

**Nov. 5, 1963**

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**3,109,616**

# AUTOMATIC RECORDER FOR CENTRALIZED TRAFFIC CONTROLLING SYSTEM

Filed Feb. 28, 1961

5 Sheets-Sheet 1

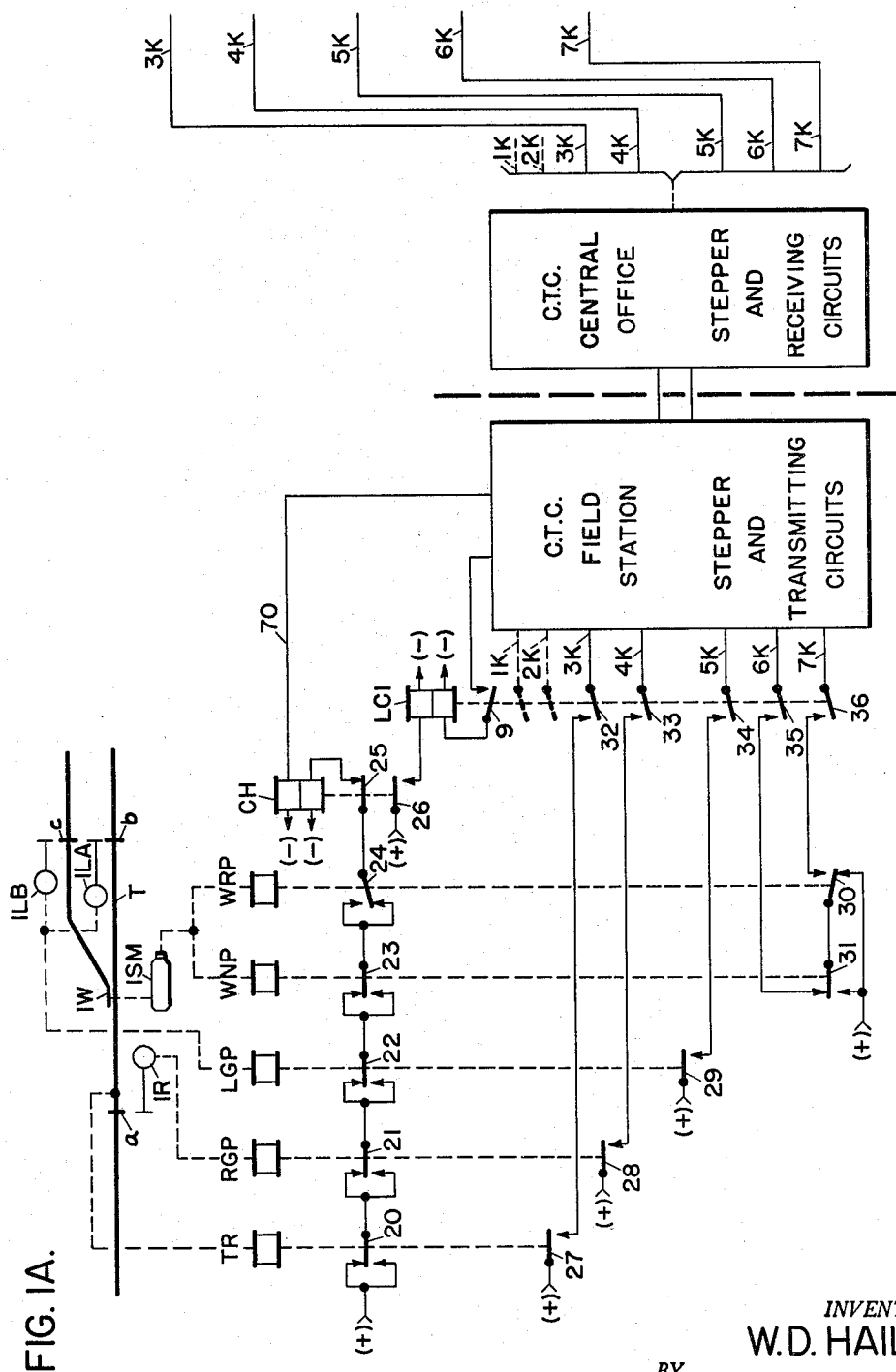


FIG. 1A.

