning, and contacts carried by said selector relays for causing the most restrictive of said track condition signals to be energized at all times that a special train order signal is energized whereby said warning signal also sounds upon each indication change to the signals of said second group.

24. In combination: first and second groups of visual signals for indicating conditions of a railway track; a third group of visual signals for indicating special train orders; energy supply circuits for the signals of each group; decoding relays selectively energized under the control of coded energy received from the trackway and having contacts for controlling the said energy supply circuits for any one of said three signal groups; a pair of selector relays also selectively energized under the control of received trackway energy and arranged to assign said decoding relay control to the first group of said signal supply circuits when the first selector relay is picked up and the second is released, to the second group of said signal supply circuits when the second selector relay is picked up and the first is released, and to the third group of said signal supply circuits when both selector relays are picked up; an audible warning signal; a chain of acknowledging relays associated with the signals of said first and second groups for causing said warning signal to sound whenever the indication displayed by said track condition indicating signals changes in the more restrictive direction; an acknowledging switch for silencing said warning; and contacts carried by said selector relays for causing the most restrictive of said track condition indicating signals to be energized at all times that both of said selector relays are picked up.

25. In a railway traffic controlling system, the

combination with a section of track of: a circuit through which trackway energy may be supplied to the rails of said section; a source of alternating current energy of a given carrier wave frequency; normally inactive means for generating energy of a different carrier wave frequency; a coding device having a circuit making and breaking contact; an approach controlled relay for connecting said rail supply circuit directly to said given frequency energy source when said section is vacant whereby then to supply steady energy to said section rails and effective when the section is occupied to discontinue such steady energy supply by continuously interrupting said direct connection, to include said coding contact in the rail supply circuit in order periodically to interrupt that circuit, and to place said normally inactive generating means in operation in order to make energy of said different carrier wave frequency available for supply to the trackway; advance traffic controlled relays also effective when the section is occupied to connect said rail supply circuit selectively to said given frequency energy source under certain conditions whereby to supply said section rails with coded given frequency energy under those conditions and to said different frequency generating means under other conditions whereby to supply the section rails with coded different frequency energy under said other conditions; and traffic governing apparatus controlled by said coded trackway energy which is received from said rails and selectively responsive according as that received energy has said given carrier wave frequency or said different carrier wave frequency.

26. In a railway traffic controlling system, the combination with a section of track of: a circuit through which trackway energy may be supplied to the rails of said section; a source of alternating current energy of a given carrier wave frequency; normally inactive means, including a rectifier and a transformer connected to the output terminals thereof, for converting energy from said given frequency source into energy of a different carrier wave frequency; a coding device having a circuit making and breaking contact; an approach control relay for connecting said rail supply circuit directly to said given frequency energy source when said section is vacant whereby then to supply steady energy to said section rails and effective when the section is occupied to discontinue said steady energy supply by continuously interrupting said direct connection, to include said coding contact in the rail supply circuit in order periodically to interrupt that circuit, and to connect the input terminals of said rectifier to said first frequency energy source in order to make energy of said different carrier wave frequency available for supply to the track rails; advance traffic controlled relays also effective when the section is occupied to connect said rail supply circuit selectively to said given frequency energy source under certain conditions whereby to supply said section rails with coded given frequency energy under those conditions and to the transformer of said different frequency converting means under other conditions whereby to supply the section rails with coded different frequency energy under said other conditions; and traffic governing apparatus controlled by said trackway energy which is received from said rails and selectively responsive according as that received energy has said given carrier wave frequency or said different carrier wave frequency.

27. In a railway traffic controlling system, the combination of: wayside apparatus for supplying the track rails with coded alternating current of a first carrier wave frequency under certain conditions, of a second carrier wave frequency under other conditions and of both of said frequencies alternately applied under still other conditions; and train carried apparatus comprising a receiver for inductively picking up said current from said rails, a pair of master relays, means controlled by the said received current for selectively energizing one or the other of said two master relays in step with the code pulses of that current according as said current is of said first or said second carrier wave frequency, and train governing means selectively responsive to code following operation of one of said master relays individually, of the other of said relays individually, and of both of said relays jointly.

