

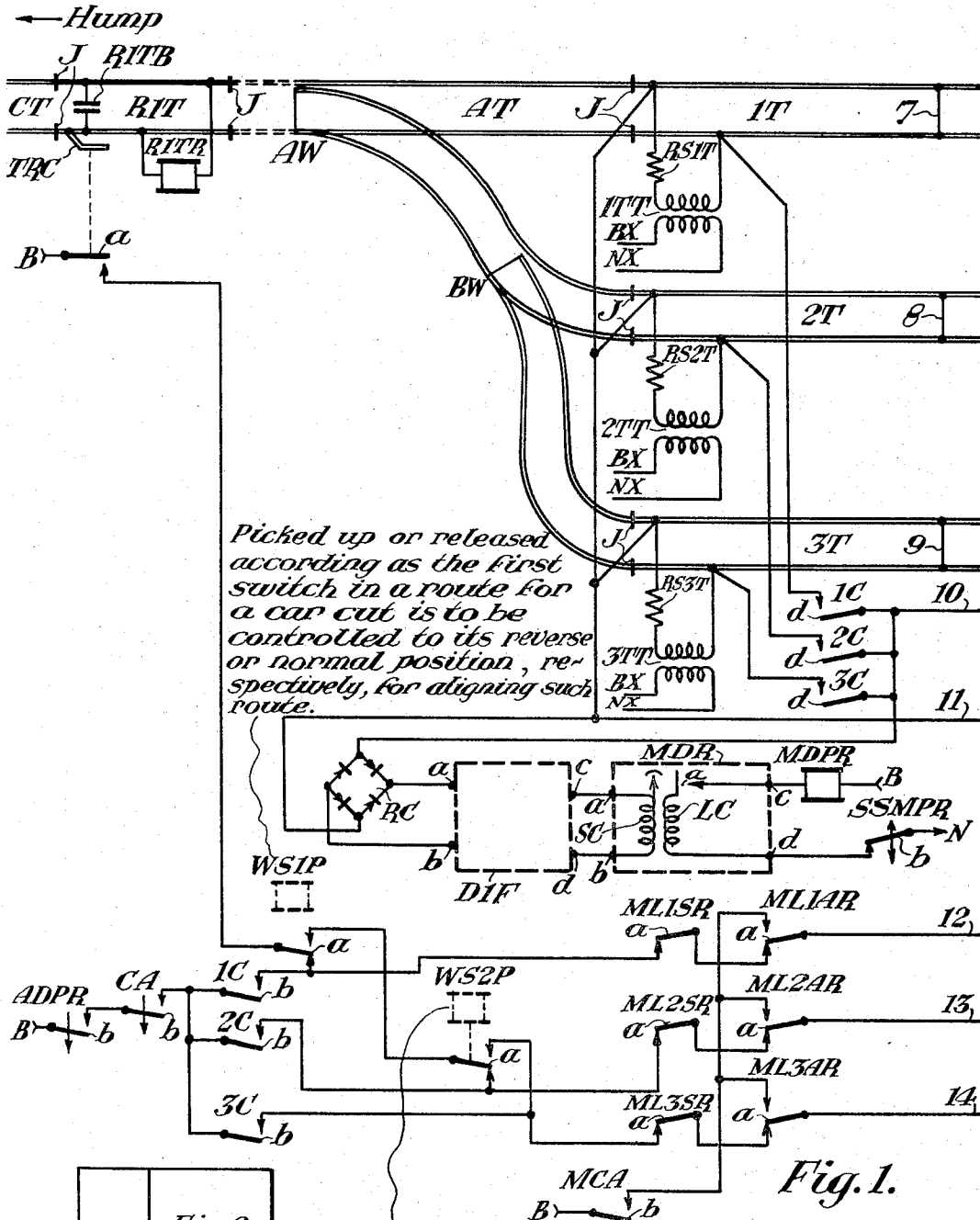
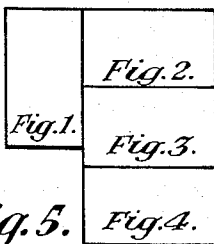
Sept. 19, 1967

E. C. DWYER ET AL
TRACK FULLNESS SYSTEM

3,342,989

Filed Dec. 27, 1960

4 Sheets-Sheet 1



Picked up or released according as the second switch in a route for a car cut is to be controlled to its reverse or normal position, respectively, for aligning such route.

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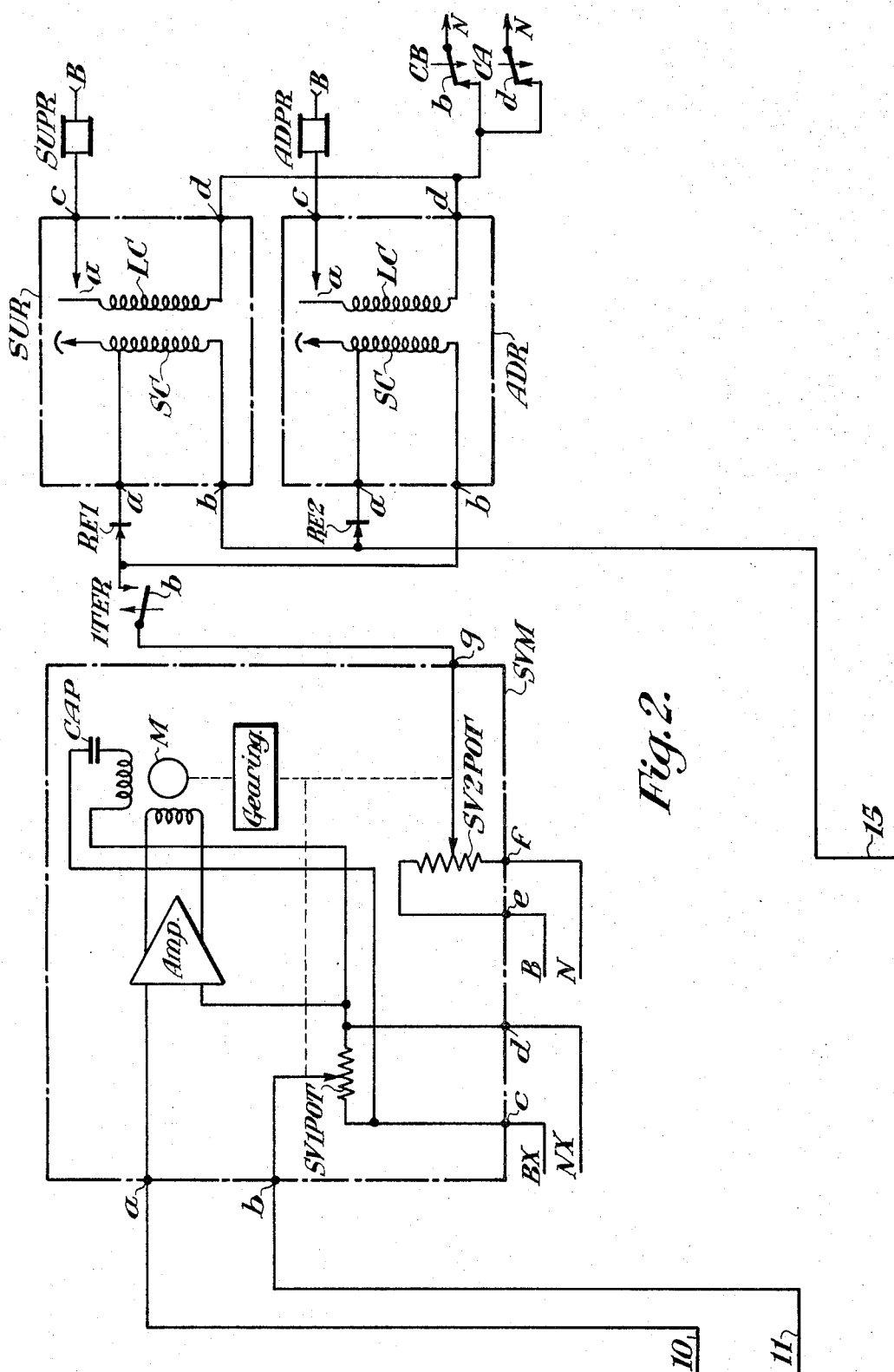
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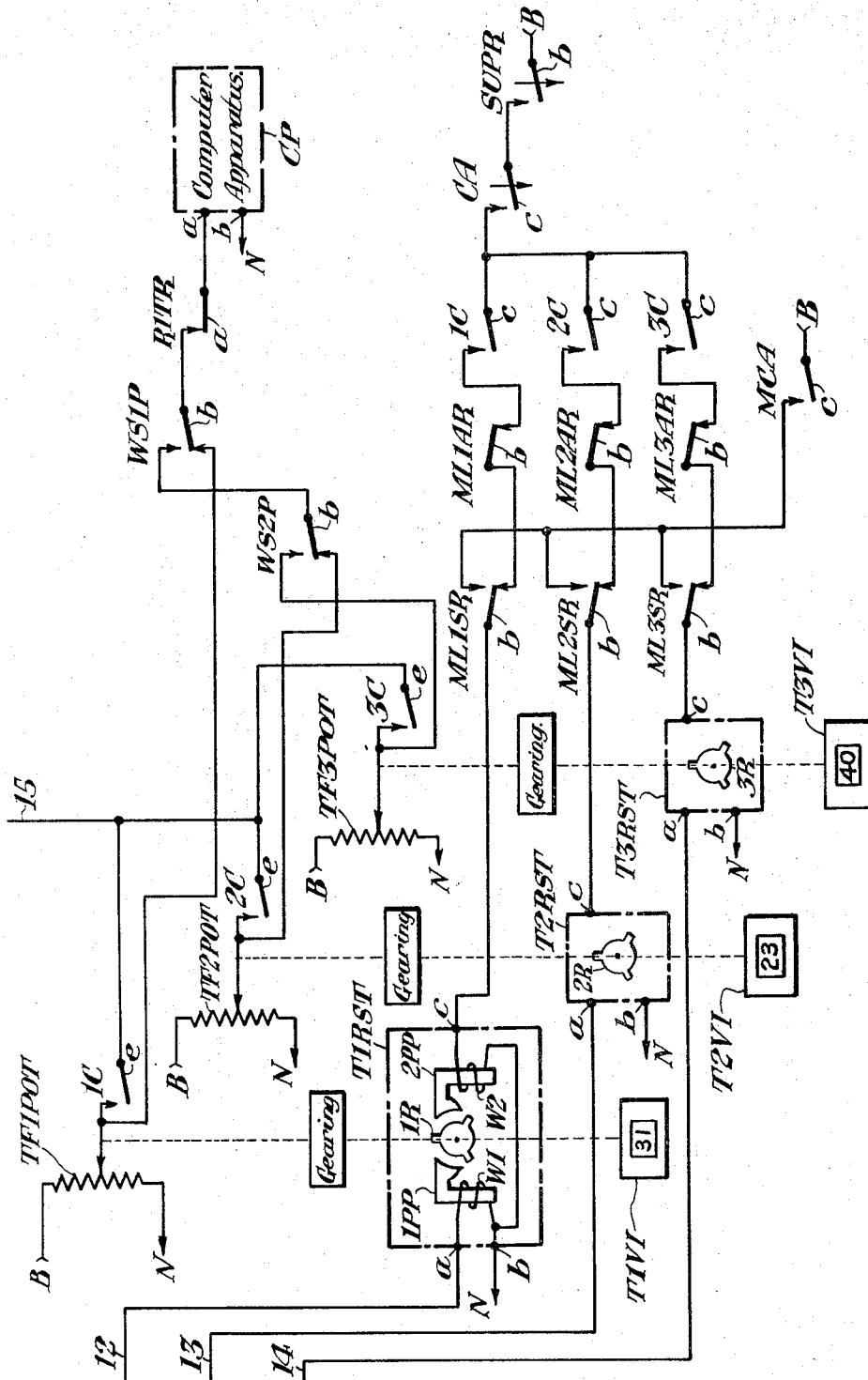


Fig. 3.

