

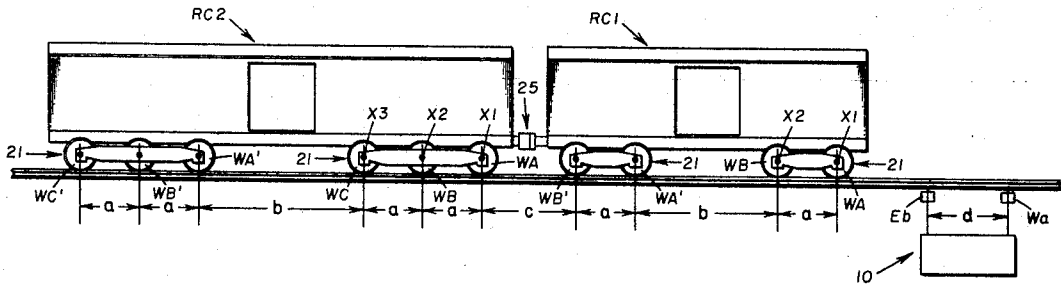
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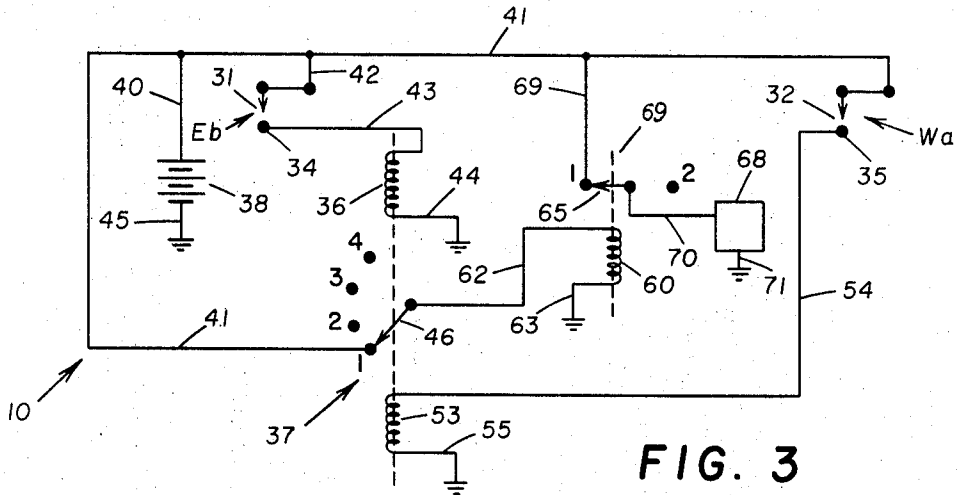
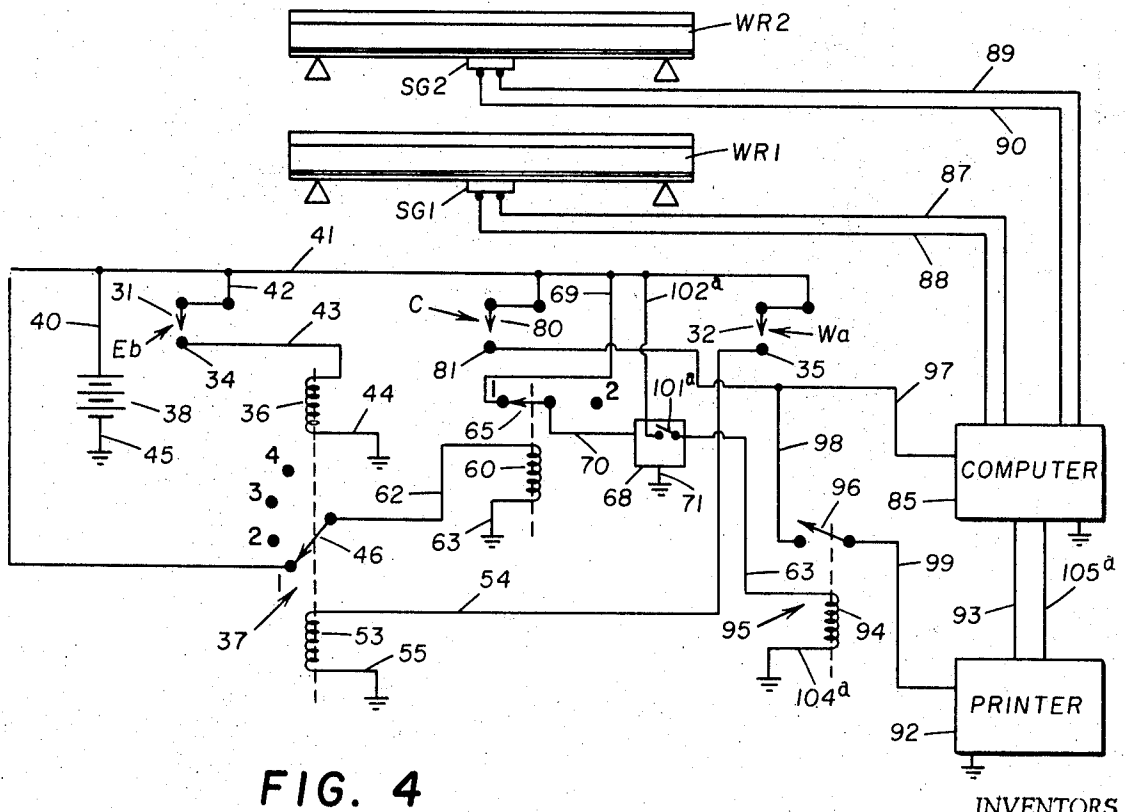
[50] Field of Search..... 246/77,
247A, 182, 169D; 177/163, 210, 211

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[54] DETECTOR SYSTEMS
16 Claims, 9 Drawing Figs.
[52] U.S. Cl..... 177/163,
246/182, 246/247
[51] Int. Cl..... G01g 21/22

ABSTRACT: A detector system for detecting movement of
railroad cars which has a plurality of wheel actuated switches
spaced along a railroad track and which provides a signal each
time a railroad car has moved past the switches.





