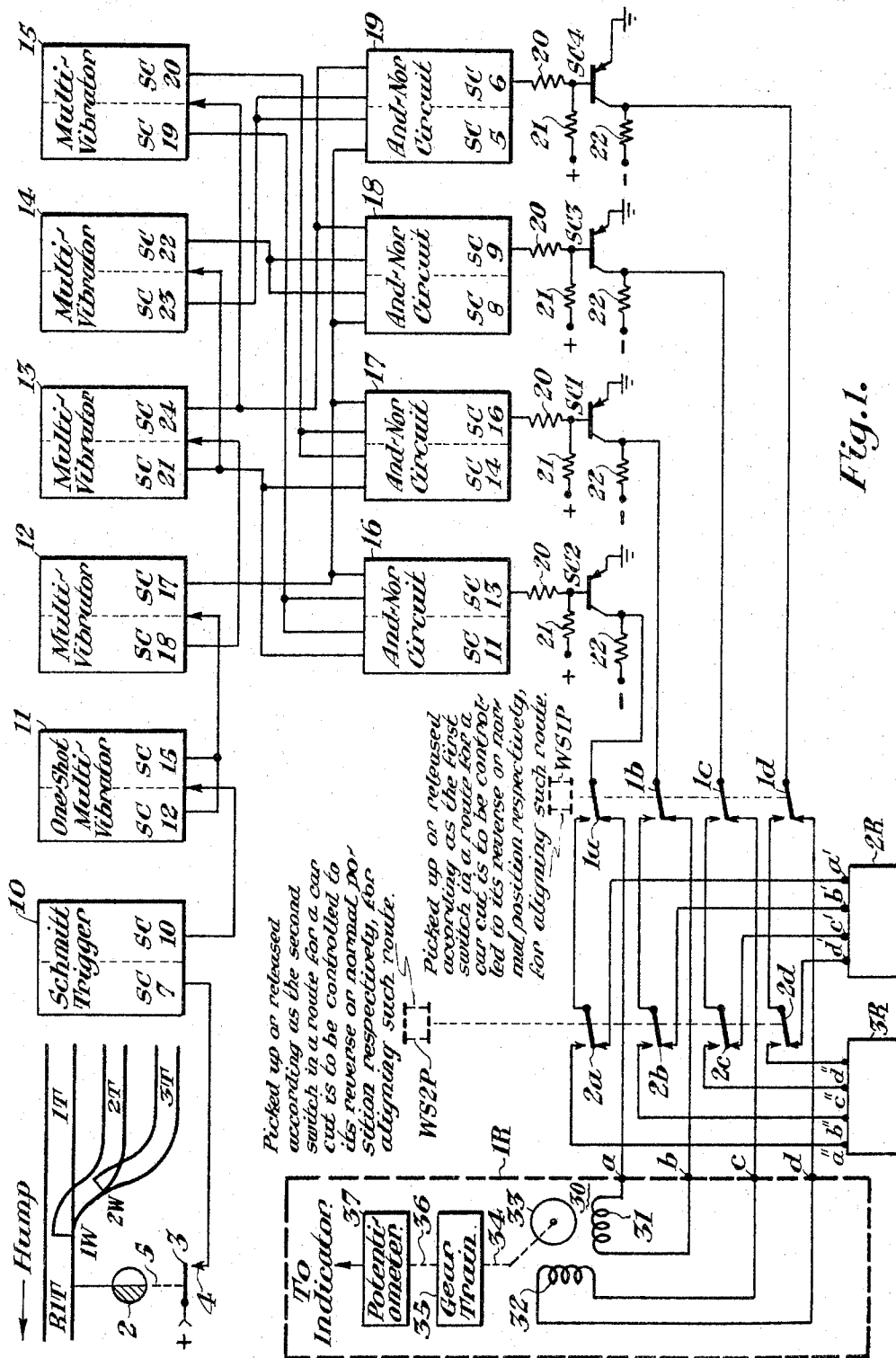




RAILWAY CAR COUNTER

Filed July 12, 1962

2 Sheets-Sheet 2

Input To Contact 4	SC 10	SC 13	SC 17	SC 24	SC 22	SC 20	SC 13	SC 16	SC 9	SC 6	SC 2	SC 1	SC 5	SC 4	SC2-SC4 Polarity of Winding 31	SC3-SC4 Polarity of Winding 32	Rotor
Initial State 0	On	Off	On	On	On	On	On	Off	Off	On	Off	On	On	Off	- To +	+ To -	
+14	Off	On	Off	Off	Off	On	On	Off	On	On	Off	On	Off	Off	- To +	No Current	
0	On	Off	On	Off	Off	On	On	Off	On	On	Off	On	Off	On	- To +	- To +	
+14	Off	On	Off	On	Off	Off	On	On	On	On	Off	Off	Off	On	No Current	- To +	
0	On	Off	On	On	Off	Off	On	On	On	On	Off	On	Off	On	+ To -	- To +	
+14	Off	On	Off	Off	On	Off	Off	On	On	On	On	Off	Off	Off	+ To -	No Current	
0	On	Off	On	Off	On	Off	On	On	Off	On	On	Off	On	Off	+ To -	+ To -	
+14	Off	On	Off	On	Off	On	On	Off	On	On	Off	On	Off	Off	No Current	+ To -	
0	On	Off	On	On	Off	On	On	Off	On	On	Off	On	Off	On	- To +	+ To -	

Fig. 2.