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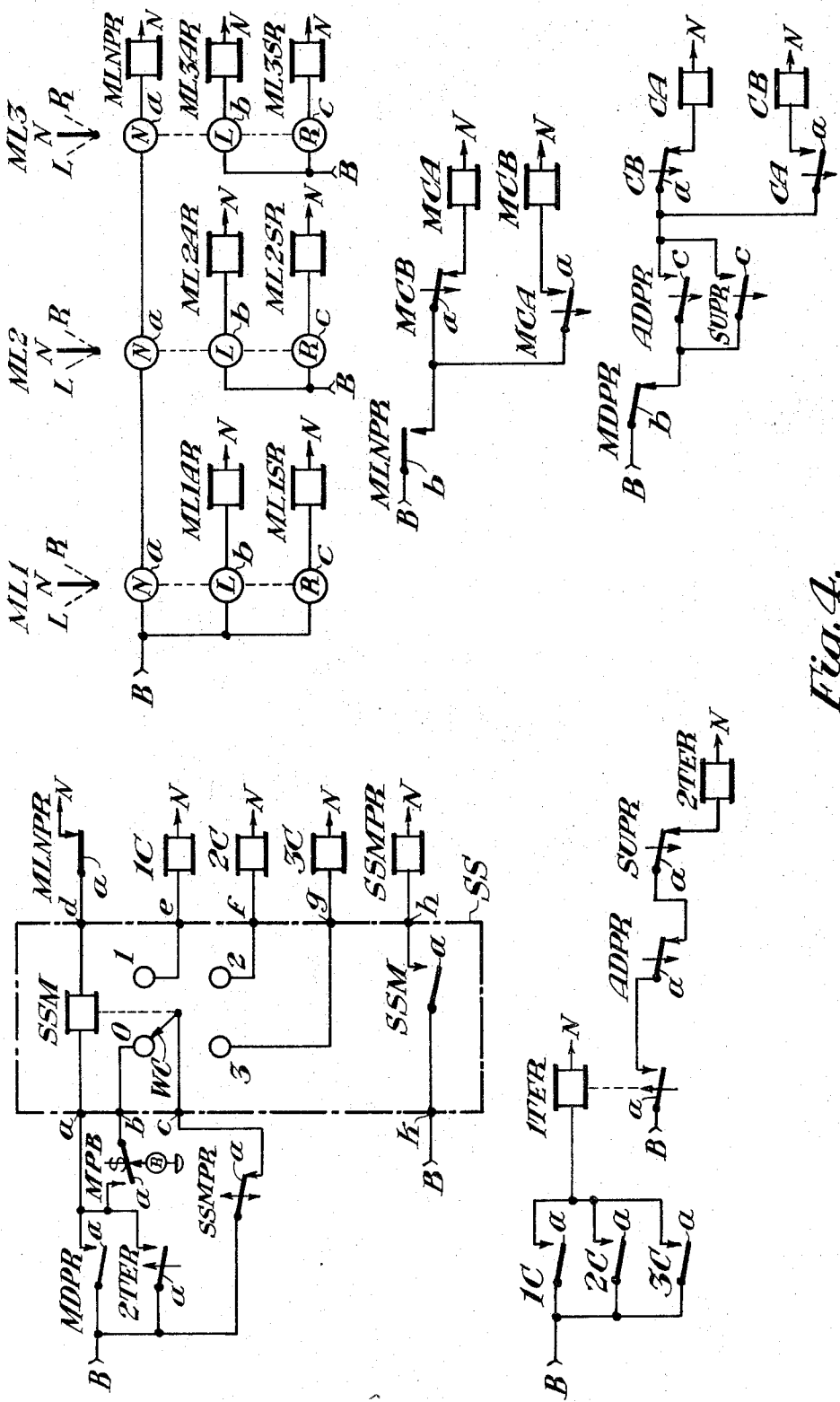


Fig. 4.

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3,342,989

TRACK FULLNESS SYSTEM

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merding, Pa., a corporation of Pennsylvania
Filed Dec. 27, 1960, Ser. No. 78,557
7 Claims. (Cl. 246—122)

Our invention relates to a track fullness system, and more particularly to a system for determining and indicating the distance cars being classified in a railway car classification yard of the gravity type have to travel in each storage track to couple with the last car previously routed to such track.

In the most modern railway car classification systems, railway yards of the gravity or hump type are employed and the railway cars to be classified are moved over the crest of the hump by a switching locomotive and thereafter proceed to their respective classification or storage tracks in the yard under the influence of gravity. In order that the cars will travel to couple with the preceding cars in their respective storage tracks but will not couple with an excessive impact, track brakes or car retarders are provided in each route to provide the correct retardation for each cut of one or more cars traversing the retarders and thereby provide the desired operation. Computers are employed to determine the correct amount of retardation for each cut and various variable factors such as cut weight, rolling resistance, etc. of each cut are supplied to the computers in order that a complete computation may be made.

Among the various factors to be considered by a computer in making a computation of the correct leaving speed of a cut from a retarder, in order that it will travel to couple without excessive impact with preceding cars, is the number of cars already in the destined storage track for the cut or, more correctly stated, the distance for the cut to travel to couple. Many of the track fullness systems heretofore employed in railway car classification yards make use of car counting or axle counting devices to determine the number of cars that have been routed to each track and, thereby, provide a measurement of the fullness of each individual track. However, the number of cars routed to each particular storage track is not always indicative of the distance to travel to coupling with preceding cars in a storage track since a previous car cut routed to that track could have stopped short of its destination and thereby have reduced the distance to travel to couple for the next car cut to be routed to that track.

It has heretofore been proposed to provide an alternating current track circuit in each storage track in a classification yard and to measure the impedance of each such track circuit to determine the distance between the entering end of the respective storage track and the nearest track circuit shunt, that is, to the nearest pair of railway car wheels and associated axle. Such a system would indicate the distance between the entering end of a storage track and the nearest railway car in the track but does not take into account cars that are routed to such storage track but have not yet reached the entering end of the track. Since the factor of the distance to travel in any particular storage track to which a car cut is routed must be known prior to the entrance of the cut into the last retarder in the respective route for the cut in order to compute the proper retardation for the cut when traversing that retarder, it is apparent that a car cut may be en route between the retarder and the entrance end of its respective storage track when it is desired to make a computation for a second car cut en route to that particular track. It is therefore essential for correct track fullness computations that each car cut en route

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between a retarder and the respective storage track for the cut be considered in the "distance to travel" computations. As previously stated, the track circuit impedance measuring system does not take into account such car cuts.

It is accordingly one object of our invention to provide a composite track fullness system that will, insofar as possible, provide true track fullness information to a car retarder leaving speed computer.

It is another object of our invention to provide a track fullness or distance to travel system that takes into account cars of unusual length and cars that stop short of coupling in their respective storage track.

It is a third object of our invention to provide a track fullness system that is self-adjusting following the removal of cars from a storage track.

It is a further object of our invention to provide means for detecting cars moving in a storage track, when a measurement of the distance to travel to coupling in that storage track is being made, and if moving cars are detected to postpone such measurement until a later time.

In accomplishing the foregoing objects of our invention we employ an axle or car counting means to provide continuous information relative to the track fullness of each storage track and means for periodically correcting such track fullness information by measurements of the distance to travel in each storage track providing no movement of a car or cars is detected in such storage track at the time such measurement is being made. We also provide means for supervisory manual correction of the track fullness information.

Other objects and characteristic features of our invention will become apparent as the description proceeds.

We shall first describe one embodiment of our invention and shall then point out the novel features thereof in claims.

In the accompanying drawings FIGS. 1 through 4 when arranged as shown in FIG. 5, comprise a diagrammatic view of track fullness or distance to travel apparatus embodying our invention.

There is shown in FIG. 1 a section of a classification yard of the gravity type into which railway cars enter from the direction of the hump indicated by the arrow in the upper left-hand corner of the drawing. Railway cars traversing the section of the yard shown enter a stretch of railway track comprising a first track section designated CT, and a second track section designated R1T. A second stretch of track indicated in the drawing by dotted lines is shown joining track section R1T to a third section of track designated AT. Track section AT connects through first and second track switches designated AW and BW, respectively, to yard car storage or classification tracks, or track sections designated 1T, 2T and 3T. That is, when switch AW occupies its normal position, as shown in the drawing, railway cars moving from the hump are routed through track section AT to storage track 1T. When switch AW occupies its opposite or reverse position the cars are routed over switch BW to storage tracks 2T or 3T according as switch BW occupies its normal position, as shown in the drawing, or its reverse position, respectively.

The rails of track section R1T are insulated from the rails of the stretch of railway track to the right thereof and from the rails of track section CT by insulated rail joints J shown in the drawing in the conventional manner by short lines drawn perpendicularly across the rails. Track section R1T is provided with a track circuit including the rails of the section, and a track battery R1TB and track relay R1TR both connected across the rails in such manner that the relay is normally energized, that is, is in its picked-up position when the rails of the track section are not shunted by the wheels and axle

or axles of a railway car. The purpose of track relay R1TR will be discussed later in this description.

The rails of each of the storage tracks 1T, 2T and 3T are insulated from the rails of track section AT by insulated rail joints J, shown in the drawings by short lines drawn perpendicularly across the rails, and each of the storage tracks is provided with an alternating current track circuit or loop circuit including the secondary winding of a track transformer, a resistor, the rails of the storage track and a conductor connected across the rails of the storage track at the end thereof remote from track section AT. This loop circuit for storage track 1T extends from one side of the secondary winding of a transformer 1TT through a resistor RS1T, one of the rails of the storage track, a conductor 7, and the other rail of the storage track to the other side of the secondary winding of transformer 1TT. The circuit for storage track 2T extends from a first side of the secondary winding of a transformer 2TT, through a resistor RS2T, one of the rails of the storage track, a conductor 8, and the other rail of the storage track to the second side of the secondary winding of transformer 2TT. Similarly, the circuit for storage track 3T extends from one side of the secondary winding of transformer 3TT, a resistor RS3T, one of the rails of the track, a conductor 9, and the other rail of the track to the other side of the secondary winding of transformer 3TT. The primary windings of transformers 1TT, 2TT and 3TT are each connected across the terminals of an alternating current source such as a generator or a commercial source of alternating current. However, for purposes of simplicity the source is not shown in the drawings, but its terminals are designated BX and NX. The purpose of the track loop circuits will be discussed later in this description.

It is believed expedient at this point in the description to discuss several conventions employed in the drawings.

First, energy for the operation of the direct current apparatus, other than track section R1T track relay, is furnished by a suitable source of control current, preferably a battery of proper voltage and capacity. For the sake of simplicity this power source is not shown in the drawings but its positive and negative terminals are identified by reference characters B and N, respectively.

Secondly, several of the relays shown in the drawings are slow acting, that is, slow to release, slow to pick up, or both. The windings of these relays are shown in the drawings by geometric rectangles, in the conventional manner, and the contacts of such relays are shown with an arrow drawn vertically through the movable portions of the contacts with the head of the arrow pointed in the direction that the contacts are slow acting. In the case of slow pickup, slow release relays, arrow heads are shown on both ends of the vertical lines drawn through the movable portion of the contacts.

Thirdly, the relay contacts are in most instances not disposed on the drawings directly below the geometric rectangles representing the respective relay windings but, where the contacts are not so disposed, the reference character designating the respective relay winding controlling each contact appears on the drawing directly above each contact or group of contacts. This arrangement is readily apparent from a brief inspection of the drawings.

Referring again to FIG. 1 of the drawings, it should be pointed out that track section CT is assumed to be a computer track section used to control the computation of a proper leaving speed for each cut of railway cars when leaving a car retarder not shown but assumed to be located in track section R1T. However, the details of the leaving speed computation control form no part of our present invention and, therefore, it is not necessary to show any track circuit or other apparatus associated with track section CT for computer control.

Further, the details of said assumed car retarder and its control form no part of our present invention and it is therefore not shown in the drawings. It should also be pointed out that in actual practice additional track sections may be located between track sections R1T and AT, and that track section AT may be provided with one or more track circuits. However, the details of this portion of the track layout also form no part of our present invention. Furthermore, as is well known, in actual yards a considerably larger number of storage tracks than three are employed but, for the purpose of simplicity, we have illustrated our invention showing only three yard classification or storage tracks.