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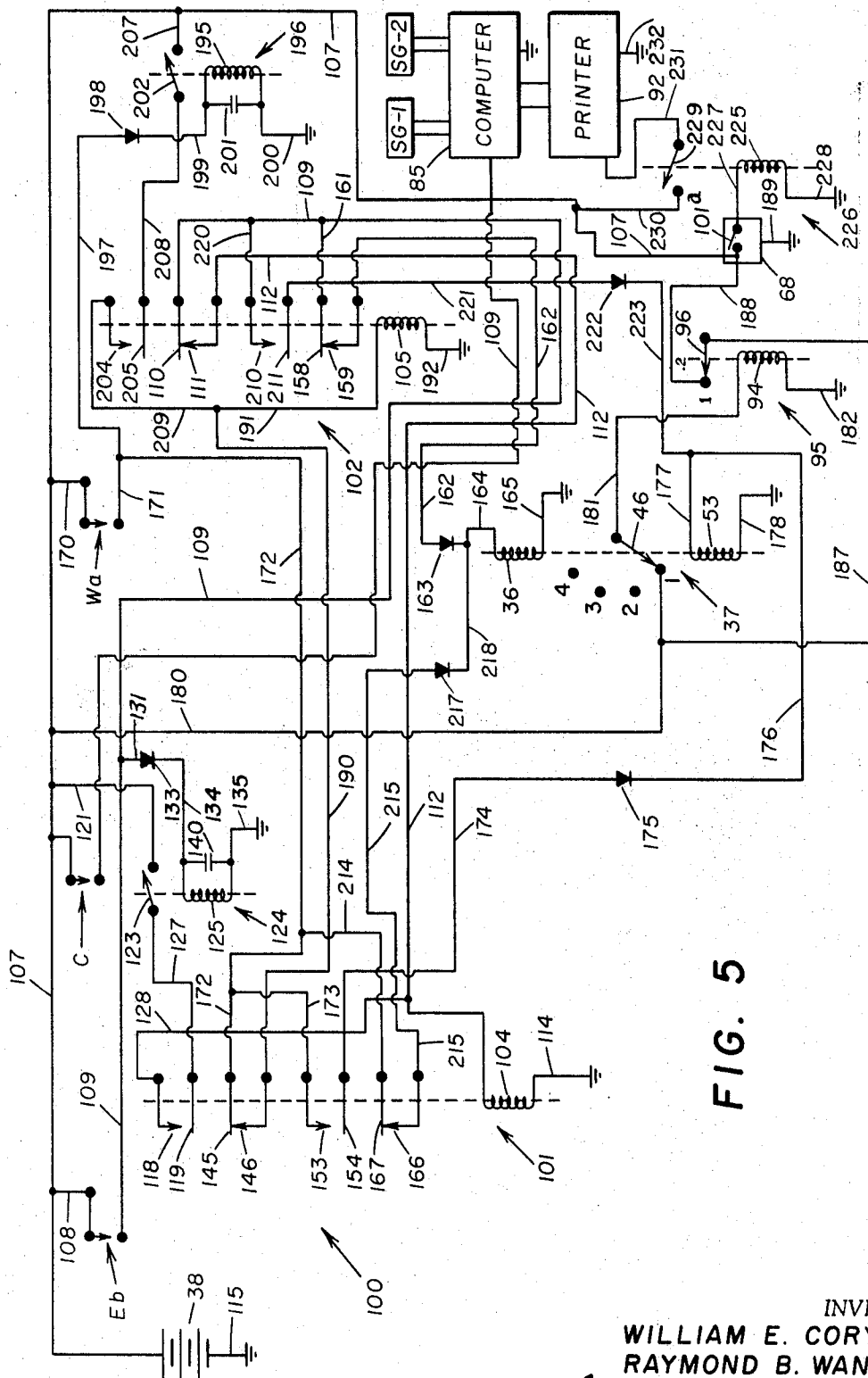
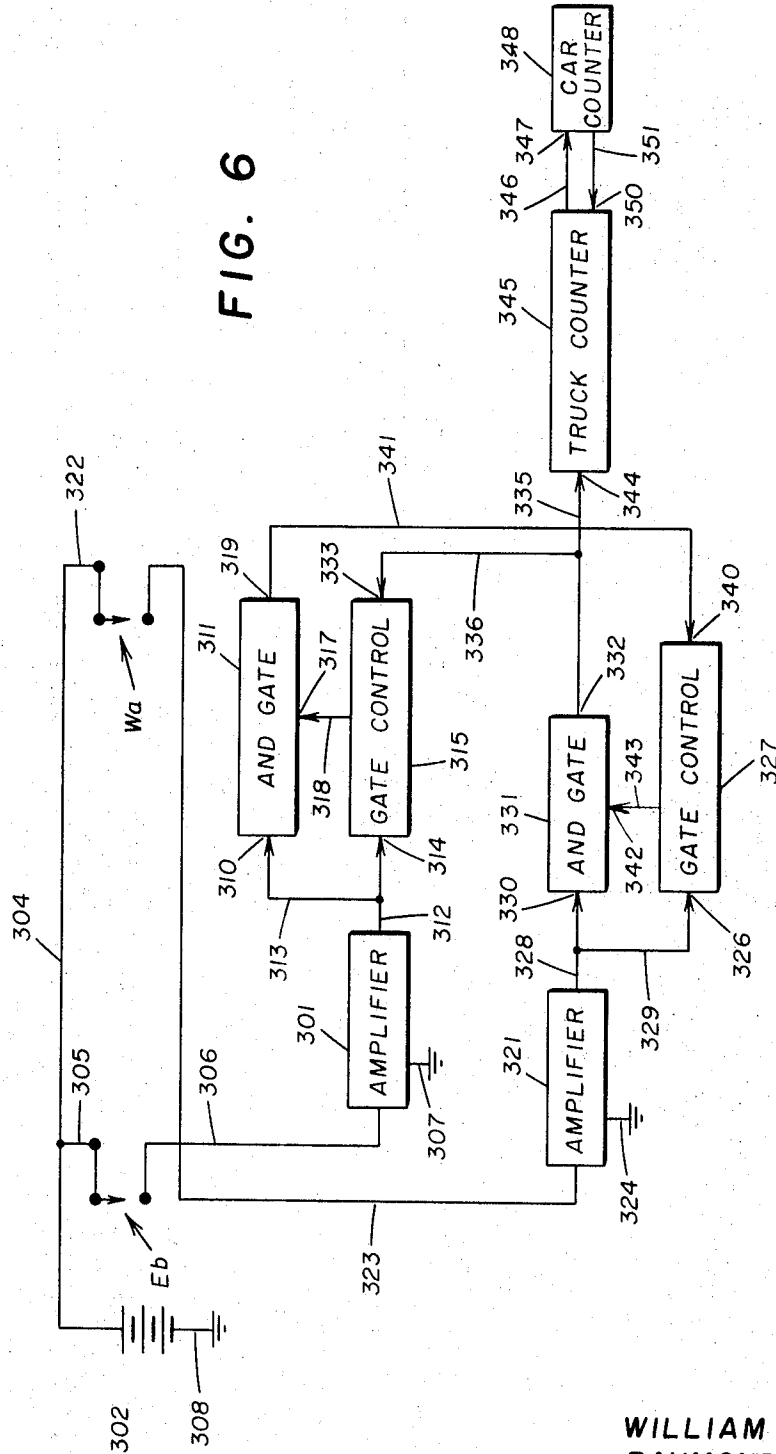