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3,274,384

RAILWAY CAR COUNTER

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9 Claims. (Cl. 246—247)

This invention relates to a railway car counting system and more particularly to a system for indicating at a remote location the number of empty car spaces remaining on a storage track in an automatic classification yard.

In the development of automatic operation of railway classification yards, particularly speed control systems for car retarders used in such yards, it has been found necessary to include, among the various factors to be considered, a measurement of the number of empty car spaces remaining on each of the storage tracks in the yard to which the railway cars may be routed. These empty car spaces represent a distance which a subsequent car or cut of cars must travel to couple with the preceding cars in the respective storage track. This factor helps in determining how fast cars should move out of a car retarder, particularly the final retarder, in order to couple at the proper speed but not couple with an excessive impact to cause damage to itself or the cars already standing on the designated storage track. When operation of the speed control system at the final retarder is to be completely automatic in determining the leaving speed and controlling the retarder pressure to obtain the leaving speed, a high degree of accuracy is required in each factor, including the track fullness or empty car space factor. 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.

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 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; however, such a system does not take into account that the nearest railway car may still be moving toward the preceding standing cars. In other words, the impedance measure will not indicate the exact distance a subsequent car has to travel since this distance is continually changing with the movement of the moving car. Further, the impedance measuring system does not take into account cars that are routed to such storage track but have not yet reached the entering end of the respective storage track. In order to obtain a high degree of accuracy in the distance of travel of subsequent cars entering this particular storage track, it was found necessary to supplement the impedance measuring system with a car counter that would subtract the exact number of car spaces remaining in a storage track during car movement thereon or when a car cut may be en route but has not yet reached the entering end of the respective storage track. Therefore, the car counting system is an effective means of anticipating the amount of space which will be removed from the storage track by the cut.

It is accordingly an object of our invention to provide an improved car counting system for railway classification yards.

It is another object of our invention to provide an im-

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proved system of indicating the number of empty car spaces remaining on a storage track in a classification yard.

Still another object of our invention is to provide an improved railway car counter to count the actual number of car spaces remaining on a designated storage track.

More specifically, it is an object of our invention to correct in car length increments for spaces that have been or shortly will be occupied by railway cars which are in motion where heretofore such motion prevented an exact measurement of the number of remaining car spaces.

These and further objects and advantages of the present invention will become apparent from the following specification when taken in connection with the accompanying drawings.

In practicing our invention, we provide a car counting system consisting of a track mounted, flange operated wheel detector which is used to count individual axles of the railway cars. The output of the detector is applied into a car counter unit comprising a unique arrangement of digital building blocks where pulses are shaped and used to move the rotor of a two-phase motor a predetermined amount for each pulse. The car counter unit comprises a novel transistorized digital arrangement including a Schmitt trigger, a one-shot multivibrator, a plurality of bistable multivibrators, a plurality of "And-Nor" circuits, and a plurality of driver amplifiers for providing an output signal to the two stator windings of the servomotor. With a phase displacement existing between the two stator windings, the rotor will turn so that its magnetic field will line up with the resultant field which exists between the magnetic fields generated in the stator windings. The rotor of the servomotor rotates one-quarter turn or 90 degrees per axle count so that four axle counts, since the great majority of cars being classified have but four axles, are required to rotate the rotor one revolution. The motor in turn is connected, through a gear train, to a potentiometer which produces a resistance change equivalent to one car space during each revolution of the rotor. Thus the counting system for a particular storage track actuates the potentiometer to change its resistance and produce an output which is equivalent to subtracting one car space for each four axle counts.

The invention will be better understood after a consideration of the following detailed description and with reference to the accompanying drawings wherein:

FIG. 1 is a schematic diagram of the counting system embodying the principles of the present invention;

FIG. 2 is a tabulated chart illustrating the sequential steps of operation of the car counting system as shown in FIG. 1.

Referring now to the drawings, and in particular to FIG. 1, there is shown a section of a classification yard of the gravity type illustrated by numeral 1 which may be only part of a classification yard containing any number of storage tracks, as is well known. Railway cars traversing the section of the yard shown enter a first section of track designated R1T from the direction of the hump indicated by the arrow in the upper left-hand corner of the figure. Track section R1T connects through first and second track switches designated 1W and 2W, respectively, to yard car storage or classification tracks or track sections designated 1T, 2T and 3T. That is, when switch 1W occupies its normal position, as shown in the drawing, railway cars moving from the hump are routed through track section R1T to storage track 1T. When switch 1W occupies its opposite or reverse position the cars are routed over switch 2W to storage track 2T or 3T according as switch 2W occupies its normal position, as shown in the drawing, or its reverse position, respectively.