There is shown located on one rail in track section R1T a wheel actuated instrument or contactor designated TRC and employed to count the axles of cars traversing the track section. The details of this contactor do not constitute part of our invention, but the contactor may be of any suitable type such as, for example, that disclosed in Letters Patent of the United States No. 1,818,970, issued August 18, 1931, to Harold C. Clausen for Track Rail Contactor. It is sufficient for the purpose of our description to point out that contactor TRC is provided with a normally open contact *a* that is momentarily actuated to a closed position by the passage of each wheel on one side of the railway cars traversing track section R1T. Contact *a* of contactor TRC is used to control a circuit for actuation of axle counting devices as hereinafter described, each four actuations of the device being assumed to represent one car. While we have shown the use of a wheel actuated device for determining the length of car cuts by obtaining a count of the number of cars traversing track section R1T, it is to be understood that other apparatus, such as photoelectric cells, track circuit arrangements etc., can be employed for counting cars and thereby determining cut length, in manners well known in the art, and that our invention is not intended to be restricted to the use of a wheel actuated device for car counting.

The windings of two relays designated WS1P and WS2P are shown in FIG. 1 by dotted line rectangles since the details of the control of these relays do not constitute part of our invention. These relays are switch control storage repeater relays and for purposes of this description may be considered to be controlled similarly to relays WS1P and WS2P shown in FIG. 3C of the copending patent application of Emil F. Brinker and David P. Fitzsimmons, Ser. No. 49,379, filed on Aug. 12, 1960, for Automatic Control System for Railway Classification Yards, assigned to the assignee of the present application and now Patent No. 3,226,541, issued Dec. 28, 1965. It is sufficient for purpose of this description to point out that relay WS1P repeats the switch control storage for the first switch in any route and relay WS2P repeats the switch control storage for the second switch in any route. That is, relay WS1P remains released when the first switch in a route for a cut of railway cars is to remain in or is to be controlled to its normal position for aligning the route for the cut and is energized when said first switch is to be controlled to its reverse position for aligning said route. Similarly, relay WS2P remains released when the second switch in a route for the cut is to remain in or is to be controlled to its normal position for aligning the route for the cut and is energized when said second switch is to be controlled to its reverse position for aligning such route. In the yard shown in FIG. 1, therefore, relay WS1P will remain released when a cut of railway cars, to be routed from the hump to storage track 1T over switch AW in its normal position, traverses the track stretch shown, and will be energized when the cut is to be routed to storage track 2T or 3T over switch AW in its reverse position. Relay WS2P will remain released when the cut is to be routed to storage track 2T over switch BW in its normal position, and will be energized when the cut is destined for storage track 3T over switch BW in its reverse position. Reference is made to said prior

patent for a complete understanding of the control of relays WS1P and WS2P, if such is desired.

Before entering into a detailed description of the overall scheme comprising our invention it is believed that it may be well to describe in some detail several of the components employed therein and the mode of operation of such components.

Referring to FIGS. 1 and 2, there is shown in FIG. 1 a motion detector including a full-wave rectifier designated RC and a differentiator designated DIF, and in FIG. 2 a servomechanism designated SVM having input terminals *a* and *b*. One of the input terminals of rectifier RC is connected with input terminal *a* of servomechanism SVM over a conductor designated 10, and is also connected in multiple with the heels of front contacts *d* of a plurality of relays 1C, 2C and 3C, to be described. The front contact points of said contacts *d* of relays 1C, 2C and 3C are connected to one rail of track sections 1T, 2T and 3T, respectively, adjacent the connections of the respective track transformers 1TT, 2TT and 3TT to the rails of each respective track section. The other input terminal of rectifier RC is connected with input terminal *b* of servomechanism SVM over a conductor designated 11, and is also connected in multiple to each of the other rails of track sections 1T, 2T and 3T adjacent the connections of the respective track transformers to the rails. The positive output terminal of rectifier RC is connected to an input terminal *a* on differentiator DIF, and the negative output terminal of rectifier RC is connected to an input terminal *b* on the differentiator. The rectifier RC and the differentiator DIF are employed to detect, at separate times, the movement of cars in each of the track sections 1T, 2T and 3T, and the servomechanism SVM produces at separate times values of output voltages or signals proportional to the track fullness of each storage track 1T, 2T and 3T. This will become more apparent later.

For motion detection and distance to travel measurements in each of the storage tracks 1T, 2T and 3T, we employ the principle that the impedance of a section of railway track from a source of alternating current connected across the rails at a first point in a track stretch to a shunt across the rails at a second point in the stretch is approximately proportional to the distance between the connections of said source to the rails and the shunt. For an example, if an alternating current source of 60 cycles per second is connected across the rails of a stretch of track and a shunt is connected across the rails or the wheels and axle of a railway car shunt the track stretch at a distance of 2000 feet from the connections to the rails of the alternating current source, the track circuit impedance of the 2000-foot section of track is approximately 0.40 ohm at infinite track ballast resistance and approximately 0.35 ohm at a ballast resistance of 1 ohm per 1000 feet. Assuming that a resistor having a resistance of approximately 10 ohms is connected between one side of the alternating current source and its connection to one of the rails of the track section, this resistance being large relative to the impedance of the described track circuit, the current through the resistor will remain approximately constant when a railway car shunts the rails at varying distances from the points of connection of the current source to the rails, but the value of voltage across the rails at said points of connection will vary approximately as the distance between such points and the nearest pair of wheels and axle of the railway car. Thus this value of voltage is indicative of the distance to travel between said points of connection of the alternating current source and the nearest railway car. It is readily apparent that, if said value of voltage is also continuously varying, such varying voltage is indicative of car motion, and it may be assumed that the nearest railway car is moving through the track section. As pointed out, storage tracks 1T, 2T and 3T are each provided with a loop track circuit arrangement which employs the principle just described.

Referring again to rectifier RC and differentiator DIF (FIG. 1), the input terminals of rectifier RC are connected at different times over front contacts *d* of relays 1C, 2C and 3C across the rails of storage tracks 1T, 2T and 3T, respectively, when each such relay is energized in a manner to be hereinafter described. For the purpose of this part of the description it will be assumed that a railway car is moving through track section 1T in a direction from left to right as shown in FIG. 1 and relay 1C is energized and closes its front contact *d* thereby connecting the alternating current voltage appearing across the rails of track section 1T to the input terminals of rectifier RC. A corresponding direct current voltage appears at the output terminals of rectifier RC and is supplied to the input terminals *a* and *b* of differentiator DIF. This direct current voltage is at a minimum when the railway car first enters track section 1T and gradually increases to its maximum value as the car advances farther into track section 1T. The differentiator DIF is shown in block diagram form since it may be one of several arrangements and its specific construction forms no part of our present invention. It is believed sufficient for this description to point out that the differentiator comprises circuits including values of constants such that a direct current voltage appears at output terminals *c* and *d* of the differentiator only when the voltage supplied to its input terminals is continuously varying in value. Differentiating circuits of the form herein employed are well known in the electrical art but for a complete description thereof reference may be made to Chapter 5 of Section III of "The Electronic Control Handbook" by Batcher and Moulic, published in 1946 by Caldwell-Clements, Inc., New York, N.Y. The direct current output from terminals *c* and *d* of differentiator DIF is supplied across terminals *a* and *b* of the control winding of a meter type relay designated MDR, to be considered as part of the aforesaid motion detector and to be described.

As previously pointed out, the input terminals *a* and *b* of servomechanism SVM (FIG. 2) are connected with the input terminals of rectifier RC over conductors 10 and 11, respectively, and when any alternating current is supplied to said rectifier it is simultaneously supplied to the input of the servomechanism. The servomechanism SVM is of an electrically driven potentiometer type well known in the art and comprises an amplifier AMP, a servomotor M, and first and second potentiometers designated SV1POT and SV2POT, respectively, the wiper arms of which are connected by means of suitable gearing to the shaft output of the servomotor as indicated by the dotted lines within the broken line rectangle enclosing the servomechanism. The servomechanism is also provided with input terminals *c*, *d*, *e* and *f* and an output terminal *g*, in addition to the input terminals *a* and *b* to which the reference voltage from each respective track section 1T, 2T and 3T is supplied over said conductors 10 and 11. Potentiometer SV1POT is a linear potentiometer supplied with alternating current across its winding from the same alternating current source as that employed to feed the loop track circuits in each of the storage tracks 1T, 2T and 3T. Terminals BX and NX of said alternating current source are connected to terminals *c* and *d*, respectively, on the servomechanism and these terminals are connected to opposite sides of the winding of potentiometer SV1POT. The wiper arm of potentiometer SV1POT is connected to input terminal *b* of the servomechanism. The input circuit of amplifier AMP is connected across input terminals *a* and *d* of the servomechanism. By this arrangement a resultant voltage equal to the difference between the voltage supplied to terminals *a* and *b* and the voltage supplied to terminals *c* and *d* of the servomechanism is supplied to the input of the amplifier. This resultant voltage is amplified until it is of sufficient power to drive the two-phase motor M and the output from amplifier AMP is supplied to the control winding of the motor. The con-

stant voltage winding of the motor is supplied with a voltage 90° out of phase with that supplied from the output of the amplifier, such phase shifted voltage being supplied across the constant voltage winding from terminals *c* and *d* of the servomechanism through a suitable phase shifting device shown as a capacitor designated CAP. The shaft of motor M is geared down through a suitable gearing arrangement and the output of the gearing arrangement is connected to the arms of potentiometers SV1POT and SV2POT as indicated in the drawings by the dotted lines previously mentioned. By this arrangement if the voltage at the output of potentiometer SV1POT is not equal to the input voltage supplied to terminals *a* and *b* of the servomechanism the motor M rotates, moving the arm of potentiometer SV1POT to reduce the voltage input to amplifier AMP to zero.

Terminals *e* and *f* of servomechanism SVM are connected to terminals B and N, respectively, of the direct current source and across the winding of potentiometer SV2POT in the servomechanism. The wiper arm of SV2POT is connected to output terminal *g* of the servomechanism and there appears at said output terminal a potential or a signal comprising a value of voltage representative of the distance to travel in each respective storage track 1T, 2T and 3T to which the input terminal *a* of the servomechanism is selectively connected. The apparatus connected to output terminal *g* of the servomechanism will be discussed hereinafter.

Such servomechanism arrangements as that just described are well known, but if a more complete description thereof desired reference may be made to chapter 2 of "Servomechanism Practice" by William R. Ahrendt, published in 1954 by McGraw-Hill Inc., New York, N.Y. FIGS. 2—2 and 2—3 and the associated description in chapter 2 of said book are specifically applicable to the servomechanism arrangement herein described.

There is shown in FIG. 3 a plurality of two-direction impulse actuated recording devices here shown as electromagnetic motors designated T1RST, T2RST and T3RST, the rotor shafts each of which are connected through suitable gearing arrangements to the arm of one of a plurality of potentiometers designated TF1POT, TF2POT and TF3POT, respectively, and to the actuating mechanism of one or a plurality of visual indicators designated T1VI, T2VI and T3VI, respectively. The shaft connections of each of the rotors to their respective associated apparatus is shown by dotted lines in the conventional manner. For purpose of simplicity, only the pole pieces and associated windings of motor T1RST are shown and will be described in any detail, it being understood that motors T2RST and T3RST are identical in construction and operation to motor T1RST.

Motor T1RST is provided with input terminals *a*, *b* and *c*, a rotor designated 1R and two pole pieces designated 1PP and 2PP. Pole piece 1PP is provided with a control winding termed a normal winding and designated W1. Similarly, pole piece 2PP is provided with a control winding termed a reverse winding and designated W2. The ends of winding W1 are connected to terminals *a* and *b* of the motor, and the ends of the winding W2 are connected to terminals *b* and *c* of the motor. Terminal *b* of the motor is connected to terminal N of the direct current source. When a pulse of energy from terminal B of the battery or direct current source is supplied, as hereinafter described, to terminal *a* of the motor, the motor rotor 1R is actuated a partial revolution in a first direction, and when a pulse of energy from terminal B of the battery is supplied, as hereinafter described, to terminal *c* of the motor, the rotor 1R is actuated a partial revolution in the direction opposite to said first direction. Such pulse actuated motors are well known. For example, an electromagnetic motor of the type disclosed in Letters Patent of the United States No. 2,432,600, issued Dec. 16, 1947, to Sture Eduard Werner et al. for Electromagnetic Motor may be used for each of the motors T1RST,

T2RST and T3RST shown in FIG. 3 of the present application. It is to be understood, however, that our invention is not to be confined to the use of such motors but any suitable bi-directional electrical impulse stepping device such as a ratchet operated device etc. can be used for each of the motors T1RST, T2RST and T3RST.