FIG. 5

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FIG. 6



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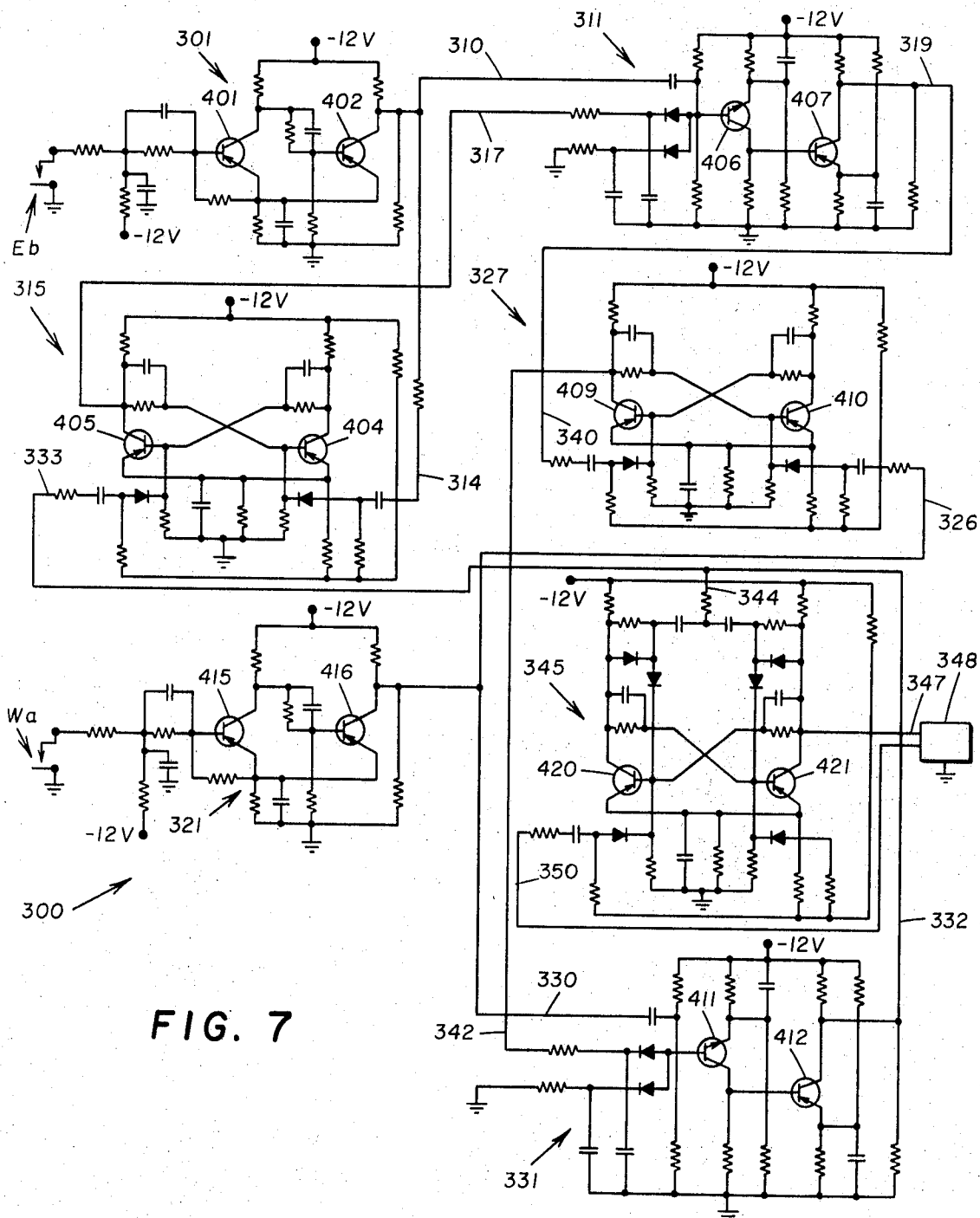
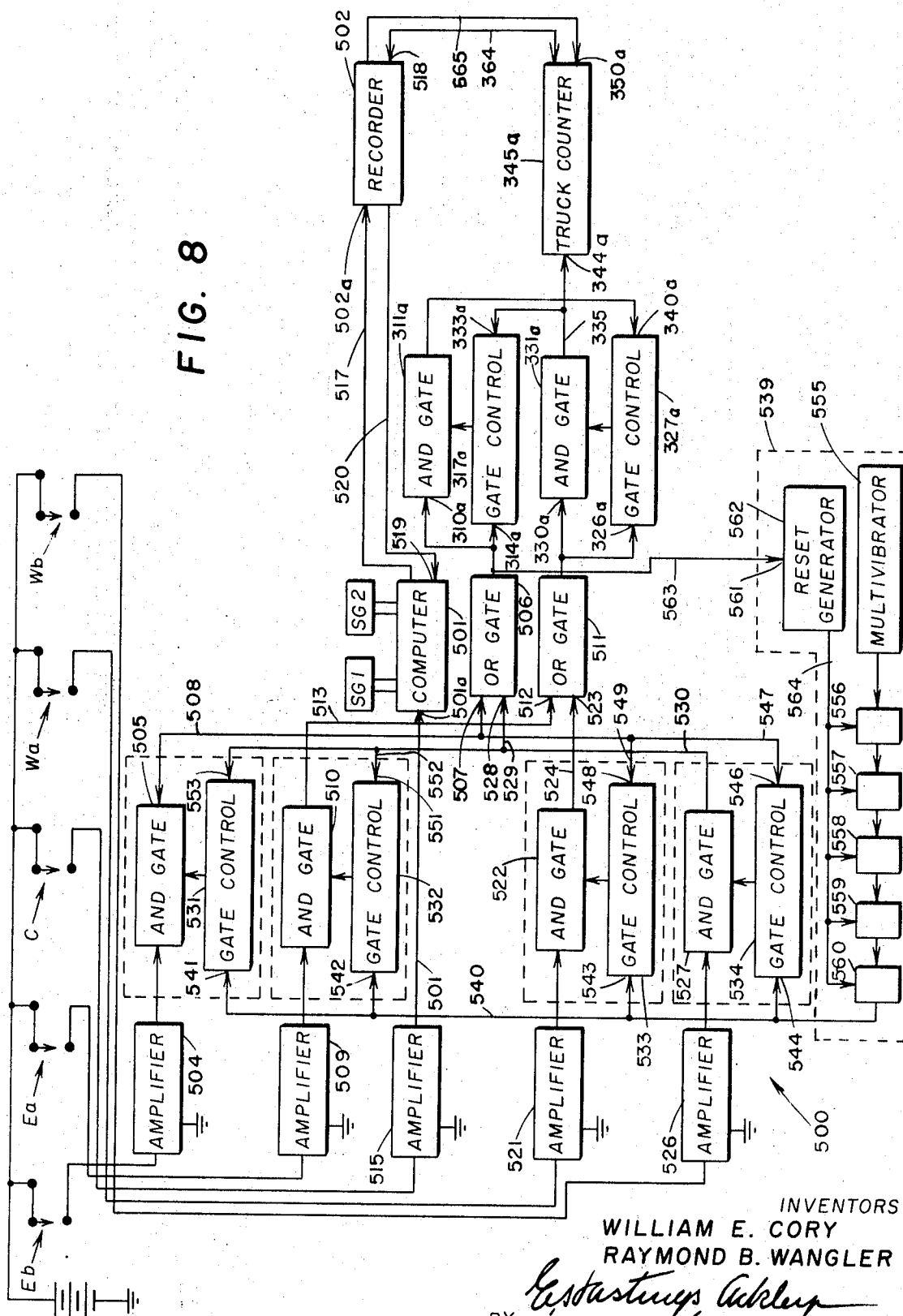