A track instrument 2, for example, a treadle, of any suitable type, is mounted adjacent the track section R1T to detect railway cars and is actuated by each wheel on one side of a passing railway car. It is assumed, that four actuations of the track instrument, a four wheel or axle count, represents a standard car length since the great majority of cars being classified have but four axles. Normally open contacts 3 and 4 are controlled through a linkage 5 by the track instrument 2 to a momentarily closed position by the passage of each wheel on one side of the railway cars traversing track section R1T. Contact 3 is connected to the positive (+) terminal of a conventional source of power, not shown, while contact 4 is connected to the input of a Schmitt trigger circuit 10 of the car counter unit. The electronic counter unit is composed of a Schmitt trigger, a one-shot multivibrator, four bistable multivibrators, four "And-Nor" circuits, and four driver amplifiers. The Schmitt trigger circuit is of the transistor variety having two transistors SC7 and SC10, and may be, for example, of the type shown and described in FIGURE 11.14, on page 122, of the General Electric Transistor Manual, fifth edition, 1960. The purpose in having the Schmitt trigger circuit at the input of the car counter unit is to take the positive pulses obtained from the axle counter, filter the noise pulses or transients that may be present therein and then generate a square wave output for use in the subsequent electronic stage. The output of the Schmitt trigger is fed into the input of a one-shot multivibrator 11 comprising transistors SC12 and SC15 for controlling the respective conductive states thereof. This circuit may be, for example, of the type illustrated and disclosed in Technical Manual No. 11-690, pages 199-201, Basic Theory and Application of Transistors, Headquarters, Department of the Army, March 1959. The purpose of this circuit is to provide a time delay of approximately one hundred and fifty (150) milliseconds. This time delay lengthens or extends the width of the pulse obtained from the axle counter to provide a minimum time for the rotor later described to be rotated. The Schmitt trigger is used to filter noise or contact bounce effects and provide a step function voltage suitable for operating a one-shot multivibrator. The output of the one-shot multivibrator 11 is applied to a bistable multivibrator circuit 12 including two transistors SC17 and SC18 which is the first stage of a binary circuit. The binary circuit comprises four bistable multivibrator circuits 12, 13, 14 and 15 with each multivibrator including a pair of transistors SC17 and SC18, SC21 and SC24, SC22 and SC23, and SC19 and SC20, respectively. Each of the bistable multivibrators includes identical circuitry, and specifically may be of the type shown in FIGURE 202, page 207, of Technical Manual No. 11-690, Basic Theory and Application of Transistors, Headquarters, Department of the Army, March 1960. As can be seen from FIGURE 202 this multivibrator has a negative diode steering circuit; however, in the present application a positive diode steering circuit was preferred to the negative steering, and therefore, as is readily apparent, these multivibrators can only be operated by positive pulses applied thereto. These multivibrators consist of two transistors so interconnected that under normal operating conditions one transistor will be conducting heavily or in saturation while the other transistor is nonconducting or cut off. As previously mentioned, the output of the monostable or one-shot multivibrator 11 is fed into the input of bistable multivibrator 12 and controls the conductive state of transistors SC17 and SC18. The output of transistor SC18 of multivibrator 12 is coupled to the input of bistable multivibrator 13. Similarly, the output of transistor SC21 of multivibrator 13 is applied to the input of bistable multivibrator 14, and in a like manner, the output of transistor 24 of multivibrator 13 is coupled to the input of bistable multivibrator 15. A better understanding of the conductive states of the multivibrator transistors and the controlling thereof will be set

forth in greater detail in the discussion in relation to their operation hereinafter.