As previously stated, the rotor shaft of motor T1RST is connected by suitable driving means through a suitable gearing arrangement to the wiper arm of potentiometer TF1POT, said arm thereby being moved in one direction when the rotor 1R of the motor is actuated by an impulse supplied to the winding W1 of the motor and in the opposite direction when the rotor is actuated by an impulse supplied to winding W2. The rotor shaft of the rotor of motor T1RST is also connected through suitable driving means to the actuating mechanism of visual indicator T1VI. This indicator is shown as displaying an arbitrarily selected number, 31, which as hereinafter described in greater detail, may be assumed to indicate the number of railway car spaces available in storage track 1T or the number of railway cars already routed to that storage track, whichever indication is desired. Such visual indicators are well known and, therefore, the details of their construction are not shown in the drawings. However, it should be pointed out that, since our system is shown using an axle counting or wheel actuated device for determining the number of cars routed to each storage track, the gearing arrangement of indicator T1VI is such that the number displayed thereby is changed only upon every four actuations of the rotor of motor T1RST in one direction or the other and the number displayed is changed to a lower or higher number in accordance with the direction of rotation of rotor 1R. If a car actuated arrangement is used for car counting, the gearing arrangement of the indicator would be such that the number displayed would be changed with each actuation of rotor 1R.

The electromagnetic impulse motors T2RST and T3RST are identical in construction to motor T1RST and each are provided with input terminals *a*, *b* and *c* similar to motor T1RST. The visual indicators T2VI and T3VI controlled by the rotors 2R and 3R of motors T2RST and T3RST, respectively, are shown displaying arbitrarily selected numbers 23 and 40, respectively, and similarly to indicator T1VI display car space available in the respective storage tracks 2T and 3T or the number of cars already routed to each storage track, as desired. For the purpose of the remainder of this description the indicators will be assumed to display the number of cars already routed to each respective track.

A stepping switch designated SS is shown in FIG. 4 enclosed in a broken line rectangle. This stepping switch is a conventional type comprising a control or stepping magnet SSM and a movable wiper contact WC, but for purpose of simplicity is shown as having only four fixed contacts designated 0, 1, 2 and 3 with which the wiper contact WC sequentially makes contact as the switch is stepped through its complete cycle. Such stepping switches are well known and it is sufficient for purposes of this description to point out that wiper contact WC is moved one step in a clockwise direction upon the deenergization of stepping magnet SSM following each energization thereof, and thereby sequentially makes contact with the fixed contacts 0, 1, 2 and 3 in that order. The stepping switch is also provided with a contact *a* controlled to a closed position upon each energization of stepping magnet SSM and returned to its normal open position upon each deenergization of said stepping magnet.

The stepping switch is shown provided with a plurality of input and output terminals *a* through *k* (omitting *i* and *j*) which are connected within the switch to different parts of the switch. Terminal *a* is connected directly to a first side of the control winding of stepping magnet SSM. Terminal *b* on the stepping switch is connected to the 0 fixed stepping contact and terminal *c* on the stepping

switch is connected to wiper contact WC. Terminal *k* of the stepping switch is connected externally to terminal B of the battery and internally to the heel of the movable portion of said contact *a* of stepping magnet SSM. The front contact point of said contact *a* is connected to terminal *h* of the stepping switch. Thus, a circuit may be completed between terminals *k* and *h* whenever stepping magnet SSM is energized. Terminal *d* of the stepping switch is connected to the second side of the control winding of magnet SSM, and terminals *e*, *f*, and *g* are connected to the stepping switch fixed contacts 1, 2 and 3, respectively. The purpose of the stepping switch component will be discussed hereinafter.

A plurality of manually operable circuit controllers comprising a spring return push-turn push button designated MPB and three three-position levers designated ML1, ML2 and ML3 are shown in FIG. 4. Push button MPB is provided with a normally open contact *a* which is actuated to a closed position when the push button is depressed as indicated by the arrow head on the movable portion of the contact. When the push button is depressed and then turned to the right as indicated by the encircled R on the push button, contact *a* remains closed so long as the push button remains so turned. When the push button is merely momentarily depressed the spring, indicated by the letter S on the push button, returns contact *a* to its normally open position as soon as the push button is released.

Manual control levers ML1, ML2 and ML3 normally occupy a center or normal position N and are operable to left and right hand positions designated L and R, respectively. There is disposed directly below each of the control levers a plurality of circles each representing a contact and each enclosing a letter N, R or L which indicates the position the respective manual control lever must occupy for the closing of a circuit through the respective contact. These contacts are indicated as controlled by each respective lever by dotted lines extending from the levers to the circles representing the associated contacts. This conventional arrangement will become more apparent as the description proceeds.

There is also shown in FIG. 4 two time element or time delay relays designated 1TER and 2TER. Such time element relays are well known in the art and each is provided with one or more contacts which are normally open and are controlled to closed positions only after a predetermined time interval following the energization of the control winding of the relay. The contacts of these relays are, therefore, indicated in the drawings as slow pickup front contacts. Upon deenergization of the control winding of such relays, following a period of energization thereof, the contacts of the relays are immediately released to their full open position.

In addition to the neutral type relays and the time element relays shown in the drawings in the conventional manner by geometric rectangles representing the windings of the relays, there is shown in FIG. 1, enclosed in a broken line rectangle, the coils and a contact of the previously mentioned meter type relay MDR. In FIG. 2, there is shown the coils and contacts of each of two additional meter type relays designated SUR and ADR, the coils and contacts of which are also enclosed in dotted line rectangles. While each of the relays MDR, SUR and ADR may be of any suitable type sufficiently sensitive to be actuated by a voltage of the order, for example, of 1.5 volts; for the purposes of this description, we have illustrated these relays as being meter-relays of a type manufactured by Assembly Products, Inc. whose address is 75 Wilson Mills Road, Chesterland, Ohio. Each of said relays is illustrated as of the type of meter-relay manufactured by said company, having a signal coil and a locking coil. It is to be understood, however, that our invention is not intended to be confined to the use of relays of such manufacture nor of the type illustrated but any

other type of relay suitable for the uses described may be employed.

Relay MDR (FIG. 1) is provided with a signal coil designated SC and a locking coil designated LC having an associated contact *a*. One side of the coil SC is connected to a terminal *a* on the relay and the other side of that coil is connected to a terminal *b* on the relay. Similarly, one side of coil LC is connected directly to a terminal *d*, and the other side of that coil is connected to a terminal *c* on the relay when said contact *a* associated with the coil is in its closed position. Contact *a* normally occupies its open position. Relays SUR and ADR (FIG. 2) are identical in construction to relay MDR and, therefore, it is not necessary to describe their internal circuit arrangement.

When a voltage signal is supplied to terminals *a* and *b* of relay MDR (FIG. 1) from the output terminals *c* and *d* of differentiator DIF, the signal coil SC of the relay is energized and contact *a* associated with relay LC is actuated to its closed position if the signal comprises a voltage in excess of a preselected value, for example, in excess of 1.5 volts. If energy from a source of current is supplied across terminals *c* and *d* of relay MDR when contact *a* is closed, locking coil LC serves to lock contact *a* in its closed position until the supply of current to that locking coil is interrupted. Contact *a* remains locked closed regardless of the interruption of the energizing current to the signal coil SC of the relay. This operation of the relay will become more apparent later in this description. Relays SUR and ADR operate in a manner similar to relay MDR, as will become apparent hereinafter.

Having described the internal details and operation of various components employed in our invention, we will now describe the apparatus controlling and controlled by said components to form the overall inventive combination, and then the operation of such circuits and apparatus.

Since the majority of the relays, employed in our invention and not already discussed, are shown in FIG. 4 of the drawings, we will first describe the apparatus and the operation thereof shown in that figure.

The stepping magnet SSM of stepping switch SS has two control circuits, the first of which is a multiple circuit extending from terminal B' of the battery in multiple over front contact *a* of relay MDP, to be discussed, and front contact *a* of relay 2TER, previously discussed, to terminal *a* of stepping switch SS, the control winding of magnet SSM, terminal *d* of the stepping switch and over front contact *a* of a relay MLNPR, to be discussed, to battery terminal N. The second control circuit for magnet SSM may be traced from terminal B of the battery over back contact *a* of a relay SSMPR, to be discussed, terminal *c* of the stepping switch SS, wiper contact WC of SS, the 0 fixed contact of SS, terminal *b* of SS, contact *a* of push button MPB, previously discussed, terminal *a* of SS, the winding of magnet SSM, terminal *d* of SS and over front contact *a* of relay MLNPR to battery terminal N. The stepping magnet SSM of stepping switch SS is thus energized whenever one of the relays MDP or 2TER becomes picked up and relay MLNPR is picked up; or when push button MPB is in its depressed position, relay SSMPR is in its released position, wiper contact WC is in contact with the 0 fixed contact of the stepping switch and relay MLNPR is picked up.

There is connected to each of the terminals *e*, *f* and *g* of stepping switch SS, one side of the control winding of each of three track selection relays designated 1C, 2C and 3C, respectively. That is, the control winding of relay 1C is connected to said terminal *e*, the winding of relay 2C is connected to terminal *f* of the stepping switch and the winding of relay 3C is connected to said terminal *g*. The other sides of the control windings of the relays are connected to terminal N of the battery. Thus, relay 1C, 2C or 3C becomes picked up whenever relay

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SSMPR is in its released position and wiper contact WC is in contact with the 1, 2 or 3 fixed contact, respectively, of the stepping switch.

One side of the control winding of a stepping switch magnet repeater relay designated SSMPR is connected to terminal *h* of the stepping switch SS, the other side of said control winding being connected to terminal N of the battery. The remainder of this control circuit has been previously discussed and relay SSMPR is energized whenever stepping magnet SSM is energized and is de-energized whenever said magnet is deenergized. However, relay SSMPR, being provided with a slow-pickup, slow-release feature, opens and closes its back contacts only after a brief time delay period following the energization and deenergization, respectively, of the control winding of the relay.

Relay 1TER, previously mentioned, has a multiple control circuit extending from terminal B of the battery in multiple over front contacts *a* of relays 1C, 2C and 3C, and thence through the winding of the relay to battery terminal N. Thus, relay 1TER is energized when one of the relays 1C, 2C or 3C is energized, but closes its front contacts only following the time delay period if the relay, as previously discussed.

Relay 2TER has a control circuit which may be traced from terminal B of the battery, front contact *a* of relay 1TER, back contact *a* of relay ADPR, to be discussed, back contact *a* of relay SUPR, to be discussed, and through the winding of relay 2TER to battery terminal N. Relay 2TER is thus energized when relay 1TER becomes picked up and relays ADPR and SUPR are released. Relay 2TER closes its front contact following the previously discussed time delay period of the relay.

A plurality of relays controlled by the previously discussed manual control levers ML1, ML2 and ML3 are shown in the upper right hand corner of FIG. 4. Relays ML1AR and ML1SR are controlled by lever ML1, relays ML2AR and ML2SR are controlled by lever ML2, relays ML3AR and ML3SR are controlled by lever ML3, and relay MLNPR is controlled by all three control levers. The control circuit for normal lever repeater relay MLNPR extends from terminal B of the battery in series through contacts *a* of levers ML1, ML2 and ML3 closed in the normal position of the levers, and through the winding of relay MLNPR to battery terminal N. Thus, relay MLNPR is picked up when levers ML1, ML2 and ML3 all occupy their normal positions as shown in the drawing.