FIG. 7

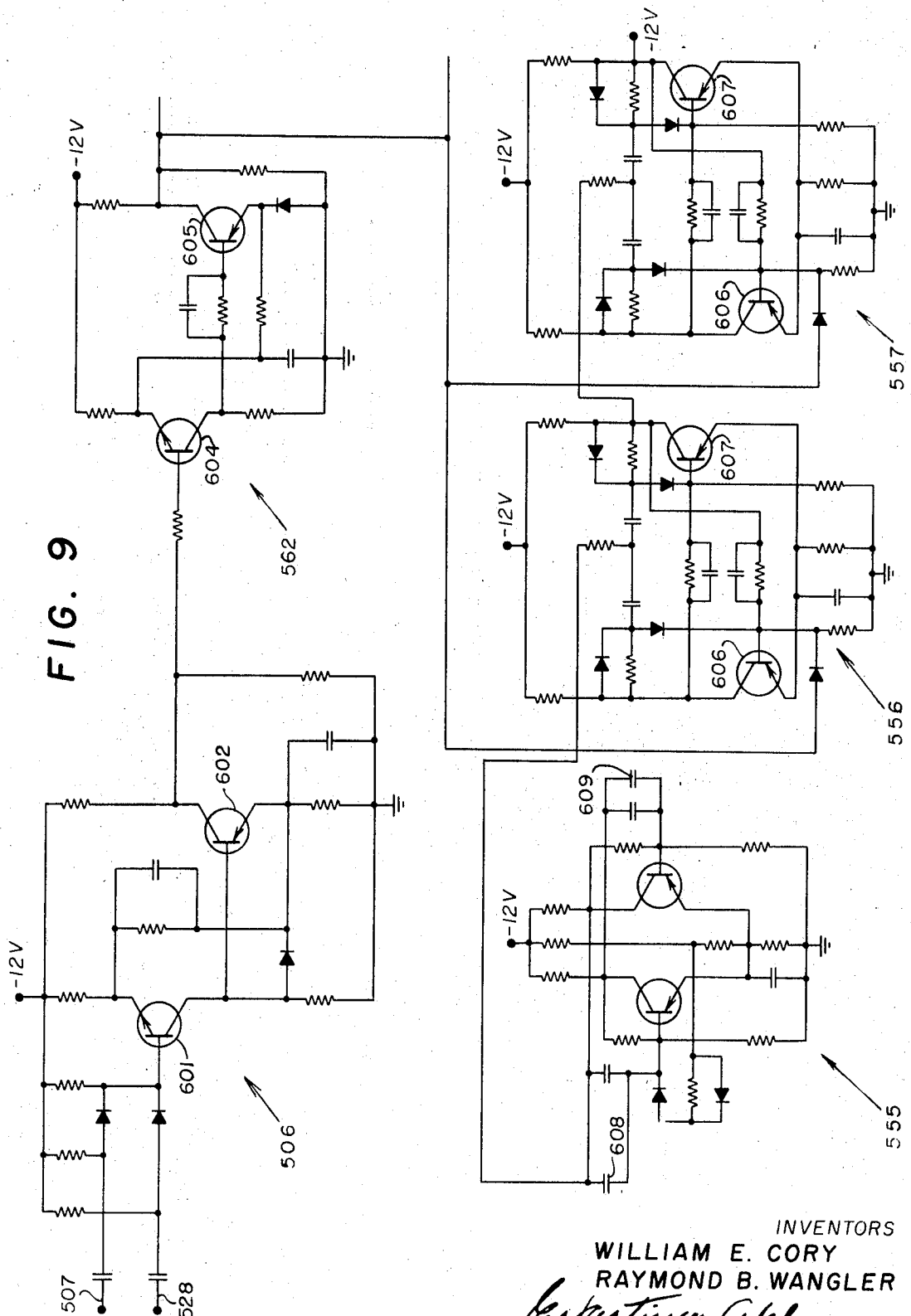
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DETECTOR SYSTEMS

This invention relates to detector systems.

An object of this invention is to provide a new and improved system for detecting predetermined groups of objects moving past a predetermined location and providing a signal each time a predetermined group of objects has moved past the location.

Another object is to provide a detector system for providing a signal each time a group of objects, the objects of each group being spaced from each other a distance smaller than the distance between each group of objects, move progressively past a predetermined location.

Still another object is to provide a detector system for providing a signal each time a group of objects, such as the wheels on a single truck of a railroad car, move past a predetermined location.

A further object is to provide a detector system having a pair of operator means, such as switches, actuable by objects as they move therepast and spaced in the direction of travel of groups of such objects a distance greater than the distance between each adjacent pair of the objects of each group but shorter than the distance between each adjacent group, and means responsive to the actuation of the operator means which provides a signal each time a group of objects moves past the operator means.

A still further object is to provide a detector system having switch means spaced in a predetermined manner along a railroad track which are actuated in predetermined sequence by the wheels of a railroad car as the railroad car moves therepast and means responsive to the actuation of the switches in such sequence which provides a control signal to a controlled device, such as a recorder, printer, computer or the like each time a railroad car moves past the switches.

A still further object is to provide a detector system for railroad cars which will function properly to provide a signal each time a car has moved therepast during the movement of railroad cars in either direction over the tracks and past the switches.

Another object is to provide a detector system for railroad cars which is responsive to the movement of the wheels of a railroad car past a plurality of wheel actuated switches spaced along the railroad track and which will function properly to provide a signal each time a car has moved past the switches regardless of the number of pairs of wheels mounted on the front and rear trucks of the car.

Still another object is to provide a detector system for sensing the weight borne by each pair of wheels of a railroad car and for determining the weight of each car by totaling the loads borne by all the pairs of wheels of a railroad car after the car has moved past the wheel actuated switches of the detector system.

Additional objects and advantages of the invention will be readily apparent from the reading of the following description of a device constructed in accordance with the invention, and reference to the accompanying drawings thereof, wherein:

FIG. 1 is a schematic side view showing railroad cars on railroad tracks provided with a detector system embodying the invention;

FIG. 2 is a fragmentary schematic perspective view of a railroad car on the tracks of FIG. 1;

FIG. 3 is a schematic diagram of the electrical circuit of a detector system embodying the invention;

FIG. 4 is a schematic electrical system of another form of the detector system;

FIG. 5 is a schematic diagram of the electric circuit of another detector system embodying the invention;

FIG. 6 is a block diagram of the control circuit of another detector system embodying the invention;

FIG. 7 is a schematic illustration of the circuit of the detector system illustrated in FIG. 6;

FIG. 8 is a block diagram of the control circuit of another detector system embodying the invention; and

FIG. 9 is a schematic illustration of a portion of the circuit of the detector system illustrated in FIG. 8.