A plurality of "And-Nor" circuits are shown to have their inputs coupled to the outputs of the binary circuit. Each "And-Nor" logic circuit 16, 17, 18 and 19 comprises two transistors SC11 and SC13, SC14 and SC16, SC8 and SC9, and SC5 and SC6, respectively. The "And-Nor" circuit has the unique characteristic of appearing cut off if either transistor or both transistors are cut off, and therefore in order to have a conductive circuit both transistors must be conducting at the same time. For more information on "NOR" logic, reference is made to FIGURE 12.8(A), page 131, of The General Electric Transistor Manual, fifth edition, 1960, which shows a modified version of the circuit utilized in the present application. The output of transistor SC17 of multivibrator 12 is coupled to the input of transistors SC13, SC16, SC8 and SC5 of "And-Nor" circuits 16, 17, 18 and 19, respectively. Similarly, the output of transistor SC21 of multivibrator 13 is connected to transistors SC11 and SC14 of "And-Nor" circuits 16 and 17, respectively. In a like manner, the output of transistor SC24 of multivibrator 13 is coupled to the input of transistors SC9 and SC6 of "And-Nor" circuits 18 and 19, respectively. Transistors SC5 and SC6 of "And-Nor" circuit 19 also have their inputs coupled to the output of transistor SC23 of multivibrator 14. Similarly, transistors SC8 and SC9 of "And-Nor" circuit 18 also have their inputs connected to the output of transistor SC22 of multivibrator 14. In a like manner, transistors SC14 and SC16 of "And-Nor" circuit 17 also have their inputs coupled to the output of transistor SC20 of multivibrator 15. Likewise, the inputs of transistors SC11 and SC13 of "And-Nor" circuit are coupled to the output of transistor SC19 of multivibrator 15. The conductive conditions of the "And-Nor" circuits are controlled by choosing the proper output or combination of outputs of the bistable multivibrators, and which operation will be described in greater detail hereinafter.

Transistors SC2, SC1, SC3 and SC4, shown as P-N-P types, however not necessarily limited thereto as is well known in the art, are power amplifiers controlled by "And-Nor" circuits 16, 17, 18 and 19, respectively. All of the amplifiers operate in the same manner, and therefore like parts, with the exception of the transistors, are indicated with like reference numerals. Transistors SC2, SC1, SC3 and SC4 have their base electrode coupled to the output of transistors SC13, SC16, SC9, and SC6, respectively, through an associated resistor 20. Further, the base electrode of each amplifying transistor is connected to the positive terminal of a power supply through an associated resistor 21 to keep the transistor reversely biased and nonconducting when both of the transistors of its respective "And-Nor" circuit are conducting heavily. The emitter electrode of each amplifying transistor is connected to ground. The collector electrode of each amplifying transistor is connected through an associated resistor 22 to the negative terminal of the power supply. The junction between resistors 22 and the collector electrodes of transistors SC2, SC1, SC3 and SC4 is connected to contacts 1a, 1b, 1c and 1d, respectively. The back points of contacts 1a and 1b are coupled through terminals a and b to field winding 31 of the two-phase motor 30, while the back points of contacts 1c and 1d are coupled through terminals c and d to field winding 32 of the two-phase motor 30. The numeral 33 designates the rotor of the two-phase motor, and is merely schematically represented, since its construction is well known in the electrical art. The rotor 33 of the two-phase motor 30 is indicated as being mechanically coupled to a suitable gear train 35 by means of the shaft 34. The gear train, in turn, is indicated as being arranged for mechanical coupling with a conventional track fullness potentiometer 37 through any suitable transmission, herein indicated by the dotted line 36. The output from potentiometer 37 may then be used to activate some type

of a visual track fullness or empty car spaces remaining indicator. For example, a calibrated voltmeter which has a full scale reading equivalent to the number of empty car spaces available in storage track 1T may be utilized as an indicator. The rotor 33 of the two-phase motor 30 rotates one complete revolution (360°) for each four axle counts on one side of a car which is representative of one standard railway car. The potentiometer 37, in turn, is driven through gear train 35 to change its circuit resistance by an amount equal to one car space for each complete revolution of the rotor 33 of the motor. This change in circuit resistance, in turn, is applied to the indicator to proportionally change and indicate the number of empty car spaces remaining in storage track 1T. The motor 30, gear train 35, potentiometer 37 and the output to the indicator are shown enclosed in a block designated 1R. Similarly illustrated in the drawing are blocks 2R and 3R, which blocks are identical in construction to 1R but are utilized to indicate the track fullness or remaining car spaces of storage tracks 2T and 3T, respectively.

Selection of the empty car spaces remaining in a particular storage track is controlled automatically by track switches 1W, 2W, relays WS1P, WS2P, and contacts 1, 1b, 1c, 1d, 2a, 2b, 2c and 2d. The windings of the two relays designated WS1P and WS2P are shown in the figure 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 application for Letters Patent of the United States, Ser. No. 49,379, filed Aug. 12, 1960, by Emil F. Brinker and David P. Fitzsimmons, for Automatic Control System for Railway Classification Yards, and now Patent No. 3,226,541, issued on Dec. 28, 1965, and assigned to the assignee of the present application. It is sufficient for purposes 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 to 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 would remain released when a cut of railway cars, to be routed from the hump to storage track 1T over switch 1W in its normal position, traverses the track section shown, and would be energized when the cut is to be routed to storage track 2T or 3T over switch 1W in its reverse position. Relay WS2P would remain released when the cut is to be routed to storage track 2T over switch 2W in its normal position, and would be energized when the cut is destined for storage track 3T over switch 2W in its reverse position. Reference is made to said copending application for a complete understanding of the control of the relays WS1P and WS2P, if such is desired.