Relay ML1AR has a pickup circuit extending from battery terminal B through contact *b* of lever ML1 closed when the lever is actuated to its left hand position, and the winding of the relay to battery terminal N. Relay ML1SR has a pickup circuit extending from battery terminal B, contact *c* of lever ML1 closed when the lever is operated to its right hand position, and through the winding of the relay to battery terminal N. Relays ML1AR and ML1SR are, therefore, energized whenever lever ML1 is actuated to its left hand or right hand position, respectively.

Relays ML2AR and ML2SR, and relays ML3AR and ML3SR have control circuits similar to that described for the corresponding relays ML1AR and ML2AR and it is believed not necessary to describe these control circuits in detail. It is sufficient for the purpose of this description to point out that relays ML2AR and ML3AR are energized whenever each respective control lever ML2 and ML3 occupies its left hand position, and relays ML2SR and ML3SR are energized when each respective lever ML2 and ML3 occupies its right hand position.

Two pairs of slow release relays MCA and MCB, and CA and CB are also shown in FIG. 4. Each pair of relays forms code generating apparatus, as will become apparent. Relay MCA has a pickup circuit extending from battery terminal B over back contact *b* of relay MLNPR, back contact *a* of relay MCB and through the winding of relay MCA to battery terminal N. Relay MCB has a

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pickup circuit extending from battery terminal B, back contact *b* of relay MLNPR, front contact *a* of relay MCA, and the winding of relay MCB to battery terminal N. When relay MLNPR is released by one of the control levers ML1, ML2 or ML3 being moved from its normal position, relays MCA and MCB start their code generating operation, relay MCA first becoming picked up, thereby picking up relay MCB. The picking up of relay MCB opens the energizing circuit for relay MCA and that relay releases following its slow-release delay period. When relay MCA opens its front contact *a* relay MCB is deenergized and releases following its slow-release delay period. The release of relay MCB again closes the pickup circuit for relay MCA which picks up and starts the code generating cycle over again. It is thus apparent that relays MCA and MCB continue their code generating action so long as relay MLNPR remains released. The slow-release feature of the relays MCA and MCB operates to slow down the code generating operation.

Relays CA and CB have a pickup circuit extending from battery terminal B, through back contact *b* of relay MDPR, front contacts *c* of relays ADPR and SUPR in multiple, and thence over two branches, the first extending over back contact *a* of relay CB and the winding of relay CA to battery terminal N, and the second extending over front contact *a* of relay CA and the winding of relay CB to battery terminal N. It is apparent that, when relay ADPR or SUPR is picked up and relay MDPR is released, relays CA and CB perform a code generating operation similar to that described for relays MCA and MCB. The purpose of the code generated by each pair of relays will be discussed hereinafter.

Winding W1 of recording device or electromagnetic motor T1RST (FIG. 3), previously discussed, has three energizing circuits, the first extending from battery terminal B in FIG. 1, contact *a* of track instrument TRC, the back point of contact *a* of switch control storage repeater relay WS1P, previously discussed, back contact *a* of relay ML1SR, the back point of contact *a* of relay ML1AR, conductor 12, terminal *a* of motor T1RST, the winding of relay W1, and terminal *b* of motor T1RST to battery terminal N. The second energizing circuit for winding W1 extends from battery terminal B (FIG. 1), front contact *b* of relay ADPR, front contact *b* of relay CA, front contact *b* of relay 1C, back contact *a* of relay ML1SR, the back point of contact *a* of relay ML1AR, conductor 12, and through winding W1 to battery terminal N. The third energizing circuit for winding W1 may be traced from battery terminal B (FIG. 1), front contact *b* of relay MCA, the front point of contact *a* of relay ML1AR and thence over conductor 12 and winding W1 to battery terminal N. It is thus apparent that a pulse of energy is supplied to winding W1 of motor T1RST with each actuation of track instrument TRC by a wheel of a railway car, if relays WS1P, ML1SR and ML1AR are all released. A pulse of energy is also supplied to winding W1 with each closure of front contact *b* of relay CA in its code generating operation, if relays ADPR and 1C are picked up and relays ML1SR and ML1AR are released. A similar pulse of energy is supplied to winding W1 with each closure of front contact *b* of relay MCA in its code generating operation, if relay ML1AR is picked up.

Similar circuits are provided for supplying pulses of energy to terminals *a* of recording devices or motors T2RST and T3RST. This first circuit to motor T2RST extends from battery terminal B through contact *a* of track contactor TRC, the front point of contact *a* of relay WS1P, the back point of contact *a* of relay WS2P, back contact *a* of relay ML2SR, the back point of contact *a* of relay ML2AR, conductor 13, and terminal *a* of motor T2RST. The second circuit to terminal *a* of motor T2RST may be traced from battery terminal B, front contact *b* of relay ADPR, front contact *b* of relay CA, front contact *b* of relay 2C, back contact *a* of relay ML2SR, the

back point of contact *a* of relay ML2AR and conductor 13 to said terminal *a*. The third circuit to terminal *a* of motor T2RST extends from battery terminal B, front contact *b* of relay MCA, the front point of contact *a* of relay ML2AR and conductor 13 to said terminal *a*.

The first circuit to terminal *a* of motor T3RST extends from battery terminal B, contact *a* of contactor TRC, the front point of contact *a* of relay WS1P, the front point of contact *a* of relay WS2P, back contact *a* of relay ML3SR, the back point of contact *a* of relay ML3AR, and conductor 14 to said terminal *a*. The second circuit to terminal *a* of motor T3RST extends from battery terminal B, front contact *b* of relay ADPR, front contact *b* of relay CA, front contact *b* of relay 3C, back contact *a* of relay ML3SR, the back point of contact *a* of relay ML3AR and conductor 14 to said terminal *a*. The third circuit to terminal *a* of motor T3RST extends from battery terminal B, front contact *b* of relay MCA, and the front point of contact *a* of relay ML3AR and conductor 14 to said terminal *a*.

By the circuits just described in the two preceding paragraphs it is apparent that a pulse of energy from terminal B of the battery is supplied to terminal *a* of motor T2RST whenever contactor TRC is actuated by a car wheel, relay WS1P is picked up and relays WS2P, ML2SR and ML2AR are released; whenever relay CA closes its front contact *b* in its coding operation, relays ADPR and 2C are energized and relays ML2SR and ML2AR are released; and whenever relay MCA closes its front contact *b* in its coding action and relay ML2AR is picked up. Similarly, a pulse of energy from terminal B of the battery is supplied to terminal *a* of motor T3RST whenever contactor TRC is actuated, relays WS1P and WS2P are picked up and relays ML3AR and ML3SR are released; whenever relay CA closes its front contact *b* in its code generating operation, relays ADPR and 3C are picked up and relays ML3SR and ML3AR are released; and whenever relay MCA closes its front contact *b* in its coding operation and relay ML3AR is picked up.

Winding W2 of electromagnetic motor T1RST (FIG. 3) has two energizing circuits, the first extending from battery terminal B through front contact *b* of relay SUPR, front contact *c* of relay CA, front contact *c* of relay 1C, back contact *b* of relay ML1AR, the back point of contact *b* of relay ML1SR, terminal *c* of motor T1RST, and the winding W2 and terminal *b* of the motor to battery terminal N. The second energizing circuit for winding W2 of motor T1RST extends from battery terminal B through front contact *c* of relay MCA, the front point of contact *b* of relay ML1SR, terminal *c* of motor T1RST, winding W2, and terminal *b* of the motor to battery terminal N. Pulses of energy are thus supplied to winding W2, by the coding operation of contact *c* of relay CA, whenever relays SUPR and 1C are picked up and relays ML1AR and ML1SR are released; and, by the coding action of contact *c* of relay MCA, whenever relay ML1SR is picked up.

Pulses of energy from terminal B of the battery are supplied to terminal *c* of motor T2RST by two circuits, the first extending from battery terminal B through front contact *b* of relay SUPR, front contact *c* of relay CA, front contact *c* of relay 2C, back contact *b* of relay ML2AR, and the back point of contact *b* of relay ML2SR to terminal *c*. The second circuit extends from battery terminal B through front contact *c* of relay MCA and the front point of contact *b* of relay ML2SR to said terminal *c*. Thus the coding action of front contact *c* of relay CA supplies energy pulses to terminal *c* of motor T2RST whenever relays SUPR and 2C are picked up and relays ML2AR and ML2SR are released, and the coding action of front contact *c* of relay MCA supplies energy pulses to said terminal *c* whenever relay ML2SR is picked up.

Pulses of energy from terminal B of the battery are supplied to terminal *c* of motor T3RST by two circuits, the first extending from battery terminal B, through front contact *b* of relay SUPR, front contact *c* of relay CA, front

contact *c* of relay 3C, back contact *b* of relay ML3AR, and the back point of contact *b* of relay ML3SR to said terminal *c*. The second circuit extends from battery terminal B, through front contact *c* of relay MCA and the front point of contact *b* of relay ML3SR to said terminal *c*. By these circuits, the coding action of front contact *c* of relay CA supplies energy pulses to terminal *c* of motor T3RST whenever relays SUPR and 3C are picked up and relays ML3AR and ML3SR are released, and the coding operation of front contact *c* of relay MCA supplies energy pulses to said terminal *c* whenever relay ML3SR is picked up.

It is to be understood that the pulses of energy supplied from battery terminal B to terminals *a* of motors T2RST and T3RST flow through a winding in each respective motor, similar to winding W1 in motor T1RST, to battery terminal N, and thereby drive the rotors 2R and 3R of motors T2RST and T3RST, respectively, in a normal or first direction. Similarly, the pulses of energy supplied to terminals *c* of motors T2RST and T3RST from terminal B of the battery flow through a winding in each respective motor, similar to winding W2 in motor T1RST, to battery terminal N, and thereby drive rotors 2R and 3R of each respective motor in a reverse or second direction opposite to said first direction.

Referring further to FIG. 1, there is shown the previously mentioned motion detector repeater relay designated MDPR and considered as part of the previously mentioned motion detector. This relay has one side of its control winding connected to terminal *c* of the motion detector meter-relay MDR, previously discussed, and the other side of its control winding connected to terminal B of the battery. In this manner relay MDPR is provided with a pickup circuit which extends from terminal B of the battery through the winding of the relay, terminal *c* of meter-relay MDR, contact *a* associated with the locking coil LC of relay MDR, through the locking coil, terminal *d* of relay MDR, and back contact *b* of relay SSMPR to battery terminal N. Relay MDPR is thus energized whenever relay SSMPR is released and contact *a* associated with locking coil LC of relay MDR is closed.

One side of the control winding of the previously mentioned slow-release relay SUPR (FIG. 2) is connected to terminal *c* of meter-relay SUR, previously discussed, and the other side of the control winding is connected to battery terminal B. Similarly, one side of the control winding of the previously mentioned slow-release relay ADPR (FIG. 2) is connected to terminal *c* of previously discussed meter-relay ADR and the other side of the winding is connected to battery terminal B. The control circuit for relay SUPR then extends from battery terminal B through the control winding of relay SUPR, terminal *c* of relay SUR, locking coil LC contact *a* of relay SUR, the locking coil LC, terminal *d* of relay SUR, and in multiple over back contacts *b* and *d* of relays CB and CA, respectively, to battery terminal N. The control circuit for relay ADPR extends from battery terminal B through the winding of relay ADPR, terminal *c* of relay ADR, locking coil LC contact *a* of relay ADR, locking coil LC, terminal *d* of relay ADR, and in multiple over back contacts *b* and *d* of relays CB and CA, respectively, to battery terminal N. Since the energization of either of the relays SUPR or ADPR starts, at times, the code generating operation of relays CA and CB and back contacts *b* and *d* of relays CB and CA, respectively, are, at times, during such operation, both open, relays SUPR and ADPR are made sufficiently slow to release that they will bridge the period of time that the back contacts of both of the relays CB and CA are open. That is, the front contacts of whichever of the relays SUPR or ADPR is picked up will not open during the period both relays CB and CA are picked up, unless the locking coil contact *a* of the respective relay SUR or ADR remains open due to the interruption of the supply of energy to the locking coil of the relay

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SUR or ADR when said back contacts of relays CB and CA are both open. It is believed that an example of the operation of relay SUR and its repeater relay SUPR will be expedient at this point in the description, it being understood that relay ADR and its repeater relay ADPR operate in a similar manner.