Referring now particularly to FIGS. 1 and 2 of the drawings, the detector system 10 embodying the invention may be used to count railroad cars RC as they move over a pair of railroad tracks R1 and R2 in a predetermined direction, in the instant case from left to right as seen in FIG. 1. Each of the cars has front and rear trucks 21 each having two or more axles X on which are rotatably mounted a pair of wheels W. A car, such as the car RC1, may have trucks each provided with two axles X1 and X2 on which are rotatable the wheels W or, may in the case of the car RC2 have three axles X1, X2 and X3. Some cars may have trucks provided with more than three axles but the distance *a* between any pair of axles of a truck of a railroad car used by American railroads is not less than 4½ feet and not more than 6½ feet, the distance *b* between the innermost axles of the trucks of each car is considerably greater than 10 feet, and the distance *c* between adjacent axles of a pair of railroad cars connected together by a coupling means 25 is not less than 7 feet. The detector system includes a pair of switches Eb and Wa which are positioned adjacent one of the rails and are spaced apart a distance *d* greater than the greatest distance *a* between any pair of axles of any truck of a railroad car but shorter than the distance *c* between the axles of adjacent trucks of two adjacent cars coupled together by the coupling 25. The switches Eb and Wa may, for example, be spaced 6 feet 9 inches apart.

Referring now particularly to FIG. 3, the switches Eb and Wa may be mechanical switches which have an operator arm or member which is engaged by each wheel W as it moves therepast or may be proximity type switches having means which sense each wheel as it passes; In any case, the movable contacts 31 and 32 of the switches Eb and Wa, respectively, are moved to engage their contacts 34 and 35, respectively, as a wheel rolling along the track R1 moves past the switches. The switch Eb, when closed, connects the winding 36 of a stepping relay 37 across a source of direct current, such as a battery 38, by means of the conductors 40, 41, 42, 43 and 44, ground and conductor 45. Each time the winding 36 is energized, it moves the movable contact 46 of the stepping relay in a clockwise direction from engagement with any particular stationary contact 1, 2, or 3 of the relay which it may have been engaging and into engagement with the next adjacent higher numbered contact 2, 3 or 4. The stepping relay has a second winding 53 which is connected across the battery 38 by the switch Wa each time it is closed by means of the conductors 40, 41, 54 and 55, ground and the conductor 45. Each time the relay winding 53 is energized and the movable contact 46 is in engagement with any one of the stationary contacts 2, 3 or 4, it moves the movable contact in a counter-clockwise direction one step to the next lower numbered contact 1, 2 or 3. The movable contact 46 of the stepping relay when it is in its position engaging its stationary contact 1 connects the winding 60 of a two-step relay 61 across the battery by means of the conductors 40, 41, 62 and 63, ground and the conductor 45. The relay winding 60 each time it is energized moves its movable contact 65 from its stationary contact 1 or 2 with which it is engaged to its other stationary contact 2 or 1, respectively. For example, if the contact 65 is initially in the position wherein it engages the stationary contact 1, the first time that the relay winding 60 is energized, after it has been deenergized, it moves the stationary contact 65 into engagement with the stationary contact 2 and when it is then deenergized and subsequently energized again, it moves the movable contact back into engagement with the stationary contact 1. The two-step relay 61 each time its movable contact moves into engagement connects any suitable controlled device 68, such as a counter, across the battery through the conductors 40, 41, 69, 70 and 71, ground and the conductor 45. The counter may be of any suitable type which advances its counting mechanism one step each time the contact 65 is energized.

In use, if a train of cars, such as the cars RC1 and RC2, is move over the tracks R1 and R2 from left to right and progressively past the switches Eb and Wa, the operative elements of the detector system being in the positions shown in FIG. 3, as

the wheel WA on the first axle X1 of the front truck 21 of the first car RC1 moves over the rail R1 and past the switch Eb, the switch Eb is closed momentarily and energizes the winding 36 of the stepping relay 37. This momentary energization of the relay winding 36 moves its movable contact 46 one step and into engagement with its stationary contact 2. The movable contact 65 of the two-step relay remains in engagement with its stationary contact 1 but its winding 60 is now deenergized. As the car RC1 continues to move to the right, the wheel WB on the axle X2 of the first truck moves past and closes the switch Eb to again momentarily energize the winding 36 of the stepping relay and its movable contact 46 is moved a second step and into engagement with its contact 3. This second closing of the switch Eb occurs before the first wheel WA reaches the switch Wa. At this time, the wheels WA and WB are positioned between the switches Eb and Wa. As the car continues to move on the rails, the wheel WA moves past and momentarily closes the switch Wa which causes a momentary energization of the relay winding 53 and the movable contact 46 is moved from its stationary contact 3 one step to its stationary contact 2. As the second wheel WB of the front truck moves past and closes the switch Wa and the relay winding 53 is again energized, the movable contact 46 of the stepping relay is moved one step to its stationary contact 1 and again connects the relay winding 60 of the two-step relay 61 across the battery. This energization of the relay winding 60 moves its contact 65 out of engagement with its stationary contact 1 and into engagement with the stationary contact 2 thus disconnecting the controlled device 68 from across the battery. The second wheel WB of the first or front truck moves past the switch Wa and closes it before the front wheel WA' of the second or rear truck of the first car RC1 can close the switch Eb.

As the car continues to move over the rails, the wheel WA' of the rear truck of the car R1 closes the switch Eb causing the movable contact 46 of the stepping relay 37 to again move one step to its stationary contact 2 again disconnecting the winding 60 of the two-step relay 61 from across the battery. This deenergization of the relay winding of the two-step relay does not cause its movable contact 65 to move. The wheel WA' continues to move toward the switch Wa and before it can reach the switch Wa the second wheel WB' of the rear truck engages the switch Eb and again closes it again energizing the relay winding 36 to move the movable contact to the stationary contact 3. The wheels WA' and WB' of the rear truck are now between the two switches Eb and Wa, and, as the car continues to move over the rails, the switch Wa, is momentarily closed by the wheel WA', then by the wheel WB' as these wheels move successively past the switch Wa. These two closings of the switch Wa and the consequent two energizations of the winding 53 causes the movable contact of the stepping relay to move to the stationary contact 2 and then to the stationary contact 1 at which time the relay winding 60 of the two-step relay is again connected across the battery and moves its movable contact 65 into engagement with the stationary contact 1 which then connects the controlled device across the battery. The controlled device 68 upon being connected across the battery now performs some function. If the controlled device is a counter, its counting mechanism is advanced one step and indicates that one car has moved past the position of the switches Eb and Wa.

The wheel WB' will move past and close the switch Wa before the wheel WA of the first truck 21 of the next car RC2 can close switch Eb since the distance between the wheel WB' of the rear truck of the first car and the wheel WA of the front truck of the second car is greater than the distance between the switches Eb and Wa.