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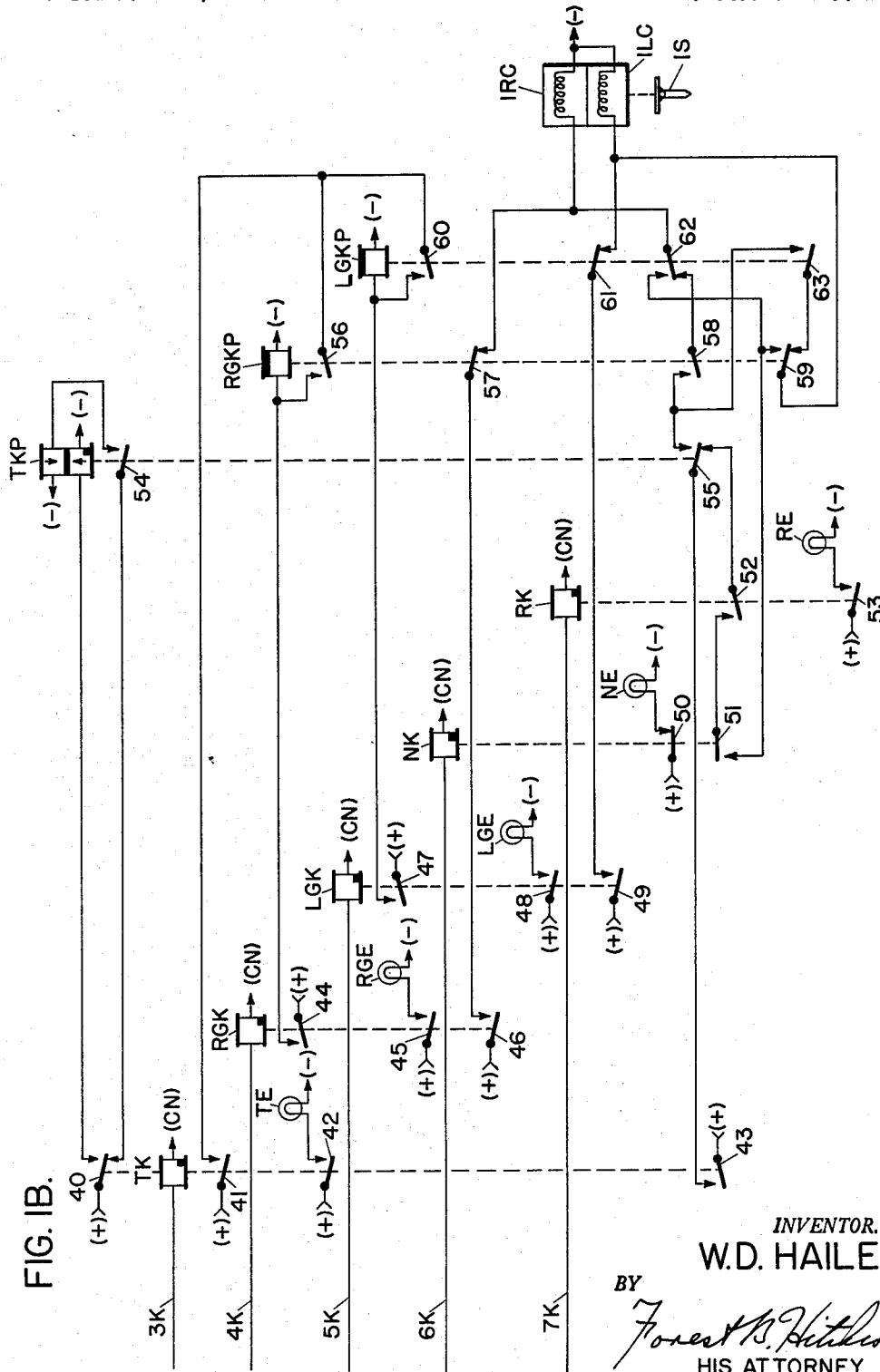
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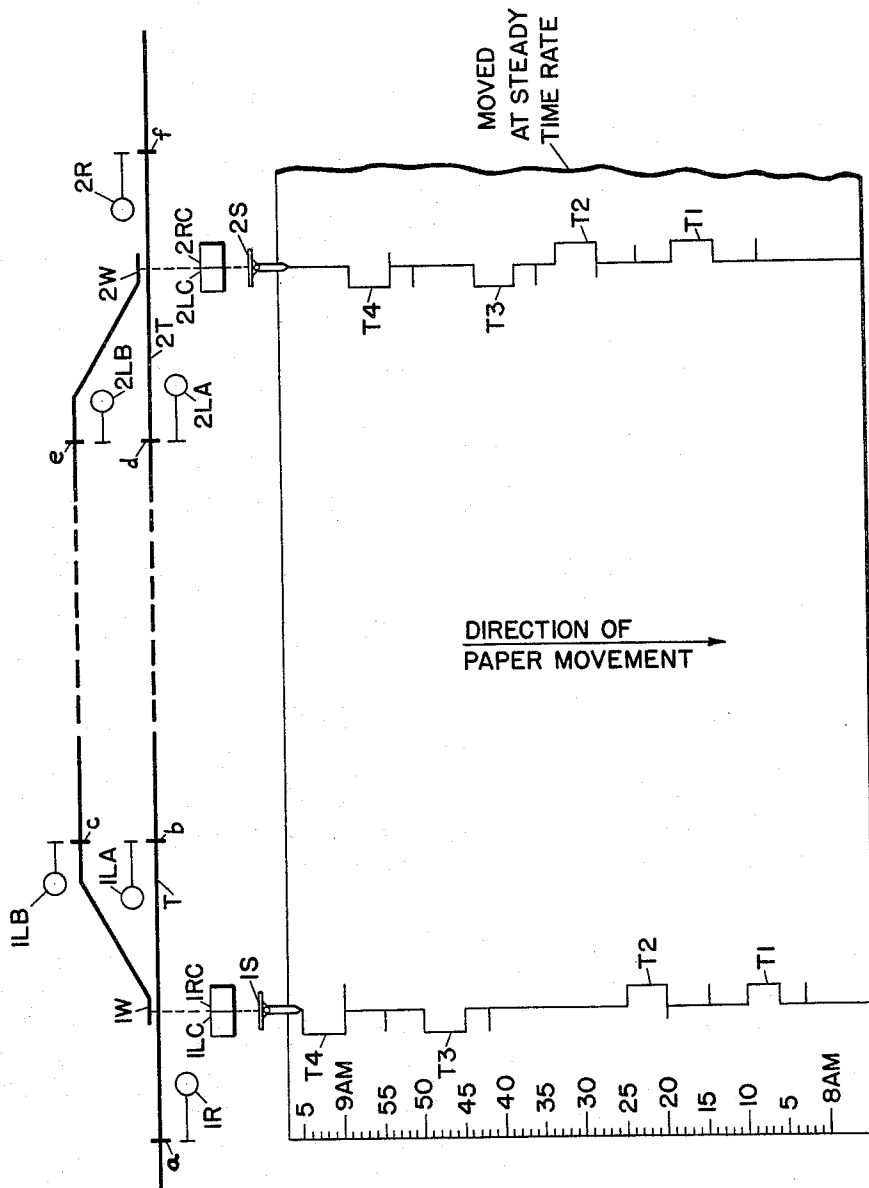
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AUTOMATIC RECORDER FOR CENTRALIZED TRAFFIC CONTROLLING SYSTEM

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AUTOMATIC RECORDER FOR CENTRALIZED TRAFFIC CONTROLLING SYSTEM

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FIG. 3A.

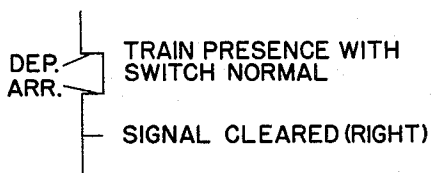


FIG. 3B.

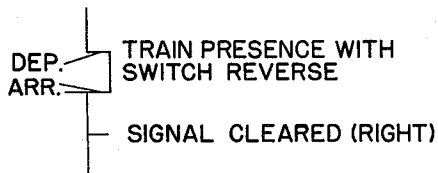


FIG. 3C.

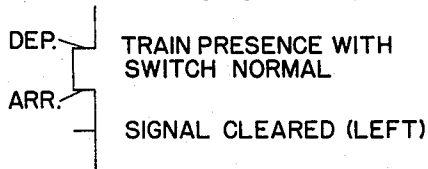


FIG. 3D.

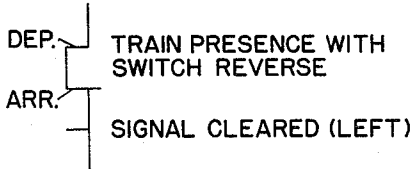


FIG. 3E.

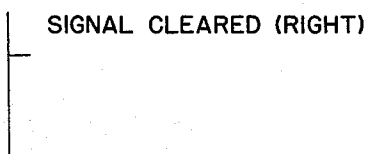


FIG. 3G.

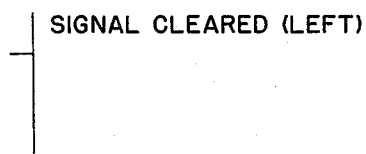
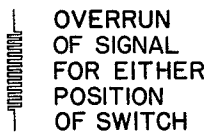


FIG. 3F.