When a signal having a sufficient value, such as for example, a signal having a value of 1.5 volts, is supplied across terminals *a* and *b* of relay SUR, the signal coil SC of relay SUR is energized to such a degree that contact *a* associated with locking coil LC is actuated to its closed position. When contact *a* closes, the locking coil LC of relay SUR is energized in series with the winding of repeater relay SUPR over the circuit including the back contacts *b* and *d* of relays CB and CA, respectively. Assuming that the energization of relay SUPR starts the code generating action of relays CA and CB, said back contacts *b* and *d* of these relays are both opened periodically during the cycles of such code generating action, thereby interrupting the supply of current to the locking coil LC and the winding of relay SUPR. Contact *a* of relay SUR is temporarily forced open by spring pressure upon such current interruption but is immediately reactuated to its closed position by the signal supplied to the signal coil SC, providing such signal is still of a value of 1.5 volts or greater. The slow-release feature of relay SUPR maintains that relay picked-up during the open periods of said contact *a* of relay SUR, and during the open periods of said back contacts *b* and *d* of relays CB and CA. In other words, said back contacts of relays CB and CA periodically open the energizing circuit for the locking coil LC of relay SUR and the winding of relay SUPR, to determine if the signal supplied to the signal coil SC of relay SUPR is still of sufficient value to actuate contact *a* of relay SUR. If the signal is of such value, contact *a* is re-actuated to its closed position and, upon the release of back contact *d* of relay CA, energy is again supplied to locking coil LC and the winding of relay SUPR. If the signal supplied to coil SC has fallen below the prescribed value, when contact *a* of relay SUR opens due to the energy being removed from coil LC, said contact *a* will remain open and relay SUPR will release following the termination of its slow-release period. The release of relay SUPR terminates the code generating action of relays CA and CB. The purpose of relays SUR and SUPR, and relays ADR and ADPR will become more apparent during the operational examples of our invention hereinafter described.

Referring again to FIG. 3, the windings of potentiometers TF1POT, TF2POT and TF3POT are each connected across terminals B and N of the battery, and the wiper arms of potentiometers F1POT, TF2POT and TF3POT are selectively connected through contacts *e* of relays 1C, 2C and 3C, respectively, to a conductor designated 15, which connects to terminal *b* of relay SUR (FIG. 2) and also through a blocking rectifier RE2 to terminal *a* of relay ADR. The winding of potentiometer SV2POT (FIG. 2) is connected across terminals B and N of the battery as previously described, and a circuit may be traced from the wiper arm of that potentiometer to terminal *g* of servomechanism SVM, front contact *b* of time delay relay 1TER, and thence to terminal *b* of relay ADR and also through a blocking rectifier RE1 to terminal *a* of relay SUR.

For the purpose of providing an example of the operation of the circuit schemes just described, we will assume that relay 1C is energized, thereby closing its front contact E (FIG. 3) and connecting the arm of potentiometer TF1POT to conductor 15, and we will further assume that relay 1TER is picked up, closing its front contact *b*. If at this time, the settings of the arms of potentiometers SV2POT and TF1POT are such that a greater positive potential is supplied to the arm of SV2POT than to the arm of TF1POT, a signal com-

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prising a flow of current will flow from terminal *g* of servomechanism SVM over front contact *b* of relay 1TER, through rectifier RE1 in its low resistance direction, terminal *a* of relay SUR, the signal coil of relay SUR, terminal *b* of relay SUR, conductor 15, front contact E of relay 1C, and the arm and winding of potentiometer TF1POT to battery terminal N. Under these conditions relay SUR is actuated in the manner previously described. If, on the other hand, the settings of the arms of potentiometers SV2POT and TF1POT are such that the positive potential appearing at the arm of TF1POT is greater than that appearing at the arm of SV2POT, then the signal or current will flow through the winding of potentiometer TF1POT to the arm of that potentiometer, front contact E of relay 1C, conductor 15, rectifier RE2 in its low resistance direction, the signal coil of relay ADR, front contact *b* of relay 1TER, terminal *g* of servomechanism SVM, and through the arm and winding of potentiometer SV2POT and terminal *f* of SVM to terminal N of the battery. At this time, relay ADR is actuated in a manner similar to that previously described for relay SUR. It is thus apparent that, if the arms of potentiometers SV2POT and TF1POT have equal settings at the time front contacts *b* of relay 1TER and *e* of relay 1C are closed, then no signals are produced, that is, no current flows in the circuits just described and neither of the relays SUR or ADR are actuated.

Contacts *e* of relays 2C and 3C control circuits to the arms of potentiometers TF2POT and TF3POT, respectively, similar to that just described to the arm of potentiometer TF1POT, and no detailed description or tracing of these circuits is considered necessary.

The outputs or signals from potentiometers TF1POT, TF2POT and TF3POT (FIG. 3) are also selectively supplied over contacts of the switch control storage repeater relays WS1P and WS2P to computer apparatus designated CP. This computer apparatus forms no part of our present invention but is shown merely to make the description complete. Such apparatus may be considered to be similar to the group retarder leaving speed computer apparatus employed in the aforesaid Emil F. Brinker and David P. Fitzsimmons, Patent No. 3,226,541. While we have shown an input, representing track fullness only, to computer CP, it is to be understood that additional inputs may also be supplied to the computer to obtain a leaving speed computation. For purposes of simplicity these additional inputs are not shown in the drawings.

As previously pointed out, leaving speed computations for each cut of cars are assumed to be made when the cut traverses track section CT (FIG. 1) and, therefore, the outputs or signals from the potentiometers TF1POT, TF2POT and TF3POT selected by relays WWS1P and WS2P are supplied to computer CP when each respective cut traverses track section CT and until such cut enters track section RIT. A first circuit for supplying a track fullness signal to computer CP extends from the arm of potentiometer TF1POT over the back point of contact *b* of relay WS1P, and front contact *a* of track relay R1TR to input terminal *a* of computer CP. A terminal *b* on computer CP is shown connected to terminal N of the battery and thus the signal from the arm of potentiometer TF1POT appears across terminals *a* and *b* of the computer.

A second circuit for supplying a track fullness signal to computer CP extends from the arm of potentiometer TF2POT over the back point of contact *b* of relay WS2P, the front point of contact *b* of relay WS1P, and contact *a* of relay R1TR to input terminal *a* of computer CP. A third circuit extends from the arm of potentiometer TF3POT over the front point of contact *b* of relay WS2P, the front point of contact *b* of relay WS1P, and contact *a* of relay R1TR to input terminal *a* of the computer CP.

Since relay WS1P remains released, as previously de-

scribed, when a cut traversing track section CT is destined for storage track 1, the output signal from potentiometer TF1POT is supplied to computer CP until the cut enters track section R1TR and track relay R1TR releases and opens its front contact *a* in the circuit to terminal *a* of computer CP. Similarly, when a cut traversing track section CT is to be routed to storage track 2, relay WS1P becomes picked up and relay WS2P remains released and the output signal from potentiometer TF2POT is supplied to computer CP until track relay R1TR is released by the entrance of the cut into track section R1T. When a cut traversing track section CT is destined for storage track 3, relays WS1P and WS2P both become picked up and the output signal from potentiometer TF3POT is supplied to computer CP until relay R1TR is released by the entrance of the cut into track section R1T.

Having described the details of the apparatus of our invention, we will now describe the operation thereof as a whole and shall then point out the novel features thereof in claims.

The first or initial step of each stepping cycle of stepping switch SS (FIG. 4) may be automatically initiated upon the termination of the preceding cycle or the first step of each stepping cycle may be manually initiated so that the stepping switch performs a cycle only when an operator so desires. That is, if only a single stepping cycle of switch SS is desired, manually operated push button MPB is momentarily depressed and then released. If continuous cycling is desired the push button is depressed and turned so that its contact *a* remains closed.

Assuming that a single stepping cycle only is desired, the momentary closing of contact *a* of push button MPB by the depression of the push button, closes the energizing circuit for magnet SSM, including back contact *a* of relay SSMPR. The energization of magnet SSM closes front contact *a* controlled by that magnet and closes the energizing circuit for relay SSMPR which becomes picked up following its slow pickup delay time. The release of push button MPB or the opening of back contact *a* of relay SSMPR, whichever occurs first, opens the energizing circuit for magnet SSM, the magnet is released and the stepping switch at that time moves its wiper contact WC from the 0 contact position to the number 1 contact position. It is to be noted that the opening of contact *a* of magnet SSM deenergizes relay SSMPR which releases at the end of its slow release period. Thereafter, the movable wiper contact WC is successively automatically stepped to the 2 and 3 and again to the 0 contact positions, in a manner hereinafter described, and when it reaches the 0 contact position stops its stepping cycle since push button MPB was previously only momentarily depressed and, therefore, its contact *a* is open.

If, however, push button MPB is depressed and turned so that its contact *a* remains closed, each time wiper contact WC is stepped to its 0 contact position, magnet SSM is again energized, as soon as relay SSMPR releases, and then released by the opening of back contact *a* of relay SSMPR. Wiper contact WC is then stepped from the 0 to the number 1 contact position. Thus, a new stepping cycle is begun.

It will be assumed that humping operations are in progress, and a number of car cuts have already been routed to their respective storage tracks and motors T1RST, T2RST and T3RST (FIG. 3) have been controlled, by the wheels of such cuts, to adjust each respective potentiometer TF1POT, TF2POT and TF3POT to a setting representative of the number of cars routed to the respective storage tracks 1T, 2T and 3T. It will be further assumed that indicators T1VI, T2VI and T3VI have been actuated by motors T1RST, T2RST and T3RST, respectively, to indicate the numbers 31, 23 and 40, respectively, representing the number of cars already routed to each respective track. The manner of so adjusting the potentiometers TF1POT, TF2POT and TF3POT and controlling the visual indicators has been previously described but it should

be further pointed out that such adjustment of each potentiometer results in an output signal or value of voltage at the arm of the respective potentiometer that is representative of the number of individual cars routed to the storage track with which the potentiometer is associated.

Assuming the continuation of humping operations and a previous actuation of push button MPB for continuous stepping operation of the stepping switch SS, when wiper contact WC of the stepping switch SS is stepped to the number 1 fixed contact position of such switch, relay 1C is energized over its previously described pickup circuit as soon as back contact *a* of relay SSMPR closes. The closing of contact *a* of relay 1C completes an energizing circuit for relay 1TER (FIG. 4), and the closing of contact *d* of relay 1C (FIG. 1) connects the inputs of servomechanism SVM (FIG. 2) and of the rectifier RC (FIG. 1) across the rails of storage track 1T, as previously described. If at this time a previous car cut is still moving in track 1T, the varying voltage supplied from the track will produce an output from differentiator D1F which energizes signal coil SC of relay MDR. Assuming the voltage to be of sufficient value, contact *a* of relay MDR is actuated and closes the energizing circuit for locking coil LC of relay MDR and the winding of relay MDPR. Relay MDPR therefore becomes picked up at this time. The picking up of relay MDPR and the closing of its front contact *a* (FIG. 4) in the energizing circuit for stepping magnet SSM energizes that magnet and prepares for the stepping of the wiper contact WC of stepping switch SS to its next fixed contact position 2. The energization of magnet SSM closes contact *a* controlled by the magnet and relay SSMPR becomes picked up following its slow pickup delay time. The picking up of relay SSMPR opens, at its back contact *b*, the energizing circuit for locking coil LC of relay MDR and the winding of relay MDPR. Relay MDPR accordingly releases and deenergizes magnet SSM and the wiper contact WC of switch SS is stepped to the number 2 fixed contact position. Relay 1C is released when relay SSMPR becomes picked up and contact *a* of relay MDR opens due to interruption of energy from differentiator D1F. Relay 1TER is also deenergized prior to the completion of its slow pick up timing period. Relay 2C becomes picked up following the release of relay SSMPR and the closing of its back contact *a*.