28. In a railway traffic controlling system, the combination of: wayside apparatus for supplying the track rails with alternating current which is periodically interrupted at one or another of a plurality of different rates of coding and which has a first carrier wave frequency under certain conditions and a second carrier wave frequency under other conditions; and train carried apparatus comprising a receiver for inductively picking up said current from said rails, a pair of master relays, means controlled by said received current for selectively energizing one or the other of said two master relays in step with the code pulses of that current according as said current is of said first or said second carrier wave frequency, decoding relays governed by said master relays and selectively responsive to the rate at which either of them operates, two groups of train governing signals adapted for selective control by said decoding relays, means responsive to operation of one of said master relays for assigning said decoding relay control to the signals of one of said groups, and means responsive to operation of the other master relay for assigning said control to the signals of the other group.

29. In a railway traffic controlling system, the combination of means for supplying the track rails with alternating current energy which is periodically interrupted at one or another of a plurality of different rates of coding and which has one or another of a plurality of different carrier wave frequencies, means for receiving said energy from said rails, a plurality of decoding relays, means responsive to the rate of coding of said received energy for selectively supplying actuating current to one or another of said decoding relays, traffic governing signals, a plurality of groups of energizing circuits for said signals, contacts carried by said decoding relays for controlling the circuits of any one of said groups, a plurality of control selector relays, means responsive to the carrier wave frequency of said received energy for selectively actuating one or another of said control selector relays, and contacts carried by said selector relays for connecting said decoding relay contacts with one or another of said circuit groups depending upon which of the selector relays is actuated.

30. In a railway traffic controlling system, the combination of: means for supplying the track rails with alternating current energy which is periodically interrupted at one or another of a plurality of different rates of coding and which is of a first carrier wave frequency under certain conditions, a second carrier wave frequency under other conditions, and of both

of said frequencies alternately applied under still other conditions; means for receiving said energy from said rails; a plurality of decoding relays; means governed by said received energy and responsive to the rate of coding thereof for selectively supplying actuating current to one or another of said decoding relays; traffic governing signals; three groups of energizing circuits for said signals; contacts carried by said decoding relays for controlling the circuits of any one of said groups; first and second control selector relays; means also governed by said received energy for actuating said first selector relay when that energy has said first carrier wave frequency and said second selector relay when that energy has said second carrier wave frequency; and contacts carried by said two selector relays for connecting said decoding relay contacts with one or another of said three circuit groups depending upon whether said first selector relay is actuated individually, said second selector relay is actuated individually, or both of said selector relays are actuated simultaneously.

31. In combination, means for supplying alternating current trackway energy which is periodically interrupted at one or another of a plurality of different rates of coding and which has one or the other of two different carrier wave frequencies, means for receiving said energy from the trackway, a first and a second master relay, means responsive to the carrier wave frequency of said received energy for selectively supplying code step pulses of operating current to one or the other of said master relays, a decoding transformer, circuit means through which said transformer receives code step pulses of primary current when either of said master relays follows code, two groups of train governing signals, energy supply circuits for the signals of each of said groups, decoding relays selectively actuated according as the output energy of said decoding transformer results from received trackway energy which is coded at one or another of said plurality of different rates, means governed by said decoding relays for controlling either of said two groups of signal circuits, and means selectively responsive to code following operation of said first and of said second master relay for assigning said decoding relay control to the signal circuits of one or the other of said two groups.

32. In combination: means for supplying alternating current trackway energy which is periodically interrupted at one or another of a plurality of different rates of coding and which is of a first carrier wave frequency under certain conditions, and of a second carrier wave frequency under other conditions, and of both of said frequencies alternately applied under still other conditions; means for receiving said energy from the trackway; a first and a second master relay; means responsive to the carrier wave frequency of said received energy for selectively supplying code step pulses of operating current to one or the other of said two master relays; a decoding transformer; circuit means through which said transformer receives code step pulses of primary current when either of said master relays follows code; three groups of train governing signals; decoding relays selectively actuated according as the output energy of said transformer results from received trackway energy which is coded at one or another of said plurality of different rates; means governed by said decoding relays for controlling any of said three groups

of signal circuits; and means selectively responsive to operation of said first master relay individually, of said second master relay individually, and of both of said relays simultaneously for assigning said decoding relay control to the signal circuits of one or another of said three groups.