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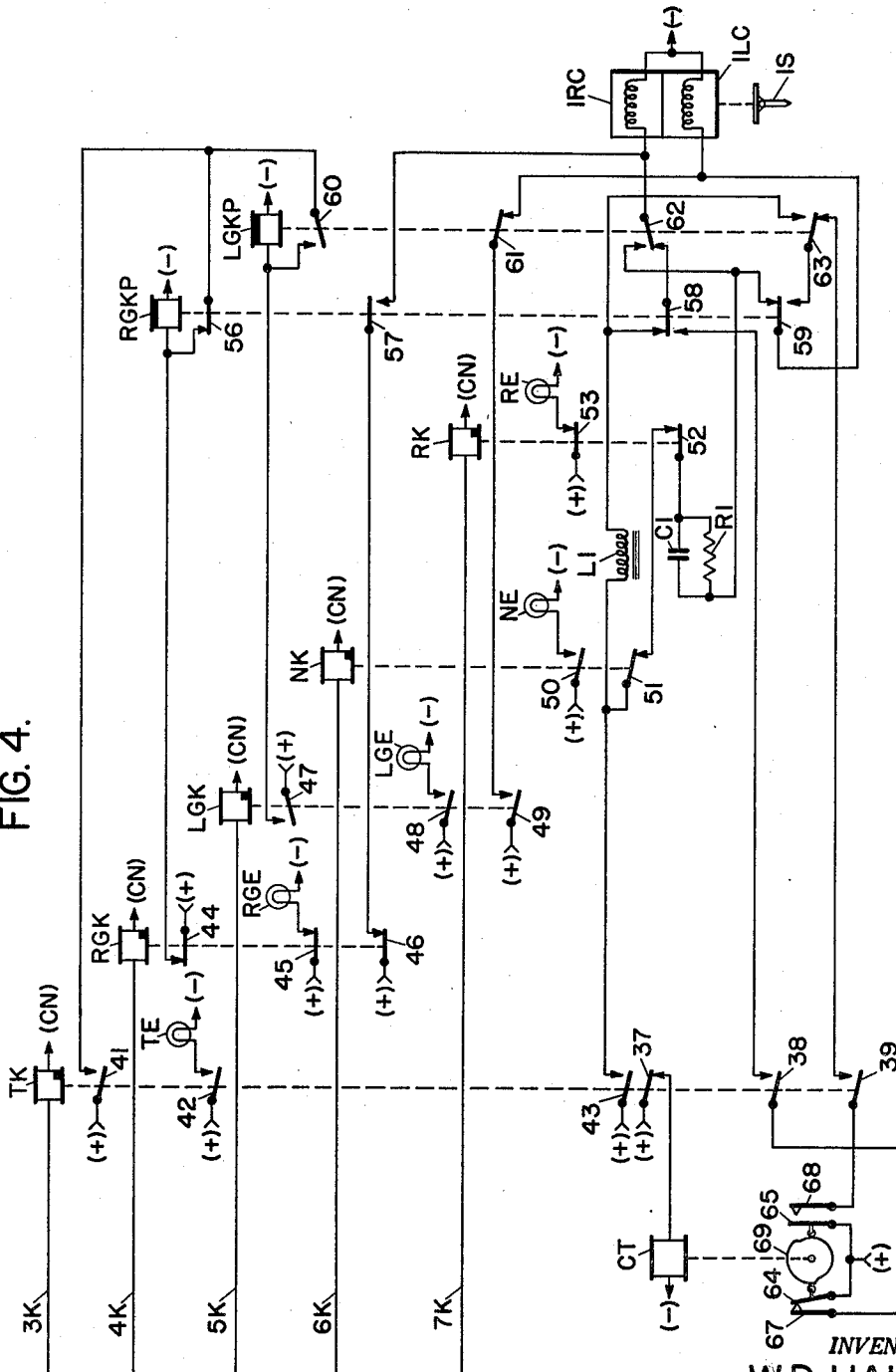
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AUTOMATIC RECORDER FOR CENTRALIZED TRAFFIC CONTROLLING SYSTEM

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FIG. 4.



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## AUTOMATIC RECORDER FOR CENTRALIZED TRAFFIC CONTROLLING SYSTEM

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Signal Corporation, a corporation of New York  
Filed Feb. 28, 1961, Ser. No. 92,256  
7 Claims. (Cl. 246-107)

This invention relates to automatic recording apparatus for use in railway dispatching and more particularly relates to improved train recording apparatus capable of recording train movement and the condition of the apparatus governing train movement over a track layout.

Recording apparatus for centralized traffic controlling systems is usually located under a transparent panel and conveniently situated in the desk portion of a centralized traffic controlling machine. It is required that such recording apparatus produce independently on a record sheet graphic representations of the occupancy of a large number of track sections, the condition of various signals along the trackway and the condition of other track controlling equipment. The graphic representations produced by the styli of such a recorder are used as the basis for traffic studies and as a disciplinary check on the train operators. Therefore, in order to more easily interpret the record sheet it is highly desirable that the graphic indications produced by each stylus of the recording apparatus provide sufficient information so that train progress throughout a complex track layout may be readily discernible.

In certain prior proposals for automatic recording apparatus the quantity and the type of information supplied by the markings produced on the record sheet has been such that when the record sheet is removed and is to be used as the basis for a study of train movement over a complex track layout or for disciplinary purposes, the operator cannot interpret each train's movement over the track layout without time consuming analysis or the use of mechanical aids, such as the drawings of lines or the like.

It is also the practice with some automatic train recorders currently being used to employ two styli, operable simultaneously, for registering two distinctive markings on a record sheet which are indicative of train movement between two given points on a track layout. However, in order to determine the condition of the wayside signal at the initial point passed, a marking on the record sheet coinciding with train presence at that point must be read with reference to the marking indicative of train passage to the second of the two points. Similar requirements are necessary in order to interpret train movement over a switch point.

In view of the above and other considerations it is proposed in accordance with the present invention to provide improved automatic recording apparatus capable of producing a graphic record from which the progress of each train over a controlled traffic layout can easily be followed without the need for mechanical aids or the necessity of referring to a second graphic representation in order to ascertain the condition of the equipment governing train movement over a selected point or the route taken by a train at that selected point.

One object of the present invention is to provide automatic recording means which will graphically indicate the time when and the direction for which each controlled wayside signal in a track layout was cleared for train passage.

Another object of this invention is to provide automatic recording means which will indicate by reference to a single graphic configuration the route taken by each train at each controlled switch in the track layout.

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A further object of the present invention is to record by means of a single graphic configuration the instant when each train entered and vacated the track section being monitored by a given stylus.

A still further object of this invention is to graphically provide distinctive markings on the record sheet whenever a train enters a track section which is governed by a restrictive signal.

Other objects, purposes and characteristic features of the present invention will be in part obvious from the accompanying drawings and in part pointed out as the description of the invention progresses.

In describing the invention in detail reference will be made to the accompanying drawings in which similar reference characters are used for designating corresponding parts throughout the various figures, and in which:

FIGS. 1A and 1B placed end to end comprise a diagrammatic illustration of one form of circuit organization of the automatic train recording apparatus according to one embodiment of this invention;

FIG. 2 is a view illustrating a portion of the record sheet with the indications made thereon by automatic recording apparatus as shown in FIG. 1 monitoring two points of a complex track layout;

FIGS. 3A through 3G illustrate the graphic configurations made by the automatic train recording apparatus according to the present embodiments of this invention for a variety of traffic conditions;

FIG. 4 illustrates schematically train recording apparatus in accordance with another embodiment of this invention.

Conventional schematic diagrams have been used for the disclosure of the circuit organization shown in the drawings. Such drawings are prepared more particularly to facilitate an understanding of the mode of operation of the system, rather than to attempt to point out all of the necessary details of construction and specific arrangement of components that may be provided by those skilled in the art in accordance with the requirements of practice. The symbols (+) and (−) have been used to indicate connections to the respective positive and negative terminals for suitable batteries or other sources of direct current.

A variety of centralized traffic controlling systems are well known to those familiar with the art, therefore, it is believed sufficient to describe only the general structure and operation of those components of a centralized traffic controlling system which are essential to an understanding of the present invention. Although any one of a number of different centralized traffic controlling systems may be used in conjunction with this invention, it is assumed, for this embodiment of the present invention, that a system similar to that described in the N. B. Coley Patent No. 2,626,314, dated January 20, 1953, is employed wherein one timer and one stepping relay bank are required for transmitting and receiving purposes at the respective central office and the field stations.

Code communication is begun at the central office by initiation of the timing device at that location by the system's operator and is in accordance with the selection of a control for transmission to the field station in order to bring about a change in the condition of the controlled switching and signalling equipment governing traffic over the track layout at said field station. The initiation of the timing device at the field location for transmission purposes occurs whenever a change in the condition of the equipment governing traffic movement over the track layout at that field station is to be indicated to the system's operator located at the central office.

The initiation of the timing device at a receiving location is in accordance with the initial opening of the line

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circuit between the central office and the field station by the transmitting station.

Code communication is effected by the operation of the system from a state of rest into a cycle of operation during which code characters are transmitted as selected "marks" and "spaces" or similar type characters may be used. The stepping rate is determined by suitably normally inactive timing devices such as code oscillators at the central office and the field stations which when initiated, operate at a predetermined rate to govern the associated stepping relays.