Due to the relatively slow response inherent in relay MDR and its associated control apparatus, relay 1TER is employed to delay the completion of the circuit from output terminal *g* of servomechanism SVM to relays SUR and ADR (FIG. 2) until it has been definitely determined that there is no motion, that is, no movement of cars in the storage track then selected. The energization of relay MDPR in the example just described indicates car movement in track section 1T so that a true distance to travel measurement for track 1T could not be made at this time. Such measurement is, therefore, postponed until the next cycle of the stepping switch when relay 1C again becomes picked up and no motion is detected in track 1T.

If there is no motion detected in storage track 2T when relay 2C becomes picked up as described above, relay MDR remains unactuated and relay MDPR remains released. The voltage appearing across the rails of storage track 2T is supplied over front contact *d* of relay 2C and conductor 10 to input terminal *a* of servomechanism SVM and potentiometer SV2POT is adjusted, as previously outlined, so that there appears at the arm of the potentiometer a signal or a value of voltage representative of the distance to travel to coupling in track 2T. This signal is supplied to output terminal *g* of servomechanism SVM and, when the time delay period of relay 1TER expires, relay 1TER closes its front contact *b* and completes the previously described circuits from said terminal *g* to relays SUR and ADR. The time delay interval of relay 1TER at this time insures the adjustment of potentiometer SV2POT, in accordance with the measured distance to travel to coupling in track 2T, before the signal appear-

ing at the arm of the potentiometer is supplied to relays SUR and ADR.

Assuming that the distance to travel to coupling in storage track 2T, as determined by the impedance of the track circuit in that track and the resultant response of servomechanism SVM, agrees with the track fullness as determined by the axle counting apparatus, potentiometers SV2POT and TF2POT (FIG. 3) will have equal settings and there will be no signal supplied to relays SUR and ADR. Therefore, relays SUPR and ADPR remain released at this time and relay 2TER (FIG. 4), whose energizing circuit is closed when front contact *a* of relay 1TER closes, becomes picked up following the expiration of its time delay period. The time delay period of relay 2TER serves to bridge the time delay inherent in the actuation of relays SUR and ADR in response to a signal supplied thereto.

When relay 2TER becomes picked up, as described above, the energizing circuit to magnet SSM is closed over front contact *a* of relay 2TER (FIG. 4) and the magnet is energized. The energization of magnet SSM closes the energizing circuit for relay SSMPR and that relay picks up following the expiration of the time delay provided by the slow pickup feature of the relay. The picking up of relay SSMPR opens back contact *a* of that relay in the energizing circuit for relay 2C and relay 2C accordingly releases, in turn releasing relay 1TER. The release of relay 1TER opens at front contact *a* of that relay the energizing circuit for relay 2TER and relay 2TER releases. When front contact *a* of relay 2TER opens the energizing circuit for magnet SSM, the wiper contact WC of stepping switch SS is moved to the number 3 fixed contact position. The deenergization of magnet SSM also deenergizes relay SSMPR which releases following the expiration of its slow release delay period. When relay SSMPR releases and closes its back contact *a*, the energizing circuit for relay 3C is completed and relay 3C becomes picked up. Front contact *a* of relay 3C closes the energizing circuit for relay 1TER and relay 1TER again starts its timing cycle.

If, when relay 3C becomes picked up as described above, there is no car motion detected in storage track 3T, relay MDR will remain unactuated and relay MDPR will remain released. Potentiometer SV2POT in servomechanism SVM will be adjusted, as previously described, in accordance with the distance to travel to coupling measurement in storage track 3T. It will be assumed that the new setting of potentiometer SV2POT and the setting of potentiometer TF3POT are out of agreement due, for example, to a series of unusual length cars being previously routed to storage track 3T.

When relay 1TER becomes picked up, following its time delay period, it closes its front contact *b* and the signals appearing at the arms of potentiometers SV2POT and TF3POT are compared. If the setting of potentiometer SV2POT is such that the signal appearing at its arm is positive relative to that appearing at the arm of potentiometer TF3POT, relay SUR is actuated, closing its contact *a* and energizing relay SUPR. Relay ADR is not actuated at this time since flow of current through the signal coil SC of relay ADR is blocked by rectifier RE2. The actuation of relay SUR and energization of relay SUPR indicates that the track fullness as determined by the car or axle counting apparatus is in excess of the actual fullness and the settings of potentiometer TF3POT and visual indicator T3VI must be revised in a direction to reduce the car count, that is, there must be a subtraction made in the count of the counting apparatus.

The picking up of relay SUPR closes front contact *c* of that relay in the energizing circuits to code generating relays CA and CB (FIG. 4), and those relays intermittently open and close their front and back contacts as previously described. Front contact *b* of relay SUPR (FIG. 3) prepares the previously described pulsing circuit to terminal *c* of motor T3RST, including front contacts *c*

of relays CA and 3C, and the intermittent opening and closing of contact *c* of relay CA drives the rotor 3R of the motor. Rotor 3R drives the arm of potentiometer TF3POT in a direction to bring the signal appearing at the arm of the potentiometer into agreement with that appearing at the arm of potentiometer SV2POT. At the same time indicator T3VI is driven by rotor 3R in a direction to reduce the car number indication displayed by that indicator.

When the setting of potentiometer TF3POT is adjusted to or sufficiently near that of potentiometer SV2POT that the difference between the signals appearing at the arms of the potentiometers is sufficiently reduced (less than 1.5 v. for example), signal coil SC of relay SUR will no longer be effective to close contact *a* of that relay. Accordingly the next time back contact *d* of relay CA and back contact *b* of relay CB both open during the code generating operation of these relays and the locking coil LC of relay SUR is thereby deenergized, contact *a* of relay SUR becomes opened, and the locking coil LC and the winding of relay SUPR remain deenergized. Relay SUPR releases, following the expiration of its slow release period, and the pulsing circuit to motor T3RST is interrupted. At the same time the code generating operation of relays CA and CB is terminated.

The release of relay SUPR closes at its back contact *a* the energizing circuit for relay 2TER (FIG. 4) and that relay becomes picked up following the expiration of its time delay period. The picking up of relay 2TER actuates stepping switch SS in the manner previously described and the wiper contact WC of the switch is stepped to its 0 fixed contact position. If push button MPB is assumed to be locked in its depressed position, as previously mentioned, the circuit over contact *a* of the push button actuates stepping switch SS, by energizing magnet SSM, and another cycle of the stepping switch is automatically initiated.

Returning to the period when relay 3C becomes energized, as described above, and servomechanism SVM is actuated to adjust potentiometer SV2POT to a setting in accordance with the distance to travel to coupling in storage track 3T, it will now be assumed that such potentiometer is so adjusted by servomechanism SVM that the signal appearing at the arm of the potentiometer is below or less than that appearing at the arm of potentiometer TF3POT when said arms are connected for comparison of such signals. Such connection takes place, as before, when front contact *b* of relay 1TER closes.

Under the above assumed conditions the signal appearing at the arm of potentiometer TF3POT is positive in respect to that appearing at the arm of potentiometer SV2POT and the resultant signal produced by the comparison of said signals energizes signal coil SC of relay ADR at this time, such signal being blocked from coil SC of relay SUR by rectifier RE1. Accordingly, contact *a* of relay ADR is actuated to its closed position and relay ADPR becomes energized. The closing of front contact *c* of relay ADPR closes the energizing circuit to code generating relays CA and CB and those relays again begin their code generating operation.

At this time the pulsing circuit to terminal *a* of motor T3RST is activated. This circuit includes front contact *b* of relay ADPR, front contact *b* of code generating relay CA, and front contact *b* of relay 3C (FIG. 1). The pulses of energy supplied over conductor 14 to terminal *a* of motor T3RST drive the rotor of the motor in the opposite direction to that previously described, that is, in a direction to increase or add to the track fullness count for track 3 as reflected by the settings of potentiometer TF3POT and indicator T3VI. When the settings or adjustments of potentiometers TF3POT and SV2POT are sufficiently in agreement, contact *a* of relay ADR opens and relay ADPR subsequently releases. The pulsing of motor T3RST is terminated and stepping switch SS is

actuated to step wiper contact WC to its 0 fixed contact position, in a manner similar to that previously described.

By the above description it is readily understood that relays SUR and ADR and their respective associated relays SUPR and ADPR form a signal comparator or signal comparing means which compares the signals provided thereto from potentiometer SV2POT and each selected one of the potentiometers TF1POT, TF2POT and TF3POT, and derives a resultant pulsing signal representative of the difference between the compared signals.

By the description of the operation of the apparatus of our invention thus far set forth, it is apparent that, by employing such apparatus, a track fullness system may be furnished wherein continuous signals, each indicative of the track fullness of an associated storage track in a classification yard, are provided each such signal is proportionate to the number of cars routed to the respective storage track or to the number of car spaces remaining in such track. Each signal is adjusted by wheel or car counting apparatus when additional cuts of cars are routed to the respective track. Further, each said signal is periodically corrected in accordance with a distance to travel to coupling determination or measurement periodically made for the corresponding storage track, providing that such correction is required and that at the time of such measurement or determination no car movement is detected in the respective storage track. Each such signal thus provided and periodically corrected may be supplied to computer apparatus, employed in the modern gravity type railway car classification yards for computing the correct leaving speed for each cut of railway cars when leaving a car retarder located in the route to the respective storage track for the cut; or such signals may be employed to provide more accurate control of devices indicating track fullness or car space available in railway car storage tracks.

Having described several operational examples of that part of our system automatically controlled, we will now briefly describe an operational example of the supervisory manual correction apparatus incorporated in our invention.

For the purpose of an example of the operation of the supervisory manual correction part of our system, we will assume that an operator desires to manually correct the track fullness signal and indication for storage track 1T. Accordingly, the operator actuates manual control lever ML1 (FIG. 4) to a position corresponding to the correction desired to be made, that is, lever ML1 is actuated to its L or left hand position if the track fullness indication for track 1T is to be increased (or when available car space is being indicated if this indication is to be decreased), and lever ML1 is actuated to its R or right hand position if such track fullness indication is to be decreased (or if available car space is being indicated when this indication is to be increased).

The movement of lever ML1 from its normal position opens contact *a* of the lever and relay MLNPR is released. The release of relay MLNPR and the opening of its front contact *a* (FIG. 4) opens the control circuits for magnet SSM of stepping switch SS to prevent or interrupt the stepping operation of such switch. The closing of back contact *b* of relay MLNPR activates the previously described code generating action of relays MCA and MCB and the front and back contacts of these relays periodically open and close.

When lever ML1 is moved to its left hand position, the previously described energizing circuit, including contact *b* of the lever, to the winding of relay ML1AR (FIG. 4) is closed and that relay becomes picked up. The picking up of relay ML1AR closes at the front point of its contact *a* (FIG. 1) a pulsing circuit for winding W1 of motor T1RST (FIG. 3). The pulses provided by the intermittent operation of contact *b* of code generating relay MCA (FIG. 1) actuate the rotor 1R of motor

T1RST in a direction to adjust the visual indication displayed by visual indicator T1VI to the desired number, and to adjust the signal from the arm of potentiometer TF1POT in a direction indicative of lesser distance to travel to coupling in storage track 1T. When the desired adjustment of the indicator and potentiometer TF1POT is obtained, the operator returns his lever to the normal position, relay ML1AR releases and relay MLNPR again becomes picked up. The release of relay ML1AR interrupts the pulsing circuit to winding W1 of motor T1RST, and the picking up of relay MLNPR interrupts the control circuit for the code generating relays MCA and MCB, which then cease their code generating operation. Front contact *a* of relay MLNPR closes the circuit between the negative terminal of the battery and terminal *d* of stepping switch SS and the apparatus is again in its normal condition.

It is to be noted that when relay ML1AR becomes picked up, as described above, back contact *b* of that relay (FIG. 3) opens and prevents any pulses of energy from being supplied to winding W2 of motor T1RST. This arrangement prevents energy pulses from being supplied to both winding W1 and W2 of motor T1RST in the event lever ML1 is actuated to its left hand position at the time relays 1C and SUPR are picked up and relay CA is performing its code generating operation.