It is assumed, as shown in FIG. 1, that the railway cars or cuts of cars are being routed to the storage track designated 1T. Under such a condition relays WS1P and WS2P are released or in their normal positions, as previously set forth, so that an energization path from the counter unit is completed through the back points of contacts 1a, 1b, 1c and 1d to terminals a, b, c and d, respectively, of indicator control apparatus 1R, thereby

displaying the car space available in the respective storage track 1T.

As is apparent, when a cut of cars is destined to the storage track designated 2T, the relay WS1P is energized or picked up and switch 1W is in its reverse position, while relay WS2P remains in its released or normal position. During such a condition, front point of contacts 1a, 1b, 1c and 1d are closed while the back point of contacts 2a, 2b, 2c and 2d remain, as shown in FIG. 1 in a closed position. The energization path now is completed from the counter unit through the front point of contacts 1a, 1b, 1c and 1d, through back point of contacts 2a, 2b, 2c and 2d, through terminals a', b', c' and d' of indicator control apparatus 2R, thereby displaying the number of empty car spaces remaining in storage track 2T.

In the third condition, it is assumed that a cut of cars is being routed to the storage track designated 3T. As is readily apparent, under such a condition relays WS1P and WS2P are both energized or picked up and switches 1W and 2W are in their reverse positions. With relays WS1P and WS2P energized a circuit is completed from the counter unit through the front points of contacts 1a, 1b, 1c and 1d through the front point of contacts 2a, 2b, 2c and 2d to terminals a'', b'', c'' and d'' of indicator control apparatus 3R, respectively, thereby indicating the car space available in the storage track 3T.

In explaining the operation of the system which has been described, reference is made to FIG. 2 which shows a tabulated chart of the sequential operation of the railway car counting system. The chart represents in sequential steps the various conditions of the transistor stages along with the position of the rotor of the motor as the wheels of a car are counted in by the axle counter. For the sake of convenience only, it is assumed that a railway car is being routed to storage track 1T and the rotor positions shown in the chart of FIG. 2 represent the rotor of motor 30 of indicator 1R. However, as is readily apparent, the sequential operation would be identical when cars are being routed to storage tracks 2T and 3T and the rotor positions shown would be those of the motor included in indicator control apparatus 2R and 3R, respectively.

Referring to the chart of FIG. 2 there are illustrated eight distinct steps performed by each element in determining the passage of a railway car to a particular storage track. Each transistor stage is represented, and its particular condition during the sequence of operation is noted. To simplify the description the Schmitt trigger, the one-shot multivibrator and the four bistable multivibrators are represented by a single transistor in a particular conductive state since these stages operate in an inverse manner. That is, when one transistor of the above-mentioned stages is "ON" or conducting, the other transistor of the stage is "OFF" or nonconducting. Therefore, looking at the chart "ON" infers that the associated transistor in the Schmitt trigger, the one-shot multivibrator and the bistable multivibrators are "OFF," while "OFF" infers the opposite. The "And-Nor" circuits 16, 17, 18 and 19 are also shown in FIG. 2 as represented by a single transistor, in this case the right transistor of each "And-Nor" circuit illustrated in FIG. 1. However, it is noted that the conductive conditions shown in the chart of FIG. 2 represent the state of "And-Nor" circuits and not the individual transistors. The transistors of the "And-Nor" circuits work together simultaneously while conducting but if either transistor is cut off, current will not flow through the associated transistor of the "And-Nor" circuit even though the latter transistor is turned "ON." Therefore, looking at the chart "ON" infers that both transistors of the "And-Nor" circuits are conducting while "OFF" infers that one or both transistors of the "And-Nor" circuit are non-conducting. The four remaining transistors SC2, SC1, SC3, and SC4 are used to drive the stator windings of the two-phase motor. Tran-

sistors SC1 and SC2 drive the stator winding 31 while transistors SC3 and SC4 drive the stator winding 32. As shown in FIG. 1, the stator windings are connected between the collector electrodes of their respective driver transistors. It will thus be seen that the polarity of the stator windings is determined by the conductive condition of the driver transistors. For example, the current direction in stator winding 31 can be successively in one direction, no current or in the other direction by having transistor SC2 conducting and transistor SC1 cut off, then both transistors SC2 and SC1 either conducting or cut off, and finally having transistor SC1 conducting and transistor SC2 cut off, respectively. The polarity of the stator windings is illustrated in the chart in FIG. 2, and by using this technique in the proper sequence, four pulses representative of four axle counts, rotate the rotor of the motor four quarter turns in succession. The last column in the chart illustrates the relative position of the rotor along with the condition of the stator fields during each sequence of the axle counting operation. As shown, with a phase displacement existing between the two stator windings, the rotor will turn so that its magnetic field will line up with the resultant field which exists midway between the magnetic fields generated in the stator windings. The electrical rotation of the stator fields is used to produce a 90 degree or one-quarter turn of the rotor for each input pulse. As previously stated, each complete revolution of the rotor produces an output change which is equivalent to subtracting one car space from the selected storage track.