Although different types of timing devices may be used for governing the rate of operation of the stepping relays, the timing device employed is similar to the oscillator illustrated in FIG. 4 which is shown as being of the torsional pendulum type of the general character disclosed in the patent to O. S. Field, No. 2,351,588, dated June 20, 1944. The oscillator CT is shown as being normally inactive but retained in one of its extreme rotated positions so that it can be started from a predetermined contacting position when it is desired to initiate the stepping of code communication apparatus at its associated station. Therefore, the oscillator CT is normally steadily energized when the system is at rest and upon setting the code communication system into operation, energy is removed from the electromagnet of the oscillator and the torsional pendulum of the oscillator is permitted to swing free in oscillations.

Central office equipment is assumed to include a control machine of the well known type used in centralized traffic controlling systems. The control machine includes a track diagram of a complex track layout of which the simple track layout shown in FIG. 1A forms a part thereof. Suitably disposed on the control panel, either directly on the control panel or below the track diagram are levers and buttons for manipulation of track switches and signals by remote control to the desired positions.

Suitable indicator lamps may be disposed along the trackway of the diagram for indicating the conditions of occupancy of the respective track sections within the controlled territory. Indicator lamps may also be provided on the control panel in accordance with the requirements of practice for indicating the positions of track switches and the conditions of the signals governing traffic movement through the track layout for which the control machine is provided.

The indicator lamps are controlled by indication relays which respond to the indication codes transmitted by the field station and apply the indications to the lamps located on the control panel of the control machine. The indication relays may be any one of a number of suitable types of relays but are shown in the present embodiments of this invention as the two position, magnetic stick relays TK, RGK, LGK, NK and RK of FIG. 1B. These relays are positioned by suitable coding relays in accordance with the polarity of the energizing current. If such a relay is in the position called for by the indicated code, the energy it will receive will tend to hold it in its present position and it will not change its position.

More specifically, referring to FIG. 1A, there is shown a simple track layout T comprising a main stretch of track connected by means of a track switch 1W with a second stretch of track. East-bound traffic over the track switch 1W is governed by the signal 1R while westbound traffic over the track switch 1W is governed by the signals 1LA and 1LB.

Also shown are suitable signal repeater relays LGP and RGP, switch repeater relays WNP and WRP and a track relay TR. These repeater relays are energized and deenergized in accordance with the condition of the device associated therewith. The relays are shown in block form without their specific circuits being illustrated as the control circuits for these repeater relays are well known to those familiar with the art.

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Associated with this group of signal repeater relays is a relay LC1 and a change relay CH which initiates the communication system into a cycle of operation when there are indications to be transmitted from the field station.

The CH relay is shown as being normally energized by a stick circuit through the front and back contacts of the signal and switch repeater relays and the track relay. The LC1 relay is energized in accordance with the deenergization of the CH relay and applies the indications represented by the position of the contacts of the track relay and the signal and switch repeater relays to the indication buses. The LC1 relay remains picked up throughout the indication cycle and is restored to its normal position when the stepper relays are picked up and the indication cycle has been completed. The CH relay is picked up by a stepper relay during the second step of the indication cycle. As the present invention is not particularly concerned with this part of the operation of the centralized traffic control system it has not been shown. However, for a detailed description of this portion of the circuit reference can be made to the N. B. Coley Patent No. 2,626,314, dated January 20, 1953.

Indications as to a change in the condition of any of the equipment governing train movement over the track layout are applied to the code buses by means of the front contacts of the LC1 relay. The first two contacts of the LC1 relay are shown by means of dotted lines as only the remaining five contacts are essential to the purposes of this disclosure. It is to be understood, however, the first contact would be employed for lockout purposes and the second contact used for station identification. The indications are transmitted by means of the field station timing device and stepper relay circuits and received by similar circuitry located at the central office. The indication relays, TK, RGK, LGK, NK and RK at the central office receive and store the indications in accordance with the polarity of the local energizing current which is determined by suitable coding relays located at the central office which are operated in accordance with the indication code received from the field station. For example, should an indication for clearing the signal 1R be transmitted from the field station, the magnetic stick relay RGK will be energized by a current of suitable polarity to cause it to close its front contacts. Should the indication relay RGK be in the position called for, it will receive an impulse of energy of the correct polarity to hold it there and there will be no change in this signal indication relay.

The indication lamps which are disposed along the control panel of the centralized traffic controlling machine are illustrated in FIG. 1B and are designated by the letters TE, RGE, LGE, NE and RE. These lamps provide the operator of the centralized traffic control machine with visual indications of the condition of the controlled devices at the field station.

Relay TKP is a dual winding slow pick up magnetic stick relay which opens and closes its contacts in accordance with the energization and deenergization of the track occupancy indication relay TK. The relays RGKP and LGKP are slow pick up relays which are energized and deenergized respectively by the signal indication relays RGK and LGK and are used to energize the right coil 1RC and the left coil 1LC respectively of the stylus mechanism.

The stylus 1S is shown as being controlled in accordance with the energization of a coil 1RC which controls the stylus for movements on the record sheet to the right of its normally median position and the coil 1LC which performs this same function for movements to the left of the median line drawn on the record sheet of the stylus. The stylus mechanism therefore is a three position device in which two coils are used with a single armature to record two separate but not simultaneous events. The coil 1RC in the unit moving the stylus 1S

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to the right. The coil 1LC moving the stylus 1S to the left. The armature is spring biased to return the stylus to its normal median position upon the removal of energy from the winding of either coil where it continues to draw a straight median line on the graph paper which is arranged to steadily move preferably toward the operator at a suitable paper speed.

FIG. 2 illustrates a portion of the record sheet used with this invention. The styli 1S and 2S are shown to indicate the ease with which the progress of a train may be followed throughout a complex track layout by following the graphic record made by each stylus.

Each stylus 1S and 2S produces a complete graphic record of the condition of the equipment and the route taken by each train at the point monitored by the stylus. Therefore, although this description of the present invention is applied principally to the stylus 1S and a simple track layout, it should be understood that the stylus 2S is operated by equipment similar to that for actuating the stylus 1S and because the recording apparatus of this invention provides a complete record of the equipment position and the route taken by each train at each field location of the track layout the complexity of a given track layout places no restriction upon the invention.

FIGS. 3A, 3B, 3C, 3D, 3E, 3F and 3G illustrate the graphic records of indications provided by the recording apparatus of this invention in response to a variety of traffic conditions at the field location being recorded by the stylus 1S. FIG. 3A shows the graphic record of indications produced by the recording apparatus in response to train movement from left to right as shown in FIG. 1A, with the signal 1R cleared for passage to the right and the track switch 1W in the normal position. The trace produced is offset from the median line in the direction of travel of the train and the length of the offset portion of the trace is a measure of the length of time required for the complete train to travel through track section T, i.e., the length of time required for the complete train to travel the distance *ab*.

Train movement from left to right with the signal 1R cleared for train passage over the switch 1W in the reverse position is illustrated in FIG. 3B. It is to be noted that the right offset portion of the trace is begun with a momentary swing of the stylus to the left of center thus recording a single line "spike" to the left of center before drawing the right offset portion of the trace which records the passage of a train from left to right.

FIGS. 3C and 3D respectively illustrate the configurations produced by the recording apparatus of this invention for the switch 1W in normal and reverse positions with the signals 1LA and 1LB cleared for train passage from right to left as shown in FIG. 1A.

It is to be noted that when a train movement is made over a switch in the reverse position the track recording this movement shows a single line "spike" in the direction opposite to the direction of the trace offset that records the direction of the train movement.

FIG. 3E shows the trace made by a stylus at the instant when the corresponding signal is cleared for a passage of a train from left to right. It is made by a quick swing to the right and back to its median position at the instant that the signal clear indication pulse is recorded at the central office. FIG. 3C shows the trace made by the stylus when the signal is cleared for a passage of a train from right to left.

If a train should enter a track section for which no signal has been cleared, i.e. if a train should "overrun" a signal this fact can be recorded on the graphic sheet as shown in FIG. 3F. FIGURE 4 shows a circuit for producing this record in accordance with this invention.