33. In a railway traffic controlling system, the combination of means for providing alternating current energy which is periodically interrupted at one or another of a plurality of different rates of coding and which has one or the other of two different carrier wave frequencies, two groups of train governing signals, energy supply circuits for the signals of each of said groups, a plurality of decoding relays for controlling either of said two groups of signal supply circuits, means responsive to the rate of coding of said alternating current energy for selectively supplying actuating current to one or another of said decoding relays, a selector relay arranged to assign said decoding relay control to one of said groups of signal circuits when the selector relay is released and to the other of said groups of signal supply circuits when the selector relay is picked up, and means for supplying energizing current to said selector relay when and only when said alternating current energy has a given one of said two carrier wave frequencies.

34. In combination, means for providing alternating current energy which is periodically interrupted at one or another of a plurality of different rates of coding and which has a given carrier wave frequency under certain conditions and a different carrier wave frequency under other conditions, two groups of train governing signals, energy supply circuits for the signals of each of said two groups, a plurality of decoding relays having contacts for controlling either of said two groups of signal supply circuits, means responsive to the rate of coding of said alternating current energy for selectively supplying actuating current to one or another of said decoding relays, a selector relay having releasing characteristics sufficiently slow to bridge the gap between successive code pulses of said alternating current energy, means for supplying code spaced pulses of energizing current to said selector relay when and only when said alternating current energy has said given carrier wave frequency, and contacts carried by said selector relay and arranged to connect said decoding relay contacts with one of said two groups of signal supply circuits when the selector relay is actuated and with the other of said groups of signal supply circuits when the selector relay is released.

35. In combination, means for providing alternating current energy which is periodically interrupted at one or another of a plurality of different rates of coding and which has one or the other of a first and a second carrier wave frequency, two groups of train governing signals, energy supply circuits for the signals of each of said groups, a plurality of decoding relays having contacts for controlling either of said two groups of signal supply circuits, means responsive to the rate of coding of said alternating current energy for selectively supplying actuating current to one or another of said decoding relays, a first and a second slow release selector relay, means for supplying code spaced pulses of energizing current to said first selector relay when and only when said alternating current energy has said first carrier wave frequency, means for supplying code spaced pulses of ener-

gizing current to said second selector relay when and only when said alternating current energy has said second carrier wave frequency, and contacts carried by said two selector relays and serially arranged to connect said decoding relay contacts with one of said two groups of signal supply circuits when the first selector relay is actuated and the second is unactuated and with the other of said two groups of signal supply circuits when the second selector relay is actuated and the first is unactuated.

36. In combination: means for providing alternating current energy which is periodically interrupted at one or another of a plurality of different rates of coding and which is of a first carrier wave frequency under certain conditions, a second carrier wave frequency under other conditions, and of both of said frequencies alternately applied under still other conditions; three groups of train governing signals; energy supply circuits for the signals of each of said three groups; a plurality of decoding relays having contacts for controlling any one of said three groups of signal supply circuits; means responsive to the rate of coding of said alternating current energy for selectively supplying actuating current to one or another of said decoding relays; a first and a second slow release selector relay; means for supplying code spaced pulses of energizing current to said first selector relay when said alternating current energy is of said first carrier wave frequency and to said second selector relay when that energy is of said second carrier wave frequency; and contacts carried by said two selector relays and arranged to connect said decoding relay contacts with one of said three groups of signal supply circuits when the first selector relay is actuated and the second is unactuated, with another of said groups of signal supply circuits when the second selector relay is actuated and the first is unactuated, and with the third of said groups of signal supply circuits when both of the selector relays are actuated.