As the second car moves over the rails, the first two wheels WA and WB of its front truck successively move past and close the switch Eb and energize the winding 36 of the stepping relay two times to cause its movable contact 46 to move two steps and into engagement with its stationary contact 3 before the first wheel WA moves into engagement with

the switch Wa. Continued movement of the car will now cause the front wheel WA to close the switch Wa before the third wheel WC of the first truck moves past and closes the switch Eb. This closing of the switch Wa by the wheel WA energizes the winding 53 and causes the movable contact 46 to move from engagement with its stationary contact 3 into engagement with its stationary contact 2. The third wheel of the first truck then moves past and closes the switch Eb to energize the winding 36 and cause the movable contact 46 to move to its engagement with its stationary contact 3. The second and third wheels of the first truck of the car RC2 then successively close the switch Wa twice to energize the winding 53 two times and cause the movable contact 46 to move back two steps and into engagement with the stationary contact 1 of the stepping relay. The winding 60 of the two-step relay is thus energized when the third wheel WC of the first truck closes the switch Wa and its movable contact is moved over into engagement with its contact 2. The wheel WC moves past the switch Wa before the wheel WA' of the rear truck of the car RC2 moves past and closes the switch Eb. The wheels WA', WB' and WC' of the rear truck then move successively past the switches Eb and Wa causing the same sequence of operation of the switches Eb, Wa and of the stepping relay as were caused by the movement of the three wheels of the front truck past the switches Eb and Wa. In this sequence of operations the movable contact 46 is moved out of engagement with the stationary contact 1 and then back into engagement with its stationary contact 1 as the last wheel WC' moves past and closes the switch Wa thus again energizing the winding 60 of the two-step relay and causing the contact 65 to move back from engagement of its stationary contact 2 into engagement with the stationary contact 1. The circuit of the controlled device 68 is again energized, and, if it is a counter, causing it to indicate that a second car has moved past the switches Eb and Wa.

It will be apparent that since the distances between adjacent wheels of the trucks of the railroad cars have the relationship described above, regardless of the number of axles to each truck, the detector system illustrated in FIG. 3 will function regardless of the number of wheels on each of the two trucks on each railroad car and that the controlled device 68 will be energized each time the last wheel of the rear truck of each car has moved past the switch Wa.

Referring now to FIG. 4 of the drawings the detector system illustrated in FIG. 3 is shown in use with a pair of gauges SG1 and SG2 which are bonded to the bottom surfaces of the weigh rails WR1 and WR2 which constitute sections of the railroad tracks R1 and R2 and which are supported at their opposite ends so that the weigh rails are free to deflect downwardly as a pair of wheels on each axle of a truck of a railroad car rolls thereover. A switch C, which may be similar in construction to the switches Eb and Wa having a movable contact 80 and a stationary contact 81, is closed by each pair of wheels to connect the strain gauges to a suitable circuit of a computer or logic device 85 which translates the variations in the resistances of the strain gauges, which vary with the downward deflection of the weigh rails, into an electric signal proportional to the load or weight supported by the weigh rails each time a pair of wheels moves past the midpoints of the spans of the weigh rails. The strain gauge SG1 is connected to the computer or logic device 85 by the conductors 87 and 88 and the strain gauge SG2 is connected across the computer 85 by the conductors 89 and 90.

The output signal of the computer is transmitted to a printer 92 by a conductor means 93 and the printer prints the accumulated weight of the loads borne by the wheels of a single car each time the last pair of wheels of the rear truck of the car moves past and closes the switch Wa due to the energization of the winding 94 of a relay 95 which causes its contact 96 to close. The contact 96, when in closed position, closes a circuit between the computer and the printer through the conductors 97, 98 and 99 and ground. Closure of this circuit by the contact 96 causes a "print" signal or command to be transmitted to the printer.

The relay winding 94, when the last pair of wheels of the rear truck of a car moves past and closes the switch *Wa*, is connected momentarily across the battery by a suitable switch or relay contact 101a in the car counter or controlled device 68 through the conductors 40, 41, 102a, 103a, 104a, ground and the conductor 45. The printer provides a feedback signal, as by the conductor means 105a, to the computer to reset the computer to zero each time it has printed the total weight of a car.

It will be apparent as a car rolls over the rails R1 and R2 and approaches the weigh rails WR1 and WR2, one of its wheels on each axle of each truck moves past the switch *Eb* and then over the weigh rails and past the switch *C* which closes to cause the computer to produce a signal which corresponds to the weight borne by the pair of wheels on each axle, and then moves past the switch *Wa*. The successive closing of the switches *Eb* and *Wa* cause the controlled device 68 to operate in a manner described above. Then the last wheel of the rear truck of each car moves past and closes the switch *Wa*, the controlled device is actuated, momentarily closes the contact 101 and thus causes the printer to print the combined weight supported by the pairs of wheels of the car which has just moved over the weigh rails and then resets the computer to zero so that the computer is then in condition to support the weight of the next car of the train.

If it is desired that the detector device count railroad cars moving in either direction along the railroad tracks, the detector system 100 illustrated in FIG. 5 may be employed which includes a pair of directional relays 101 and 102 which, when the cars are moving from left to right over the railroad tracks, function to cause the winding 36 of the stepping relay 37 to be energized each time the switch *Eb* is closed and the relay winding 53 to be energized each time the switch *Wa* is closed and which, when the cars are moving in the opposite, or right to left, direction over the railroad tracks, function to cause the relay winding 36 to be energized when the switch *Wa* is closed and the winding 53 to be energized when the switch *Eb* is closed.

The winding 104 of the first directional relay is connectable across the battery 38 only when the winding 105 of the second directional relay 102 is not energized and vice versa. If the railroad car is moving from left to right and the various operative elements of the detector device 100 are in the initial positions illustrated in FIG. 5, the switch *Eb* will be closed as the first wheel *WA* of the front truck of the first car RC1 moves therepast and will connect the winding 104 across the battery 38 through the conductors 107, 108, and 109, the normally closed contacts 110 and 111 of the second directional relay, the conductors 112 and 114, ground and the conductor 115. Energization of the winding 104 causes the holding contacts 118 and 119 of the relay 101 to close and connect the relay winding 104 across the battery through the conductors 107 and 121, the contact 123 of a timer relay 124 whose winding 125 is connected across the battery each time the switch *Eb* closes, and the conductors 127, 128, 112 and 114, ground and the conductor 115. The timer relay 124 may be of any suitable type which holds its contact 123 closed for a predetermined period each time its winding 125 is momentarily connected across the battery by the switch *Eb* through the conductors 107, 108, 109, and 131, a unidirectionally conductive device 133, such as a diode, the conductors 134 and 135, ground and the conductor 115. The timer relay has suitable means for holding its contact closed, as by maintaining the winding 125 energized for such period. For example, a capacitor 140, connected across the winding 125, charges at the time when the switch *Eb* is momentarily closed and then discharges through the relay winding 125, when the switch *Eb* opens. If desired, a resistance may be connected in series with the capacitor to decrease the rate of its discharge through the winding. When the first relay winding 104 is energized, its normally closed contacts 145 and 146 open to prevent connection of the winding 105 of the second directional relay across the battery, its normally closed contacts 167 and 166 open to prevent the energization of the winding 36 of the stepping relay by the clo-

sure of the switch *Wa*, and its normally open contacts 153 and 154 close to permit energization of the winding 53 of the stepping relay by the closure of the switch *Wa*.