FIG. 4 is an alternate network similar to that shown in FIG. 1B except that it provides that an LCR network be used in lieu of the relay TKP to provide a pulse of energy to cause the stylus mechanism to momentarily move in a direction contrary to the di-

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rection of train movement if the track switch is in the reverse position when track occupancy occurs.

A second distinction of the circuit shown in FIG. 4 is the use of a timing device to produce the graphic record of a train "overrunning" a stop signal which is shown in FIG. 3F. The timing device is indicated as being a torsional pendulum type of oscillator CT similar to that used in the Coley patent cited above. However, it is to be understood that any suitable timing device or the oscillator employed with the centralized traffic controlling system may be used and it is to be further understood that the oscillator selected may be used to provide a distinctive configuration for a train "overrunning" a stop signal in the same manner as shown in FIG. 4 with the circuit organization shown in FIG. 1.

Referring to FIG. 1A and FIG. 1B, let us now assume that wayside signal 1R has been cleared by the operator at the central office for train passage from left to right with the track switch 1W in the normal position. Signal repeater relay RGP will become deenergized, momentarily opening the stick circuit, including front contact 25 and the lower winding of the relay CH, causing that relay to drop away. The deenergization of the relay CH completes an obvious circuit through its back contact 26 for the energization of relay LC1 which in closing its front contacts 32, 33, 34, 35 and 36 connects the contacts of the repeater relays to the field station CTC stepper and timing circuits. The LC1 relay is held up throughout the indication cycle by means of a stick circuit including its front contact 9.

This indication is transmitted over the line wires by means of the stepper circuits at a rate determined by the field station timing equipment and is received at the central office and applied to the indication relays by similar stepper and timing circuits causing the signal indication relay RGK to become energized. The energization of the signal indication relay RGK closes its front contact 45 resulting in the energization of the indication lamp RGE on the control panel of the centralized traffic controlling system machine thereby apprising the operator of the change in condition of the wayside signal 1R.

Energization of the relay RGK closes its front contact 44 completing an obvious circuit for energizing the signal indication repeater relay RGKP. This relay is a slow pick up relay hence its contacts are picked up only after a momentary lapse of time.

Energization of the signal indication relay RGK also closes its front contact 46 completing a circuit which includes back contact 57 of the slow pick up relay RGKP and the right coil 1RC of the stylus mechanism. The right coil of the stylus mechanism is energized by means of this circuit until back contact 57 of the signal indication repeater relay RGKP is opened. The momentary energization of the coil 1RC offsets the stylus 1S to the right of the median position. When back contact 57 of relay RGKP is opened, the coil 1RC is deenergized and the stylus 1S is restored to its normally median position producing the initial graphic indication shown in FIG. 3A.

It has been previously mentioned that the signal indication relay RGK is a magnetic stick relay and consequently it will remain in its last operated position, until it is energized by energy of the opposite polarity sense from the coding relays of the traffic controlling system. It is to be noted therefore that the relay RGKP after a momentary delay in picking up will thereafter remain energized in accordance with the picked up position of the relay RGK until its stick circuit is opened at the front contact 41 on the track indication relay TK after release of relay RGK.

Let us now assume that a train T1 accepts this signal with the switch 1W in the normal position and a track occupancy indication is transmitted from the field station to the central office by the drop away of front contact 20 of the track relay TR again opening the stick circuit

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for the relay CH. This track occupancy indication is transmitted to the central office and the indication relay TK is energized causing the pick up of its front contact 42 energizing the track occupancy indication lamp TE by an obvious circuit.

Energization of the indication relay TK also closes its front contact 40 completing an obvious circuit to the lower winding of the track occupancy indication repeater relay TKP causing this relay to become energized. The relay TKP is a dual winding magnetic stick relay which is slow to pick up.

The pick up of front contact 41 of the indication relay TK completes a stick circuit for the indication repeater relay RGKP. This circuit includes (+), front contact 41 of the relay TK, front contact 56 of relay RGKP, the windings of RGKP, to (-). Hence the signal indication repeater relay RGKP remains energized after relay RGK releases until train T1 vacates the track circuit.

The closure of front contact 43 of the track occupancy indication relay TK completes a circuit to the right coil 1RC of the stylus mechanism. This circuit includes (+), front contact 43 of relay TK, front contact 55 of relay TKP, front contact 58 of relay RGKP, back contact 62 of relay LGKP and the windings of the right coil 1RC of the stylus mechanism to (-). Energization of the right coil 1RC will cause the stylus mechanism 1S to become displaced to the right of its median position and to retain that position for as long as the track occupancy indication relay TK is energized in accordance with the movement of the train T1 through the track circuit monitored by relay TK.

When the track occupancy indication relay TK becomes deenergized in response to the train T1 leaving the track circuit, front contact 43 is dropped away removing energy from the right coil 1RC of the stylus mechanism and the stylus 1S returns to its median position. Since the record sheet is moved at a suitable rate in accordance with the passage of time the configuration shown in the FIG. 3A is produced.

Referring to FIG. 3A it is to be noted that the stylus is offset from its median position in the direction of train movement and the length of the offset portion of the configuration provides an indication as to the length of time it took the complete train T1 to travel the distance *ab*. The lower horizontal portion of the configuration provides a graphic record of the arrival of the front of the train T1 at point *a* and the upper horizontal portion of the configuration provides a graphic record of the departure of the rear of the train from point *b*.

Referring to that portion of the record sheet shown in FIG. 2 it can be seen that signal was cleared for train passage from left to right at approximately 8:03 a.m. and the train T1 entered the track section with the switch 1W in the normal position at approximately 8:06 a.m. It can also be seen that the complete train required four minutes to pass through the distance *ab*.

Referring to the track layout diagram above the record sheet it is to be noted that the configurations produced by the single stylus 1S convey the information that the train T1 passed from point *a* to point *b* with the signal 1R cleared for train passage and the switch 1W in the normal position and also the time required by the train T1 to complete its passage through the track section *ab*. It is also to be noted that this information was conveyed without reference to the indications provided by another stylus.

Let us now assume that the signal 1R is again cleared by the operator at the central office for train passage from left to right as shown on the page in anticipation of the movement of a train T2 through the track circuit, with the track switch 1W in the reverse position and the switch indication relay RK is energized and the switch indication relay NK is deenergized in response thereto.

The clearing of the signal 1R by the operator at the central office will again cause the signal indication

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repeater RGP to become deenergized dropping away its front contact 21 and opening the stick circuit for the relay CH through its front contact 25. Deenergization of the relay CH closes its back contact 26 energizing the relay LC1 through an obvious circuit and placing the indication on the code buses.

The specific indication of the change in the condition of the wayside signal 1R will, of course, be transmitted through back contact 28 of the signal indication repeater relay RGP and front contact 33 of the relay LC1.

When the indication is received at the central office by means of the centralized traffic controlling code communication system circuits, relay RGK closes its front contact 45 thereby completing an obvious circuit to the indication lamp RGE located on the control panel of the centralized traffic controlling machine.

Energization of the relay RGK closes its front contact 44 completing a circuit to the windings of the signal indication repeater relay RGKP. Energization of the indication relay RGK momentarily completes a circuit to the right coil 1RC of the stylus mechanism during the time the signal indication repeater relay RGKP delays in picking up. This circuit includes (+), front contact 46 of indication relay RGK, back contact 57 of indication repeater relay RGKP, the right coil 1RC of the stylus mechanism, to (-). Energization of the coil 1RC momentarily offsets the stylus 1S to the right of its normally median position until back contact 57 of relay RGKP is picked up.