37. In a railway traffic controlling system, the combination of means for supplying alternating current trackway energy which is periodically interrupted at one or another of a plurality of different rates of coding and which has a given carrier wave frequency at times and a different carrier wave frequency at other times, a master relay, means controlled by said trackway energy for supplying code step pulses of operating current to said master relay as long as the trackway energy is of said given carrier wave frequency, a control selector relay having releasing characteristics sufficiently slow to bridge the gap between successive pulses of said coded trackway energy, a circuit controlled by said master relay through which said selector relay is supplied with code step pulses of actuating current whenever said master relay follows code, a decoding transformer, an exciting circuit for said decoding transformer which includes a contact of said master relay, contacts carried by said selector relay and arranged to connect said decoding transformer to said exciting circuit whenever that relay is actuated and to maintain the transformer disconnected from the circuit at all other times, decoding relays selectively picked up by the output energy of said decoding transformer according as said master relay contact operates at one or another of said plurality of different code rates, and traffic governing apparatus controlled by said decoding relays.

38. In a railway traffic controlling system, the

combination of means for supplying alternating current trackway energy which is periodically interrupted at one or another of a plurality of different rates of coding and which has one or the other of a first and a second carrier wave frequency, a first and a second master relay, means responsive to the carrier wave frequency of said trackway energy for selectively supplying code step pulses of operating current to one or the other of said master relays, a first and a second control selector relay having releasing characteristics sufficiently slow to bridge the gap between successive code pulses of said trackway energy, a circuit controlled by said first master relay through which said first selector relay is supplied with code step pulses of actuating current whenever said first master relay follows code, a circuit controlled by said second master relay through which said second selector relay is supplied with code step pulses of actuating current whenever said second master relay follows code, a decoding transformer, circuit means effective upon the operation of either of said master relays and an actuation of the associated selector relay to supply said transformer with code following pulses of primary current, decoding relays selectively picked up by the output energy of said decoding transformer according as said master relay follows one or another of said different codes, and traffic governing apparatus controlled by said decoding relays.

39. In a railway traffic controlling system, the combination of means for supplying alternating current trackway energy which is periodically interrupted at one or another of a plurality of different rates of coding and which has one or the other of a first and a second carrier wave frequency, a first and a second master relay, means responsive to the carrier wave frequency of said trackway energy for selectively supplying code step pulses of operating current to one or the other of said two master relays, a first and a second slow release control selector relay, a circuit controlled by said first master relay through which said first selector relay is supplied with recurring pulses of actuating current when said first master relay follows code, a circuit controlled by said second master relay through which said second selector relay is supplied with recurring pulses of actuating current when said second master relay follows code, first and second pole changing circuits respectively controlled by said first and second master relays, a decoding transformer, a source of exciting current for said transformer, contacts carried by said first selector relay and arranged to connect said transformer to said exciting source by way of said first pole changing circuit whenever said first selector relay is actuated, contacts carried by said second selector relay and arranged to connect said transformer to said exciting source by way of said second pole changing circuit whenever said second selector relay is actuated, decoding relays selectively picked up by the output energy of said decoding transformer, and traffic governing apparatus controlled by said decoding relays.

40. In combination, means for supplying alternating current trackway energy which is periodically interrupted at one or another of a plurality of different rates of coding and which is of a first carrier wave frequency under certain conditions, a second carrier wave frequency under other conditions, and of both of said frequencies alternately applied under still other conditions, a first and a second master relay, means responsive

to trackway energy of said first carrier wave frequency for supplying code step pulses of operating current to said first master relay, means responsive to trackway energy of said second carrier wave frequency for supplying code step pulses of operating current to said second master relay, a pole changing circuit controlled by each of said master relays, a decoding transformer, a source of exciting current for said transformer, means responsive to code following operation of said first master relay for connecting said transformer to said exciting source by way of said first pole changing circuit, means responsive to code following operation of said second master relay for connecting said transformer to said exciting source by way of said second pole changing circuit, said two connections being made in such manner as to permit the two pole changing circuits to operate in parallel when said two master relays respond to alternate code pulses of said first frequency and said second frequency trackway energy, decoding relays selectively picked up by the output energy of said decoding transformer, and traffic governing apparatus controlled by said decoding relays.