When the relay winding 104 is energized, each closure of the switch *Eb* connects the winding 36 of the stepping relay 37 across the battery through the normally closed contacts 158 and 159 of the second directional relay 102 by means of the conductors 107, 108, 109, 161 and 162, a unidirectionally conducting device 163, the conductors 164 and 165, ground and the conductor 115. The winding 53 of the stepping relay 37 cannot now be energized by closure of the switch *Eb* since the normally open contacts 210 and 211 of the second directional relay 102 remain open. Also winding 36 of the stepping relay 37 cannot be energized by closure of the switch *Wa* since the normally closed contacts 166 and 167 of the first directional relay 101 are now open. During the movement of a car across the rail track and past the switches *Eb* and *Wa*, each time the switch *Eb* is closed, the winding 36 of the relay winding is energized and connected across the battery 38 through the conductors 107, 108, 109, and the closed contacts 158 and 159 of the second directional relay 102 to cause the movable contact 46 of the stepping relay to be moved one step in a clockwise direction. Each closure of the switch *Wa* will now cause the movable contact of the stepping relay to be moved one step in a counterclockwise direction, such closure of the switch *Wa* will now cause the winding 53 of the stepping relay to be connected across the battery through the conductors 107, 170, 171, 172, and 173, the now closed contacts 153 and 154 of the first directional relay 101, the conductor 174, the unidirectionally conducting device 175, of the conductors 176, 177 and 178, ground and the conductor 115.

The movable contact 46, each time it is in the position where it engages its contact 1, connects the winding 94 of the two-step relay 95 across the battery through the conductors 107, 180, 181 and 182, ground and the conductor 115. The two-step relay each time it is energized twice in succession, in the manner previously described, connects a controlled device 68 such as a counter across the battery through the conductors 107, 180, 187, 188 and 189, ground and the conductor 115.

The relay winding 125 once it has been connected across the battery 38 maintains its contact 123 closed for a length of time longer than the length of time needed for a car, traveling at a predetermined normal speed, to move past the switches *Eb* and *Wa* so that when switch *Eb* is closed, the relay winding 105 cannot be energized by the closure of the switch *Wa* during such movement of a train of cars past the switches *Eb* and *Wa* from left to right.

If the train of cars is moved from right to left over the tracks R1 and R2, and past the switches *Wa* and *Eb*, the switch *Wa* is closed first and connects the winding 105 of the second directional relay 102 across the battery through the conductors 107, 170, 171 and 172, the normally closed contacts 145 and 146 of the directional relay 101, the conductors 190, 191 and 192, ground and the conductor 115. Simultaneously, the closure of the switch *Wa* connects the winding 195 of its timer relay 196 across the battery through the conductors 107, 170, 171 and 197, a unidirectionally conductive device 198, the conductors 199 and 200, ground and the conductor 115. The winding 195 has a capacitor 201 connected thereacross to cause it to remain energized for a predetermined period of time, for example 30 seconds, after each momentary closure of the switch *Wa*.

The movable contact 202 of the timer relay 196, when the winding 105 has been energized and has caused the normally open holding contacts 204 and 205 of the second directional relay to close, connects the relay winding 105 across the battery through the conductors 107, 207, 208, 209, 191, and 192, ground and the conductor 115. Energization of the winding 105 simultaneously causes its contacts 158 and 159 to move to open position to prevent energization of the relay winding 36 by the closure of the switch *Eb* and its normally open contacts 210 and 211 to close in order that the closure of the switch *Eb*

will cause energization of the winding 53 of the stepping relay. When the relay winding 105 is energized, each closure of the switch *Wa* will cause the connection of the stepping relay winding 36 across the battery through the conductors 107, 170, 171, 172, 214, now closed contacts 166 and 167 of the first directional relay 101, the conductor 215, a unidirectionally conductive device 217, the conductors 218, 164, 165, ground and the conductor 115. Each closure of the switch *Eb*, when the winding 105 is energized, causes the other winding 53 of the stepping relay to be connected across the battery through the conductors 107, 108, 109 and 220, the now closed contacts 210 and 211 of the second directional relay 102, the conductors 221, the unidirectionally conductive device 222, the conductors 223, 176, 177 and 178, ground and the conductor 115.

In use, when a train of cars is moved from left to right over the tracks R1 and R2 past the switches *Eb* and *Wa*, the switch *Eb* will be closed first and thereafter the periodic closure of the switch *Eb* will cause the timer relay 124 to keep its contact 123 closed thus keeping the relay winding 104 of the directional relay 101 energized during the period of time that the train of cars are moving past the switches *Eb* and *Wa* and for a predetermined period of time thereafter, for example 30 seconds, if the period of closure of the timer relay is 30 seconds. During this movement of the train of cars, the stepping relay 36 will be energized in the manner described above each time the switch *Eb* is closed and the relay winding 53 of the stepping relay will be energized each time the switch *Wa* is closed. This operation of the stepping relay will cause the movable contact 96 of the two-step relay to move out of engagement with its contact 1 and into engagement with its contact 2 each time the wheels of the last axle of the front truck of a car have moved past the switch *Wa* and then back into contact with its contact 1 when the wheels on the last axle of the rear truck of the car have moved therepast to energize the controlled device 68 once the car moves past the two switches *Eb* and *Wa*.

If the train of cars is moving from right to left over the tracks, the switch *Wa* is closed first, by a wheel on the first axle of the front truck of the first car in the train of cars, the relay winding 105 will be energized and will be maintained energized due to the action of the timer relay 196 which keeps its contact 202 closed during the normal rate of movement of the cars over the tracks and past the two switches *Wa* and *Eb*. Each closure of the switch *Wa* will now cause the winding 36 of the stepping relay to be energized and each closure of the switch *Eb* will cause the winding 53 of the stepping relay to be energized in the manner described above, and the counter or controlled device 68 will be energized or actuated each time the wheels on the last axle of the rear truck of each car move past the switch *Eb*.

The detector system 100 may also be employed to weigh each car of the train as it moves past the switches *Eb* and *Wa* and over weigh rails which have the strain gauges SG1 and SG2 bonded to their bottom surfaces in the same manner as described above in connection the system illustrated in FIG. 4. The switch C is closed each time a pair of wheels moves over the weigh rails to cause the computer 85 to translate the variations in the resistances of the strain gauges into an electric signal. The accumulated weight of the loads borne by the wheels of each car is caused to be printed by the printer 92 when the contact 101a in the controlled device 68 is momentarily closed as the last pair of wheels of the rear truck of each car moves past and closes the switch *Wa*. The contact 101a when closed connects the relay winding 225 of a relay 226 across the battery 38 through the conductors 107, 227 and 228, ground and the conductor 115. Energization of the relay winding 225 causes its contact 229 to close and connect an appropriate circuit of the printer 92 across the battery through the conductors 107, 230, 231 and 232, ground and the conductor 115.