Initially, when a railway car is absent from the track section R1T, contacts 3 and 4 are open and a zero input is applied to the Schmitt trigger 10. The normal condition of the Schmitt trigger 10 is maintained since no input is present, that is, transistor SC10 is "ON" or conducting heavily and transistor SC7 is "OFF" or nonconducting. Under such a condition no output pulse is being applied to the input of the monostable multivibrator 11 and the transistors SC12 and SC15 remain in their normal condition with SC12 "ON" and SC15 "OFF." During this quiescent period of the one-shot multivibrator 11 no positive pulse is being fed into the bistable multivibrator 12, and therefore transistors SC18 and SC17 remain in their normal operating conditions "OFF" and "ON," respectively. All of the multivibrators 11, 12, 13, 14 and 15 operate in the same manner. A binary switch when the previous transistor to which it is connected goes into conduction and provides a positive pulse. For example, transistors SC17 and SC18 switch when transistors SC12 and SC15 switch while transistors SC21 and SC24 switch state when transistor SC18 goes into conduction. Transistors SC22 and SC23 switch state when transistor SC21 goes into conduction while transistors SC19 and SC20 switch state when SC24 goes into conduction. As is readily apparent all the multivibrators are in a quiescent condition, and therefore multivibrators 13, 14 and 15, like multivibrator 12, remain in their normal operating conditions with transistors SC24, SC22 and SC20 "ON" and transistors SC21, SC23 and SC19 "OFF." As heretofore stated, the conductive conditions of the "And-Nor" circuits 16, 17, 18 and 19 are controlled by choosing the proper output or combination of outputs of the bistable multivibrators 12, 13, 14 and 15. The "And-Nor" circuits are arranged in a manner such that an "OFF" condition of a particular transistor of the binary circuit forwardly biases the transistors of the "And-Nor" circuit, while on the other hand an "ON" condition of a particular transistor of the binary circuit maintains the transistors of the "And-Nor" circuits cut off when no forward bias is present thereon. It can thus be seen that the "OFF" condition of transistor SC19 of multivibrator 15 forwardly biases transistors SC11 and SC13, and therefore the "And-Nor" circuit 16 is maintained in an "ON" condition. The "OFF" condition of transistor SC21 of multivibrator 13 forwardly biases transistor SC14; how-

ever, the "ON" condition of transistors SC17 and SC20 of multivibrators 12 and 15, respectively, maintains transistor SC16 cut off, and as previously set forth, the "And-Nor" circuit will appear "OFF" or cut off if either transistor or both transistors of the circuit are cut off. Therefore, "And-Nor" circuit 17 appears cut off or in an "OFF" condition. Similarly, the "ON" condition of transistors SC17, SC24 and SC22 of multivibrators 12, 13 and 14, respectively, maintains transistors SC8 and SC9 cut off, thereby rendering "And-Nor" circuit 18 in an "OFF" condition. The "And-Nor" circuit 19 is maintained in an "ON" condition due to the forwardly biasing of transistors SC5 and SC6 by the "OFF" condition of transistor SC23 of multivibrator 14. The driver transistors SC2, SC1, SC3 and SC4 are controlled in a manner such that when their respective "And-Nor" circuit is in an "ON" condition the driver transistor is reversely biased and in an "OFF" condition while, on the other hand, when their respective "And-Nor" circuit is in an "OFF" condition the driver transistor is forwardly biased to an "ON" condition. As is readily apparent, the "ON" condition of "And-Nor" circuits 16 and 19 maintains transistors SC2 and SC4 in an "OFF" condition, respectively, while the "OFF" condition of "And-Nor" circuits 17 and 18 maintains transistors SC1 and SC3 in an "ON" condition, respectively. Referring to FIG. 1, under such transistor operating conditions an electron current path can be traced from the negative (-) terminal of the power supply through resistor 22 connected to the collector electrode of transistor SC2, to contact 1a, from the back point of contact 1a, to terminal a, through stator winding 31, to terminal b, to the back point of contact 1b, to the collector-emitter electrodes of transistor SC1 and finally from the emitter electrode to ground. In a like manner, an energization path may be traced from the negative (-) terminal of the power supply connected to the collector electrode of transistor SC4 to the grounded emitter electrode of transistor SC3 for energizing the stator winding 32. The polarities of the stator windings under this condition are illustrated in the chart of FIG. 2. Further, the initial position of the rotor 33 is likewise illustrated in the chart of FIG. 2.