If lever ML1 is moved to its right hand position rather than to its left hand position as described above, relay ML1SR becomes energized over its pickup circuit including contact *c* of lever ML1. The code generating operation of relays MCA and MCB is actuated as before and the closing of the front point of contact *b* of relay ML1SR closes the previously described circuit for supplying pulses of energy to winding W2 of motor T1RST. The rotor 1R of motor T1RST is actuated in a direction opposite to that previously set forth and drives indicator T1VI to adjust its visual number indication in the desired direction which would be the opposite direction to that in which it was previously adjusted. Rotor 1R also drives the arm of potentiometer TF1POT to adjust the output signal in a direction indicative of greater distance to travel to coupling in storage track 1T, that is, in a direction opposite to that in which it was previously adjusted. When the desired adjustments of indicator T1VI and potentiometer TF1POT are obtained, the operator returns lever ML1 to its normal position. The pulses supplied to winding W2 are thereby interrupted and the apparatus is controlled to its previous normal condition, in a manner similar to that previously described.

Back contact *a* of relay ML1SR (FIG. 1) in the circuit including front contacts *b* of relays ADPR and CA to winding W1 of motor T1RST prevents the application of pulses of energy to winding W1, when energy pulses are being supplied to winding W2 in the manner just described.

By the above operational examples, the manner in which the track fullness apparatus for each of the other storage tracks may be adjusted by the manual actuation of their respective control levers is readily apparent, and no further operational examples of supervisory manual corrections are believed necessary.

From this description it is apparent that, with apparatus of our invention as shown in FIGS. 1 through 4 of the drawings, a composite track fullness system is provided which continuously provides a signal for each storage track in a railway car classification yard, each said signal normally being adjusted in accordance with the number of cars routed to the respective storage track, and each said signal being periodically corrected, if required, in accordance with a distance to travel to coupling measurement periodically made for the respective storage track. Our invention thus provides an economical track fullness system wherein provision is periodically made for unusual length cars, cars that stop short of coupling in their respective storage tracks, cars that are

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routed to a storage track but have not yet reached the entrance end of such track, and for cars that may be proceeding towards coupling and have not yet come to rest.

Although we have herein shown and described only one form of apparatus embodying our invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of our invention.

Having thus described our invention, what we claim is:

1. A system for determining the fullness of each storage track in a railway car classification yard comprising a single track connected through track switches to a plurality of car storage tracks, said system comprising in combination, a wheel actuated device in said single track, a source of potential, means for each storage track controlled by said wheel actuated device for deriving from said source of potential a first signal proportional to the number of cars routed to that storage track, a track selection device, a servomechanism, a motion detector; means controlled by said track selection device, said servomechanism and said motion detector for periodically selecting each storage track and deriving from said source of potential a second signal proportional to the distance to the nearest car in the selected storage track providing the motion detector detects lack of motion in such selected track; a signal comparator, means controlled by said track selection device and by said signal comparator for deriving a third signal representative in value of the difference between said first and second signals derived for each selected storage track, said third signal having one of two opposite polarities in accordance with the greater value between the then compared first and second signals, and means controlled by said third signal in accordance with its polarity and value for controlling the first signal deriving means for the selected track to derive a corrected first signal equal to said second signal derived from such selected track.

2. A track fullness system for a railway car classification yard including a single track leading to a plurality of storage tracks comprising, means in said single track responsive to each car traversing that track for determining the length of car cuts destined for each storage track; means for each storage track, controlled by said length determining means, for regulating from a source of potential a first voltage output proportional to the total length of the last car cut destined for that storage track and the car cuts already in such storage track; means for periodically selecting each storage track, determining the distance to travel to coupling with the preceding car cuts in the selected storage track and regulating from said source of potential a second voltage output proportional to said distance in the selected track; means controlled by said selecting means for detecting car motion in said selected storage track, means for comparing said first and second voltages for each selected track, providing all cars in the track then selected are at rest, and deriving a third voltage equal to any difference in value between such first and second voltages and having a first or second polarity in accordance with the greater value of the then compared first and second voltages; and means controlled by each said third voltage for controlling the first output regulating means for the storage track then selected to adjust the first voltage output for that track to a greater or lesser value in accordance with the first or second polarity respectively of said third voltage so as to equal the second voltage output for such track, whereby each first output regulating means is periodically corrected to make allowance for cars of unusual lengths or that fail to completely travel to coupling with the preceding cars in the respective storage track.

3. In a gravity type railway car classification yard comprising a single track diverging into a plurality of car storage tracks and automatic car routing apparatus, a

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system for determining the distance to travel to coupling with the preceding cars in each storage track; said system comprising, in combination, a wheel counting device in said single track, a potentiometer for each said storage track, means controlled by said wheel counting device and said car routing apparatus for adjusting the setting of the potentiometer for each storage track in accordance with the number of cars routed to that track, a direct current source of voltage potential, means controlled by each potentiometer for regulating a value of output voltage from said source of potential proportional to the setting of that potentiometer, a loop track circuit for each storage track each such circuit including the rails of the respective track and a source of alternating current connected across the rails at one end of such track, a servomechanism including an output circuit, a motion detector comprising a differentiator connected across the output side of a rectifier, a stepping switch, means controlled by said stepping switch for sequentially and periodically selecting each storage track and connecting the input circuit of said servomechanism and the input side of said rectifier across the rails of the storage track then selected, another potentiometer; means controlled by said servomechanism and said motion detector for adjusting the setting of said other potentiometer in accordance with a value of voltage potential supplied to said input circuit of said servomechanism from the rails of the storage track across which such servomechanism and said motion detector are then connected, only providing that said motion detector detects lack of motion in said track; means controlled by said other potentiometer for regulating another value of output voltage from said source of potential proportional to the setting of such other potentiometer, means controlled by said stepping switch for connecting in series opposing relationship said other output voltage with the output voltage from the potentiometer for the storage track then selected and producing a resultant voltage in a direction and of a value proportional to the difference between said output voltages, and means controlled by said resultant voltage and said stepping switch for readjusting the setting of the potentiometer for the storage track then selected to regulate the output voltage from that potentiometer to equal the other output voltage then regulated by said other potentiometer.

4. In a gravity type railway car classification yard including a single track connecting into a plurality of car storage tracks, a track fullness system comprising, a wheel actuated device in said single track; means for each storage track, controlled by said wheel actuated device, for producing an output signal proportional to the number of cars routed to the respective storage track; visual indication means for each storage track, controlled by said wheel actuated device, for displaying a number corresponding to said output signal for the associated signal producing means; a manually operable control device for each storage track each said device having a normal position and manually operable to first and second actuated positions; means controlled by each control device, when actuated to its said first position, for controlling the signal producing means for the track associated with such actuated device to adjust its output signal in a first direction and for controlling the associated visual indicator to change its display in a corresponding first direction, both in accordance with the length of time the associated control device remains in its first actuated position; and means controlled by each control device, when actuated to its second position, for controlling the signal producing means for the track associated with such actuated device to adjust its output signal in a second direction and for controlling the associated visual indicator to change its display in a corresponding second direction, both in accordance with the length of time the associated control device remains in its second actuated position.

5. In a railway car storage yard including a single track connecting into a plurality of storage tracks, a system for indicating the empty car space between the entrance end of each storage track and the nearest car standing in such track, said system comprising, means controlled by each cut of cars traversing said single track for adjusting a first signal for the storage track to which the respective cut is destined in accordance with the number of cars in that cut, said signal being adjusted proportionately to the total number of cars routed to that storage track; means for periodically selecting each storage track and adjusting a second signal for that track proportionately to the empty car space between the entrance end of such track and the nearest car standing in the track, means for comparing said first and second signals for the selected storage track and deriving a third signal for that track representative of the difference in value and polarity between the two compared signals, motion detector means responsive to the detection of a moving car in the selected storage track for interrupting the comparison of the first and second signals for that selected storage track, and means controlled by each derived third signal in accordance with its value and polarity for readjusting the first signal adjusting means for the corresponding track to increase or decrease said first signal to bring such first signal substantially into agreement with the second signal for that track.

6. A system for indicating railway car space between a preselected entering point in a railway car storage track and the nearest car standing in said track, said system comprising, means responsive to cuts of cars approaching said track for counting each car to enter said storage track, a source of electrical energy, a first potentiometer having a winding connected across the terminals of said source and an adjustable wiper arm, means responsive to said counting means for adjusting the arm of said potentiometer in accordance with the number of cars counted by the counting means, a source of alternating current connected across the rails of said storage track adjacent said entering point, an electrically actuated potentiometer type servomechanism having its input circuit connected across the rails of said storage track adjacent said entering point, a second potentiometer having a winding connected across the terminals of said source of electrical energy and an adjustable wiper arm, means controlled by the actuation of said servomechanism for periodically adjusting the arm of said second potentiometer in accordance with the impedance of the rails of said storage track between the point of connection to the rails of said source of alternating current and the nearest axle and associated pair of wheels of a railway car standing in the track, a motion detector device connected across the rails of said storage track adjacent said entering point, voltage comparing apparatus having an input circuit and responsive to the difference in value and the relative polarity of voltages connected thereto, means controlled by said motion detector device for periodically connecting in series opposing relationship the electrical outputs from the arms of said potentiometers to said input circuit of said voltage comparing apparatus only when said motion detector device indicates a lack of motion in said storage track, means controlled by said voltage comparing apparatus for controlling said counting means to readjust the arm of said first potentiometer in a direction determined in accordance with the relative polarity of the greater voltage connected to the input of said voltage comparing apparatus until the output at the arm of that potentiometer equals the output at the arm of the second potentiometer, and a visual car space indication device selectively actuated by said counting means.

7. In a gravity type railway car classification yard comprising a single track stretch leading to a plurality of railway car storage tracks and including a car speed control apparatus in which the desired speed for each

car cut is determined by a signal responsive computer to which is supplied a plurality of signals each in accordance with one of a plurality of factors including the factor of the distance to travel to coupling with the preceding cars in the respective storage track to which the cut is to be routed; a track fullness system in such yard for continuously providing a signal for each said storage track indicative of the distance to travel to coupling in such track, said track fullness system comprising, in combination, an electrical pulse actuated counting device for each said storage track each device having forward and reverse windings, means in said single track stretch actuated by each car cut traversing the stretch for supplying electrical pulses to the forward winding of the counting device for the storage track to which such cut is routed in accordance with the number of cars in the cut, a source of electrical energy potential, a potentiometer for each said counting device each potentiometer having a winding connected across said source of potential and an actuable wiper arm, means controlled by each said counting device for actuating the wiper arm of the corresponding potentiometer to produce a signal at such wiper arm proportionate to the number of cars counted by such counting device, a source of alternating current connected across the rails of each said storage track at the entrance end thereof, a stepping switch, an electrically driven servomechanism having an input circuit, a motion detector device having an input circuit, means controlled by said stepping switch for selectively and periodically connecting said input circuits across the rails of each said storage track adjacent the connections to such rails of the respective said alternating current source, another potentiometer having its winding connected across said source of electrical energy potential and an actuable wiper arm, means controlled by said servomechanism for actuating the wiper arm of said other potentiometer to produce a signal at such wiper arm proportionate to the railway car space available in the storage track to which the input circuit of the servomechanism is then connected, a signal comparing device having an input circuit, means controlled by said stepping switch and by said motion detector devices for connecting to the input circuit of said signal comparing device for comparison and in an opposing relationship the signal from the arm of said other potentiometer and the signal from the arm of the potentiometer for the counting device for the storage track then selected by the stepping switch only providing that said motion detector detects lack of car movement in the track then selected, means controlled by said signal comparing device for producing electrical pulses providing there is a difference in the signals then compared and for the duration of the existence of such difference; means controlled by said stepping switch and said signal comparing device for selectively supplying, according to the polarity of the difference between the two signals then compared, the last-mentioned electrical pulses to the forward and reverse windings, respectively, of the counting device for the track then selected by the stepping switch, whereby such counting device actuates the arm of the associated potentiometer to bring the signal from the arm of that potentiometer into agreement with the signal from the arm of said other potentiometer; and means for selectively supplying to said computer the signals from the arms of the potentiometers associated with the counting devices, each such signal being selected in accordance with the storage track to which a car cut traversing said single track stretch is to be routed.

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