41. In a railway traffic controlling system, the combination of means for supplying alternating current trackway energy which is interrupted at one or another of a plurality of different rates of coding and which has one or another of a plurality of different carrier wave frequencies, means for receiving said energy from the trackway, a plurality of groups of visual signals for indicating the permissible running speed of a train, circuits for supplying operating current to the signals of each of said groups, a plurality of decoding relays having contacts for selectively completing said current supply circuits for the signals of any of said groups, means governed by said received energy when of any of said different carrier wave frequencies for selectively picking up said decoding relays according as that received energy is coded at one or another of said plurality of different rates, selector relay means also governed by said received energy and arranged to assign said decoding relay control to one or another of said groups of signal current supply circuits depending upon whether that received energy is of one or another of said different carrier wave frequencies, an audible warning signal, means including a chain of acknowledging relays controlled by the said operating current for the selected visual signal for causing said audible warning signal to sound whenever said selected visual signal is changed to produce a new indication which is more restrictive than the former, and means including a manually operable acknowledging switch for silencing said warning signal.

42. In a railway traffic controlling system, the combination of wayside means for supplying alternating current trackway energy which is interrupted at one or another of a plurality of different rates of coding and which has one or another of a plurality of different carrier wave frequencies, train carried means for receiving said energy from the trackway, two groups of train carried visual signals for indicating the permissible running speed of the train, circuits for supplying operating current to the signals of each of said groups, a plurality of decoding relays having contacts for selectively completing the said current supply circuits for the signals of either of said two groups, means governed by said received energy when of any of said different car-

rier wave frequencies for selectively picking up said decoding relays according as that received energy is coded at one or another of said plurality of different rates, selector relay means also governed by said received energy and arranged to assign said decoding relay control to one of said groups of signal current supply circuits under certain conditions and to the other of said groups of signal current supply circuits under other conditions, an audible warning signal, means including a chain of acknowledging relays controlled by the said operating current for the selected visual signal for causing said warning signal to sound whenever said selected visual signal is changed to produce a new indication which is more restrictive than the former, and means including a manually operable acknowledging switch for silencing said warning signal.

43. In a railway traffic controlling system, the combination of: a plurality of train carried visual signals arranged respectively to indicate a clear condition of the track, a plurality of restrictive conditions of the track, and special train orders; means located partly in the trackway and partly on board the train and continuously responsive to advance traffic and special train order conditions for supplying energizing current to a selected one or another of said signals according as said advance traffic conditions permit the train to proceed at an unrestricted or a reduced speed and according as special train orders are to be transmitted to the train; a first train carried audible warning signal; means, including a

chain of acknowledging relays controlled by said energizing current for the selected visual signal, for causing said warning signal to sound whenever the selection among said visual signals changes from the giving of one track condition indication to the giving of another track condition indication which is more restrictive than the first; means, including a manually operable acknowledging switch, for silencing said first audible warning signal; and a second train carried audible warning signal arranged to operate whenever the selection among said visual signals is changed to produce a special train order indication.

44. In a railway traffic controlling system, the combination of a section of track, wayside means at the exit end of said section for there supplying the section rails with pulses of alternating current energy which have one or another of a plurality of different carrier wave frequencies and which recur at one or another of a plurality of different code rates, other wayside means controlled by traffic conditions in advance of said section for selecting both the carrier wave frequency and the rate of recurrence of said energy pulses, and traffic governing apparatus controlled by the said pulses which are received from said rails and selectively responsive both to the rate at which those pulses recur and to the carrier wave frequency of the energy of which they are constituted.

HERBERT A. WALLACE.

CERTIFICATE OF CORRECTION.

Patent No. 2,194,371.

March 19, 1940.

HERBERT A. WALLACE.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 28, first column, lines 29 and 31, claim 3, for the word "responsible" read responsive; same page, second column, line 73, claim 9, for "direction" read direct; page 33, first column, line 23, claim 33, after "signal" insert supply; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 30th day of April, A. D. 1940.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.