When the train T2 accepts this signal with the track switch 1W in the reverse position and the track occupancy indication is received at the central office, track occupancy indication relay TK is energized causing the pick up of its front contact 41 resulting in the completion of a stick circuit for the signal indication repeater relay RGKP. This circuit includes (+), front contact 41 of relay TK, front contact 56 of relay RGKP, the windings of relay RGKP, and (-).

The energization of the track occupancy indication relay TK also closes its front contact 40 completing an obvious circuit for energizing the lower winding of the track occupancy indication repeater relay TKP. The relay TKP is slow to pick up and during the interim that its back contact 55 is still closed, a momentary circuit for energization of the left coil 1LC of the stylus mechanism is completed. This circuit includes (+), front contact 43 of relay TK, back contact 55 of relay TKP, front contact 52 of the switch indication relay RK, back contact 51 of the switch indication relay NK, front contact 59 of relay RGKP, the left coil 1LC of the stylus mechanism and (-). Energization of the coil 1LC causes the stylus 1S to be momentarily offset from its normal median position to the left of the median position.

When back contact 55 of relay TKP finally picks up, energy is removed from the left coil 1LC and a circuit is completed to right coil 1RC of the stylus mechanism. This circuit includes (+), front contact 43 of relay TK, front contact 55 of relay TKP, front contact 58 of relay RGKP, back contact 62 of relay LGKP, the right coil 1RC of the stylus mechanism and (-). Completion of this circuit causes the stylus 1S to be actuated to the right of its normal median position and the stylus 1S will be displaced in this manner for as long as the track occupancy indication relay TK is energized in response to track occupancy of the track circuit being monitored by the stylus. When the train T2 leaves the track circuit *ac*, the relay TK is deenergized in response to the indication received from the field station and opens its front contact 43, removing energy from the right coil 1RC of the stylus mechanism and the stylus 1S is restored to its median position.

The configuration which illustrates the above situation is shown in FIG. 3B. It is distinguishable from the configuration indicative of a switch in the normal position by the small line or "spike" to the left of the median line which was produced by the quick over and back swing

of the stylus as a result of the energization of the left coil 1LC of the stylus mechanism during the interim that back contact 55 of relay TKP delayed in opening.

Referring to the sample record sheet shown in FIG. 2, we find that the configurations produced by the stylus 1S of the recording apparatus inform us that the signal was cleared for the passage of train T2 from left to right at approximately 8:15 a.m. and also that the train T2 entered the track circuit *ac* at 8:20 a.m. with the track switch 1W in the reverse position and the train T2 passed out of the track circuit *ac* at approximately 8:25. This information was produced by means of a single stylus 1S and without reference to any other configuration.

The operation of the circuit organization of this invention for train movement from right to left on the page is essentially the same as train movement in the opposite direction. Consequently in the interest of brevity, the following explanation will only concern itself with the operation of the circuit after the indications have been received at the central office by the indication relays TK, RGK, LGK, NK and RK.

Let us assume that the wayside signal 1LA has been cleared by the operator at the central office for passage of train T3 over the track switch 1W in the normal position and the signal indication relay LGK has become energized closing its front contact 48 completing an obvious circuit to the signal indication lamp LGE on the control panel of the centralized traffic controlling machine.

Energization of the relay LGK also closes its front contact 47 completing an obvious circuit for energizing the signal indication repeater relay LGKP which is designed to pick up slowly. During the time interval that the relay LGKP is delayed in picking up, a control circuit is completed for energizing the left coil 1LC of the stylus mechanism. This circuit includes (+), front contact 49 of relay LGK, back contact 61 of relay LGKP, the windings of the left coil 1LC of the stylus mechanism and (-). Energization of the left coil 1LC will displace the stylus 1S to the left of its normal median position for as long as back contact 61 of relay LGKP remains closed. When after a brief delay, the relay LGKP picks up its back contact 61, energy is removed from the left coil 1LC of the stylus mechanism and the stylus is restored to its median position.

When the train T3 accepts the clear signal 1LA and passes onto the track section *ba*, the track occupancy indication relay TK becomes energized closing its front contact 42 completing an obvious circuit to the track occupancy signal indication lamp TE on the control panel of the centralized traffic controlling machine.

The closure of front contact 40 of relay TK causes the energization of the lower winding of the track occupancy indication repeater relay TKP which closes its front contact 55 completing a circuit to the left coil 1LC of the stylus mechanism. This circuit includes (+), front contact 43 of the energized relay TK, front contact 55 of relay TKP, front contact 63 of relay LGKP, back contact 59 of relay RGKP, the windings of the left coil 1LC of the stylus mechanism and (-).

The stylus 1S, in response to energization of the left coil 1LC of the stylus mechanism, will now be displaced to the left of its median position and will remain in that position until the track occupancy indication relay TK no longer is energized in response to track occupancy of the track section *ba* by the train T3. The circuit to the left coil 1LC of the stylus mechanism is then opened by the drop away of front contact 43 of relay TK and the stylus 1S will be restored to its median position. The above situation is portrayed by the configurations shown in FIG. 3C.

Referring to FIG. 2 of the sample record sheet, it can be seen that a specific graphic record is provided as to the time the signal 1LA cleared and the direction for which said signal was cleared. A specific configuration is also provided showing the track switch 1W in the

normal position when the train entered the track circuit *ba* and the length of the vertical portion of the offset portion of the trace indicates the time the complete train T3 spent traversing the track section i.e. the time the complete train T3 required to travel through the distance *ba*. Also, the length of the median line between the "spike" recording signal clearance and the lower horizontal line of the offset portion of the trace is a measure of the length of time which elapsed between signal clearance and train arrival in the track section governed by that signal.

If the track switch 1W is in the reverse position and train movement over the switch 1W is from right to left the circuit organization of this invention would initially cause the stylus 1S to be momentarily actuated in a direction opposite to that of its final displacement on the left side of the median line. This configuration is illustrated for train T4 on the sample record sheet shown in FIG. 2.

Referring to FIG. 1B let us assume that the signal indication relay LGK and the signal indication repeater LGKP have been picked up in response to the wayside signal 1LB having been cleared by the operator at the central office and that the stylus 1S has produced the configuration shown on the record sheet for the train T4 indicative of the signal 1LB in its non-restrictive condition. Let us also assume that the switch 1W has been placed in the reverse position and therefore the switch indication relay RK is energized and the switch indication relay NK is deenergized.

When the train T4 accepts this signal 1LB it will cause the energization of the track occupancy indication relay TK completing an obvious circuit for the track occupancy indication lamp TE on the control panel of the centralized traffic controlling machine. Energization of the relay TK closes its front contact 40 completing a circuit for the energization of the lower winding of the track occupancy repeater relay TKP. A stick circuit for relay LGKP, through front contact 41 of relay TK is also completed, including front contact 60 of relay LGKP.

The pick up of front contact 43 of relay TK causes the momentary energization of the right coil 1RC of the stylus mechanism and energy will be provided for this coil 1RC during the time back contact 55 of energized relay TKP is delayed in picking up. This circuit includes (+), front contact 43 of relay TK, back contact 55 of relay TKP, front contact 52 of relay RK, back contact 51 of relay NK, front contact 62 of relay LGKP and the right coil 1RC of the stylus mechanism. Energization of the coil 1RC causes a momentary displacement of the stylus 1S to the right of its median position until back contact 55 of the slow pick up relay TKP is opened and the stylus 1S is restored to its normal median position.

When front contact 55 of relay TKP closes, a circuit is completed to the left coil 1LC of the stylus mechanism. This circuit includes (+), front contact 43 of relay TK, front contact 55 of relay TKP, front contact 63 of relay LGKP, back contact 59 of relay RGKP, the left coil 1LC of the stylus mechanism and (-). The stylus 1S will be displaced to the left of the median position and will remain at its final displacement point for as long as relay TK remains picked up in response to track occupancy of the track section *ca* by the train T4. When the train T4 passes out of the track section *ca*, relay TK drops away opening front contact 43, removing energy from the left coil 1LC of the stylus mechanism and the stylus 1S is again restored to its median position. The configuration produced by the circuit organization of this invention for the above conditions of train passage is shown in FIG. 3D.