Assuming now that a railway car is present on track section R1T and the first axle of the car actuates track instrument 2 so that contacts 3 and 4 are momentarily closed, closing of the contacts 3 and 4 completes a circuit from the positive (+) terminal of the power supply to the input of the Schmitt trigger 10. A positive input pulse to the Schmitt trigger 10 causes the conductive condition of the transistors SC7 and SC10 to reverse, that is, transistor SC7 is turned "ON" while transistor SC10 is turned "OFF." With transistor SC7 conducting and transistor SC10 nonconducting a positive gate is applied to the transistor SC12 of one-shot multivibrator 11. A positive input gate to transistor SC12 of the one-shot multivibrator causes a switching action to occur therein so that transistor SC12 is turned "OFF" and transistor SC15 is turned "ON." As hereinbefore set forth, the one-shot multivibrator switches when the previous transistor to which it is connected goes into conduction and provides a positive gate which is applied to the base of the normally conducting transistor SC12. The switching action of the one-shot multivibrator provides a positive input pulse to be fed into multivibrator 12. Similarly, a positive input pulse to multivibrator 12 causes a switching action to occur therein so that transistor SC18 is turned "ON" while transistor SC17 is turned "OFF." The turning on of transistor SC18 provides a positive pulse to be applied to the input of multivibrator 13. With a positive input pulse, multivibrator 13 is caused to switch, that is, transistor SC21 is turned "ON" and transistor SC24 is turned "OFF." The turning on of transistor SC21 produces a positive pulse to be applied to the input of multivibrator 14 so that a switching action occurs therein. This switching action reverses the con-

ductive condition of the multivibrator so that transistor SC23 is turned "ON" and transistor SC22 is turned "OFF." The turning off of transistor SC24 fails to provide a positive pulse to the input of multivibrator 15 so that this multivibrator remains in its present state, that is, transistor SC19 "OFF" and transistor SC20 "ON." As previously set forth, the "And-Nor" circuits are arranged in such a manner that an "OFF" condition of a particular transistor of the binary circuit forwardly biases the transistor of the "And-Nor" circuit, while on the other hand an "ON" condition of a transistor of the binary circuit maintains the transistors of the "And-Nor" circuit cut off when no forward bias is present thereon. It can thus be seen that the "OFF" condition of transistor SC19 of multivibrator 15 forwardly biases transistors SC11 and SC13 so that "AND-Nor" circuit 16 remains in an "ON" condition. The "ON" condition of transistors SC21 and SC20 of multivibrators 13 and 15, respectively, maintains transistor SC14 of "And-Nor" circuit 17 cut off, and as hereinbefore stated, the "And-Nor" circuit will appear cut off if either or both transistors of the circuit are cut off. Therefore, "And-Nor" circuit 17 appears cut off or in an "OFF" condition. The "OFF" condition of transistor SC22 of multivibrator 14 forwardly biases transistors SC8 and SC9, and therefore maintains "And-Nor" circuit 18 in an "ON" condition. Similarly, the "OFF" condition of transistors SC17 and SC24 of multivibrators 12 and 13, respectively, maintains transistors SC5 and SC6 in a conductive state, thereby rendering "And-Nor" circuit 19 in an "ON" condition. As previously set forth, an "OFF" condition of an "And-Nor" circuit turns on its respective driver transistor while an "ON" condition of an "And-Nor" circuit maintains its respective driver transistor in a nonconductive state. Therefore, it follows that the "ON" condition of "And-Nor" circuits 16, 18 and 19 maintains transistors SC2, SC3 and SC4 in an "OFF" condition, respectively, while the "OFF" condition of the "And-Nor" circuit 17 maintains transistor SC1 in an "ON" condition. As is readily apparent, the conductive conditions of transistors SC2 and SC1 are identical to their preceding conditions and, therefore, the energization path to stator winding 31 remains unchanged. However, due to the conductive condition change of transistor SC3 the current path to stator winding 32 is interrupted, that is, no current flows through stator winding 32 and, therefore, no field is produced by the winding. Thus, it can be seen from the chart in FIG. 2, that the resultant field is produced only by stator winding 31 and the rotor of the motor will rotate counterclockwise to position itself with this resultant field.

Subsequently, when the contacts 3 and 4 are opened due to the release of track instrument 2 a zero (0) condition again appears at the input of the Schmitt trigger. With such an input the various circuits undergo a change of state and correspondingly produce a change in the rotor position, as shown in the chart of FIG. 2. The remaining sequential steps of the counting operation are self-explanatory as clearly illustrated in the chart of FIG. 2 and, therefore, a detailed description of each step appears unnecessary. It is noted that the last sequential step of the counting operation returns the counter to its initial condition so that the counter is automatically prepared to proceed with any subsequent counting operations.

The system is capable of operating for car speeds from over zero (0.0) mile per hour to a maximum expected speed of approximately twelve (12) to fifteen (15) miles per hour.

From this description it is apparent that the system of our invention provides a means in a railway classification yard for accurately counting the number of empty car spaces remaining in each storage track. The utilization of transistor digital circuits increases the efficiency due to the small power requirements and low heat dis-

sipating characteristics of the transistors. Further, the system is highly reliable, accurate and requires very little maintenance since the number of moving parts that are susceptible to wear has been kept at a minimum.