Referring to the record sheet shown in FIG. 2, it can be seen that a specific indication is provided which registers the time at which the signal 1LB was cleared for

the passage of train T4 from right to left and another indication is provided showing the time required by the complete train T4 to travel the distance *ca* with the track switch 1W in the reverse position. Thus it can be seen that by providing a single stylus and the circuit organization of this invention at each track switch point, the route followed by each train traveling through a complex track layout may be indicated on the record sheet. A graphic record is provided of the time when and the direction for which each wayside signal governing the entrance to each said route is cleared, and also the time which elapsed between the clearance of a given wayside signal and entry of a train into the track section governed by said wayside signal.

The description of the operation of the recording apparatus of this invention has up to this point concerned itself solely with the stylus 1S and the circuit organization necessary to control the movements of said stylus so as to produce the pertinent graphic indications. However despite the fact that similar apparatus is required to actuate each stylus monitoring each point on the track layout from which information is desired, certain additional information can be obtained from the record sheet when a plurality of styli are employed.

Consequently, referring to FIG. 2 the passage of train T1 over the route *af* may be followed by reference to the graphic configurations produced by the cooperation of styli 1S and 2S. The circuit organization for the stylus 2S is not shown but it is to be understood that it is similar to that employed with the stylus 1S.

The graphic record of indications produced by the stylus 1S provides the time when and the direction for which wayside signal 1R was cleared for the passage of train T1 from left to right as shown on the page. It can also be seen that the train T1 entered the track section *ab*, with the switch 1W in the normal position at approximately 8:06 a.m. and left the track section *ab* at 8:10 a.m. The configurations produced by the stylus 2S indicate the time when the wayside signal 2LA was cleared for the passage of T1 over the track section *df*. It can also be seen that the train T1 entered the track section *df* with the track switch 2W in the normal position at 8:13 a.m. and cleared the point *f* of the track section *df* at 8:18 a.m.

It can thus be seen that the distance between the lower horizontal portion of the switch configuration produced by the stylus 1S for train T1 and the upper horizontal portion of the switch configuration produced by the stylus 2S for train T1 projected onto the time scale of the record sheet is a measure of the time required for the complete train T1 to travel the distance *af*. Of course, knowing the time required for the train T1 to travel a fixed distance *af*, permits calculation of the speed of the train.

Referring to the graphic indication made by the stylus 2S for the train T4, it can be seen that the wayside signal 2R was cleared for train passage from right to left on the page at 8:50 a.m. and the train T4 accepted this signal and at 8:53 a.m. entered the track section *fe* with the track switch 2W in the reverse position. It can also be seen that the train T4 cleared at point *e* at 8:58 a.m. and required five minutes for the complete train to travel the distance *fe*.

The configuration produced for train T4 by the stylus 1S in response to the recording apparatus of this invention illustrates that the wayside signal 1LB was cleared at 8:55 a.m. and the train T4 accepted this signal and entered the track section *ca* with the switch 1W in the reverse position at 9:00 a.m. and traversed the track section *ca* by 9:05 a.m. Thus, if the lower horizontal portion of the configuration produced by the stylus 2S and the upper horizontal portion of the configuration produced by the stylus 1S is projected onto the time scale of the record sheet, the difference between the two horizontal lines is a measure of

the time required by the train T4 to travel the distance *fa* over the track switches 2W and 1W in the reverse position. That is to say, the complete train T4 required from 8:53 a.m. to 9:05 a.m. to travel the distance *fa* with the track switches 2W and 1W in the reverse position.

A modified embodiment of this invention is illustrated when FIG. 4 is placed end to end with respect to FIG. 1A. This circuit arrangement may be employed to produce the quick over and back swing of the stylus when a track switch is positioned in the reverse position. In view of the previous circuit description, a sufficient understanding of this circuit arrangement may be obtained without the need for a complete detailed explanation. Briefly, the circuit organization shown in FIG. 4 substitutes an inductor L1, capacitor C1, and resistor R1 for the track occupancy indication relay TKP of FIG. 1B.

Let us assume that the wayside signal 1R has been cleared for train passage from left to right on the page with the track switch 1W in the reverse position and in response thereto the signal indication relay RGK, the signal indication repeater relay RGKP and the switch indication relay RK have been energized and their contacts picked up by means of the code communication circuits.

Now when a train accepts this signal and enters the track section *ab*, the track occupancy indication relay TK becomes energized in response to the indication transmitted from the field station by means of the centralized traffic controlling system. The energization of relay TK completes an obvious circuit to the track occupancy indicator lamp TE through front contact 42 and the closure of front contact 41 of relay TK completes a stick circuit for the signal indication repeater relay RGKP through front contact 56 of that relay.

Energization of the relay TK also closes its front contact 43, thereby establishing two possible circuit paths through which current may flow. One path is through the inductor L1. The second path is provided through back contact 51 of relay NK, front contact 52 of relay RK (switch 1W reverse), the resistor R1/capacitor C1 combination, front contact 59 of relay RGKP and the left coil 1LC of the stylus mechanism to (—).

When the contact 43 on relay TK closes the instantaneous reactance of the inductive branch of this circuit is a maximum while the instantaneous reactance of the capacitive branch is at a minimum. Therefore when contact 43 first closes there is a momentary flow of current much greater in the left coil 1LC than in the right coil 1RC. After a short period of time which is fixed by electrical time constants selected for this circuit network the stylus will move to the right after being displaced to the left for a brief period.

The final energization of the right coil 1RC of the stylus mechanism 1S through a circuit including (+), front contact 43 of relay TK, inductor L1, front contact 58 of relay RGKP, back contact 62 of relay LGKP, the right coil 1RC of the stylus mechanism and (—). As the right coil 1RC of the stylus mechanism is thus energized in accordance with the energization of the relay TK which is responsive to train presence in the track circuit *ab*, the stylus 1S will be maintained offset to the right of its median position for as long as the train occupies the track circuit *ab*.

The configuration produced will be that shown for the switch in FIG. 3B. It is of course the same configuration as that shown by the circuit organization when the relay TKP was included herein. The stylus 1S is restored to its median position when energy is removed from the right coil 1RC of the stylus mechanism by the opening of front contact 43 of relay TK when the train leaves the track circuit *ab*.

FIG. 4 illustrates another feature which may be employed with the circuit organization of this invention. The oscillator CT is used to provide a distinctive indication if a train should enter a track section at a time when

the wayside signal governing the track section is in a restrictive condition. This same information can be deduced from the lack of a signal clear indication record when the circuit organization shown in FIG. 1 is employed. However, as the record sheets used with train

recorders contain a large number of indications, a distinctive indication which concerns itself solely with a situation where a train "overruns" a stop signal would have value in that it would be more readily discernible. Although any one of a variety of timing devices may be used, including the timing devices used with the centralized traffic controlling system, the timing device employed in this feature of the circuit organization of this invention is illustrated as being an independent oscillator of the torsional pendulum type. The oscillator CT is shown as being normally steadily energized whenever the track occupancy indication relay TK is deenergized. When relay TK opens its back contact 37 in response to train pressure in the track circuit *ab*, energy is removed from the windings of the electromagnet of the oscillator CT and the torsional pendulum of the oscillator is thus permitted to swing free in oscillation. The amplitude and periodicity of the oscillations are determined by the characteristics of a torsional involute spring in combination with the inertia of the torsional pendulum to obtain the desired frequency of operation.