Although we have herein shown and described only one form of railway car counting 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 railway car counting system for a storage track comprising,
 - means for producing a signal representative of each axle of each railway car entering the storage track,
 - solid state electronic means responsive to each signal for counting the number of cars routed to said storage track,
 - and means including a motor having a pair of stator windings and a rotor responsive to said counting means for producing an output representing the number of empty car spaces remaining in said storage track.
2. A system for indicating the available railway car spaces remaining in a storage track, comprising,
 - a wheel actuated means for deriving a signal in accordance with each axle of a passing railway car entering said storage track,
 - an electronic transistorized digital means responsive to each signal for counting the number of cars routed to said storage track,
 - and means including a motor having at least two stator windings and a rotor responsive to said counting means for producing an output representative of the number of car spaces remaining in said storage track.
3. In a railway car counting system for a railway car classification yard including a single track leading to a plurality of storage tracks, the combination comprising,
 - switching means for routing railway cars into a preselected one of said plurality of storage tracks,
 - detector means in said single track for producing a signal in accordance with each axle of each routed railway car,
 - transistorized electronic means including a plurality of triggered circuits responsive to each signal for counting the railway cars routed to the preselected one of said plurality of storage tracks,
 - and means including a motor having a plurality of stator windings and a rotor responsive to said counting means for producing an output representative of the railway car spaces remaining in the preselected one of said plurality of storage tracks.
4. In a railway car counting system for storage tracks in an automatic railway classification yard, comprising in combination,
 - a wheel actuated device for producing a signal in response to the passage of each axle of a car entering said yard,
 - an electronic transistorized counting unit including a plurality of switching circuits responsive to each signal for counting the number of cars routed to said storage tracks,
 - and means including a motor having stator and rotor means responsive to said counting unit for producing an output indicative of the number of car spaces remaining in said storage tracks.
5. In a railway car counting system for storage tracks in a railway car classification yard,
 - a wheel actuated device for producing electrical pulses in response to the passage of each axle of a railway car entering the yard,
 - an electronic counting unit including a plurality of transistor switching circuits responsive to each of said pulses for counting the number of cars routed to said storage tracks,

and means including a two-phase motor controlled by said counting unit for producing an output signal representative of the number of empty car spaces remaining in said storage tracks.

6. In a railway car counting system provided with an automatic switching system to route railway cars into preselected storage tracks in a classification yard,

a wheel counting device for producing an electrical pulse in accordance with the passage of each axle of the railway cars entering the yard,

an electronic counting apparatus including a plurality of transistor switching stages responsive to each electrical pulse for producing a change of state in said transistor stages,

means including a motor having at least two stator windings and a rotor responsive to the change of state of said transistor stages for producing an output representative of the number of cars routed to said preselected storage tracks,

and means responsive to said output for producing an indication of the number of empty car spaces remaining in said preselected storage tracks.

7. In a railway car counting system for a storage track in a classification yard,

a wheel actuated device for producing an electrical pulse for each axle of passing railway cars entering said yard,

an electronic digital circuit arrangement including a plurality of transistor switching stages responsive to said electrical pulses for providing a series of sequential switching operations representative of the number of railway cars routed to said storage track,

an electromechanical means responsive to said series of switching operations for producing an output in accordance with the number of railway cars routed to said storage track,

and an indicator means responsive to said output for producing an indication of the number of railway car spaces remaining in said storage track.

8. In a railway car counting system for a storage track in a classification yard,

a wheel actuated device for producing an electrical pulse for each axle of each passing railway car entering said yard,

an electronic digital circuit arrangement including a plurality of transistor switching stages,

means for applying said electrical pulses to the input of said digital circuit for producing an eight step sequential switching operation representative of each railway car entering said yard,

a motor means,

and an indicator means,

said motor means coupled to said digital circuit and operated by said sequential switching operation to cause an output change in said indicator equal to one railway car for each four electrical pulses produced by said wheel actuated device.

9. In a railway car counting system for a storage track in a classification yard,

a wheel actuated device for producing an electrical pulse for each axle of each passing railway car entering said yard,

an electronic digital circuit arrangement including a Schmitt trigger,

a plurality of multivibrators,

a plurality of "And-Nor" circuits and a plurality of driver stages,

means for applying said electrical pulses to the input of said digital circuit for producing an eight step sequential switching operation representative of each railway car entering said yard,

a motor including two stator windings and a rotor,

means coupling said stator windings to the output of said digital circuit wherein said rotor rotates one complete revolution in response to said eight step sequential switching operation,

a potentiometer connected to said rotor for producing a resistance change proportional to one railway car for each complete revolution of the rotor,

and an indicator responsive to said change in resistance to provide an output signal indicative of the number of car spaces remaining in said storage track.

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