In accordance with rotary oscillation of the pendulum CT respective left movable contact finger 64 and right movable contact finger 65 are selectively alternately opened and closed against cooperating fixed finger 67 and 68 respectively by a suitable contact actuation means such as the cam 69.

Assume a train entered the track section *ab* and the wayside signals are displaying restrictive aspects. Under these circumstances both signal indication repeater relays RGKP and LGKP would be deenergized. When the track occupancy indication relay TK is energized in response to track occupancy by the train, the oscillator contacts are connected directly and alternately to the right coil IRC and left coil ILC of the stylus mechanism causing the stylus 1S to oscillate about its median position. The configuration produced is shown in FIG. 3F.

More specifically energization of the track occupancy indication relay TK in response to track occupancy opens its back contact 37 removing energy from the windings of the electromagnet of the oscillator CT and the torsional pendulum of the oscillator swings free actuating the cam 69. During the time left movable contact finger 64 touches fixed contact finger 67, a circuit is completed for energizing the right coil IRC of the stylus mechanism. This circuit includes (+), left movable contact finger 64, fixed contact finger 67, front contact 38 of relay TK, back contact 58 of relay RGKP which is deenergized in view of the stop aspect displayed by the wayside signal 1R, back contact 62 of relay LGKP which is deenergized in view of the stop aspects displayed by wayside signals 1LA and 1LB, the right coil IRC of the stylus mechanism and (-). Energization of the right coil IRC causes the stylus 1S to be offset to the right of its normally median position.

A second circuit is completed to the left coil ILC of the stylus mechanism when the actuating cam 69 places right movable contact finger 65 against its cooperating fixed contact finger 68. This circuit includes (+), right movable contact finger 65, fixed contact finger 68, front contact 39 of relay TK, back contact 63 of relay LGKP, back contact 59 of relay RGKP, the left coil ILC of the stylus mechanism and (-). Energization of the left coil ILC causes the stylus 1S to be offset to the left of its normal median position. Thus it can be seen that the stylus 1S is made to oscillate about its median position in accordance with the oscillations of the oscillator CT whenever a train enters a track section with the wayside signal governing said track section displaying a

"stop" aspect. This specific configuration is shown in FIG. 3F.

A railway traffic recorder has been shown which is capable of producing by means of a single stylus specific records at the time when and the direction for which each wayside signal governing entrance to each train route of a complex track layout is cleared and also shows clearly which route was taken by each train at each controlled switch as well as the time required for each train to traverse the track section containing the controlled switch. The recorder also produces a distinctive configuration on the record sheet whenever a track circuit becomes occupied and the wayside signals governing entrance to that circuit display a stop aspect. All of the above information is provided without reference to a second stylus or the indications produced by it. Therefore, if a number of styli were employed for monitoring traffic conditions at selected points of a complex track layout, train movements and the condition of the equipment governing such movements could easily be followed by referring to the records of indications produced by the stylus governing each said selected point.

Having thus shown and described two specific embodiments of the present invention it is desired to be understood that this has been done for the purpose of showing how this invention may be applied rather than illustrating its scope or the exact construction preferably employed in practice and it is to be further understood that the specific construction shown is susceptible of considerable modification to adapt the invention to the particular traffic controlling system to which it may be applied, all without departing from the spirit or scope of the present invention, except as limited by the appended claims.

What I claim is:

1. In apparatus for recording the route taken by a train through a track layout having a track switch for establishing different routes through said track layout, with detection means for each said route for registering track occupancy, the combination comprising, switch position indication means selectively operated in accordance with the position of said track switch, circuit means including only one stylus for recording distinctive configurations, and control means operated by said detection means for rendering said switch position indication means effective for providing a distinctive control for said stylus of said circuit means in accordance with the position of said track switch for as long as said control means is actuated by said detection means in response to track occupancy.

2. In apparatus for recording the route taken by a train through a track layout having a track switch for establishing different routes through said track layout, each said route including detection means for registering track occupancy, the combination comprising, switch position indication means selectively operated in accordance with whether said track switch is in a first or second position, track indication means operated by said detection means in response to track occupancy, circuit means including only one stylus operable from a normal to first and second conditions for providing distinctive configurations, and control means actuated by said track indication means for operatively connecting electrically said switch position indication means to said circuit means for displacing said stylus of said circuit means to said first condition for as long as said control means is actuated by said track indication means and said track switch is in a first position and for operatively displacing said stylus of said circuit means to said second condition and thereafter to said first condition for as long as said control means is actuated by said track indication means and said track switch is in said second position.

3. In apparatus for recording the condition of a wayside signal governing train movement over a railroad track section, said track section including detection means

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for registering track occupancy, the combination comprising, track indication means actuated by said detection means in response to track occupancy, timing means actuated by said track indication means for providing a distinctive output, recording means including only one stylus for recording distinctive configurations, and signal indication means operated by said wayside signal for operatively connecting electrically said distinctive output of said timing means to said recording means when said wayside signal is in a restricted condition and said track indication means is actuated by said detection means in response to track occupancy.

4. In apparatus for recording the condition of a wayside signal governing train movement over a railroad track section, each said track section including detection means for registering track occupancy, the combination comprising, track indication means actuated by said detection means in response to track occupancy, signal indication means responsive to said wayside signal for effecting a control circuit whenever said wayside signal is cleared for train passage, recording means including only one stylus for recording distinctive configurations, timing means actuated by said track indication means for providing a distinctive output, and repeater means operated by said signal indication means for connecting said control circuit of said selected signal indication means to said recording means for providing distinctive configurations whenever said wayside signal is cleared and for selectively connecting said distinctive output of said timing means to said recording means whenever said track relay registers track occupancy and said wayside signal is in a restricted condition.

5. In recording apparatus for a track layout having a track switch for establishing different routes through said track layout with a wayside signal for monitoring the entrance to each said route, each said route including detection means for registering track occupancy, the combination comprising, indication means responsive to the position of said track switch and the direction for which said wayside signal is cleared for selectively establishing a plurality of control circuits, recording means including only one stylus for providing distinctive configurations and means responsive to said indication means and said detection means for selectively rendering said established control circuits effective for actuating said stylus to provide distinctive configurations in accordance with said indication means.

6. In recording apparatus for a track layout having a track switch for establishing different routes through said track layout and provided with a wayside signal for mon-

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itoring the entrance to each said route, each said route including detection means for registering track occupancy, the combination comprising, signal indication means responsive to each said wayside signal for selectively establishing one of a plurality of control circuits, switch indication means responsive to the position of said track switch for selectively establishing one of a plurality of control circuits, recording means including only one stylus for providing distinctive configurations, repeater means responsive to said signal indication means for rendering said established circuit of said signal indication means effective for actuating said stylus to provide a distinctive configuration, and means thereafter responsive to said detection means in accordance with track occupancy for rendering said established control circuit of said switch indication means effective for actuating said stylus of said recording means to provide a distinctive configuration for as long as said detection means registers track occupancy.

7. In recording apparatus for a track layout having a track switch for establishing different routes through said track layout and provided with a wayside signal for monitoring the entrance to each said route, each said route including detection means for registering track occupancy, the combination comprising, signal indication means selectively operated in accordance with the direction for which each said wayside signal is cleared, switch indication means selectively operated in accordance with the position of said track switch, recording means including only one stylus for recording distinctive configurations, repeater means selectively energized by said signal indication means for effecting a distinctive control for said stylus of said recording means for providing a distinctive configuration, control means thereafter energized by said detection means in response to train presence for selectively connecting said switch indication means to said recorder means for as long as said train is present for providing a second distinctive configuration, whereby said stylus records a distinctive configuration for the direction for which said wayside signal is cleared and thereafter records a distinctive configuration for the position of said track switch for as long as said detection means registers track occupancy.

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