Referring now particularly to FIG. 6 of the drawings, the detector system 300 is the electronic equivalent of the detector

system 10 illustrated in FIG. 3 and may be employed to count the cars of the train as they move in one direction, for example, from left to right over tracks R1 and R2. The switch *Eb* each time it is closed connects the input circuit of a squaring amplifier 301 across a source of current, such as a battery 302, through the conductors 304, 305, 306, 307, ground and the conductor 308. The square pulse output of the squaring amplifier is applied to the signal input circuit or terminal 310 of an AND gate 311 through the conductor means 312 and 313 and to the open input circuit or terminal 314 of a gate control 315 through the conductor means 312. The output of the gate control, which may be a flip-flop circuit, is transmitted to the control input circuit or terminal 317 of the AND gate through the conductor means 318. The gate control when a pulse has been applied to its open input circuit opens the AND gate so that a subsequent pulse applied to the input circuit of the AND gate will cause the AND gate to transmit or provide an output pulse to its output circuit or terminal 319.

The switch *Wa* similarly connects the input circuit of an amplifier 321 across the battery 302 through the conductors 304, 322, 323 and 324, ground, and the conductor 308. The output of the squaring amplifier 321 is transmitted to the open input circuit or terminal 326 of a gate control 327 by the conductor means 328 and 329 and to the signal input circuit or terminal 330 of an AND gate 331 by the conductor means 328. The output circuit or terminal 332 of the AND gate is connected to the close input circuit or terminal 333 of the gate control 315 through the conductor means 335 and 336. The gate control 315 when a pulse has been applied to its close input circuit causes the AND gate 311 to close and the AND gate will not thereafter transmit a pulse applied to its signal input circuit 310 until after a pulse is again applied to the open input circuit 314 of the gate control 315.

The output of the first AND gate 311 is transmitted to the close input circuit or terminal 340 of the gate control 327 through the conductor means 341. The output of the gate control 327, which is identical to the gate control 315, is transmitted to the control input circuit or terminal 342 of the AND gate 331 through the conductor means 343. The output of the AND gate 331 is also transmitted by the conductor means 335 to the input circuit or terminal 344 of a truck counter 345, which may be a flip-flop circuit as will be explained below, which transmits a pulse or signal through a conductor means 346 to the input circuit or terminal 347 of a controlled device 348 to cause it to perform a function, for example, if it is a counter to count the number of cars in a train by actuating a counter of the like upon the transmission to the controlled device of a signal pulse after the two trucks of each car have moved past the switches *Eb* and *Wa*.

The AND gate 311 is initially closed and the AND gate 331 is initially open. A pulse applied to the open input circuits 314 and 326 of the gate controls 315 and 327, respectively, causes the gate controls to open their associated AND gates 311 and 331, respectively, while a pulse applied to the close input circuits 333 and 340 of the gate controls will cause the gate controls to close their associated AND gates 311 and 331, respectively.

In use, when a train of cars, such as the cars RC1 and RC2, is moved from left to right over the tracks R1 and R2 and sequentially past the switches *Eb* and *Wa*, as a wheel WA on the first axle X1 of the front truck 21 of the first car RC1 moves over the rail R1 and past the switch *Eb*, the switch *Eb* is closed momentarily causing the input circuit of the squaring amplifier 301 to be energized momentarily. The output pulse from the squaring amplifier 301 is not not transmitted through the AND gate 311 since it is now closed but is effective to actuate the gate control 315 and cause it to open the AND gate 311 so that the next output pulse of the amplifier 301 will be transmitted through the AND gate 311. As the car RC1 continues to move to the right, a wheel WB on the second axle X2 of the first truck moves past and closes the switch *Eb* to again connect the input circuit of the squaring amplifier 301 across the battery and the now open AND gate 311 now transmits the

pulse to the close input circuit 340 of the gate control 327 which closes the AND gate 331. The application of the second pulse to the "OPEN" input circuit of the gate control 315 does not cause any change in its condition since the gate control is now holding the AND gate 311 in its open position. This second closing of the switch *Eb* occurs before the first wheel *WA* can close the switch *Wa* as previously described.

At this time the wheels *WA* and *WB* of the first truck are positioned between the switches *Eb* and *Wa*, the AND gate 311 is still open and the AND gate 331 is now closed. As the cars continue to move on the rails, a wheel *WA* on the first axle moves past and momentarily closes the switch *Wa* which causes the input circuit of the squaring amplifier 321 to be connected across the battery 302. The output of the squaring amplifier 321 is not transmitted to the truck counter 345 or to the close input circuit 333 of the gate control 315 since the AND gate 331 is now closed, but is transmitted to the open input circuit 326 of the gate control 327 which causes the AND gate 331 to be opened. The continued movement of the car across the tracks then causes the switch *Wa* to be closed a second time as a wheel *WB* on the second axle of the first truck moves past momentarily closes the switch *Wa*. This second closing of the switch *Wa* again causes the amplifier 321 to transmit a pulse to the AND gate 331, which since it is now open transmits a pulse to the truck counter 345 to place it in condition to transmit a signal to the car counter the next time a pulse is transmitted to it through the AND gate 331. The pulse from the AND gate 331 is also simultaneously transmitted through the AND gate 331 to the close terminal 333 of the gate control 315 and the gate control 315 then causes the AND gate 311 to close.

The detector system is now again in its initial condition, the AND gate 311 being closed and the AND gate 331 being open. The continued movement of the car *RC1* will now cause the wheels *WA'* and *WB'* of the rear truck of the first car *RC1* to move successively past and close the switch *Eb* twice and then move successively past and close the switch *Wa* twice whereupon the same sequence of operation of the gate controls and the AND gates takes place as occurred during the movement of the wheels *WA* and *WB* of the first truck resulting in the transmittal of a second pulse to the truck counter 345 when the switch *Wa* is momentarily closed as the last wheel *WB'* of the rear truck moves therepast. The truck counter now transmits a signal to the car counter which, if it is a printer or recorder, will cause a record to be made that one car has passed the switches *Eb* and *Wa*.

The switch *Wa* is, of course, closed by the movement therepast of a wheel *WB'* on the last axle of the rear truck before the switch *Eb* can be closed by the movement therepast of a wheel *WA* on the first axle *X1* of the front truck of the next car *RC2*. As the three-axle front truck of the second car moves past the switch *Eb* and *Wa*, the switch *Eb* is closed twice as the wheels *WA* and *WB* move therepast causing the AND gate 311 to be open and the AND gate 331 to be closed in the manner described above. The wheel *WA* then moves past the switch *Wa* causing the gate control 327 to open the AND gate 331. Before the second wheel *WB* can close the switch *Wa* a second time, however, the third wheel *WC* moves past and closes the switch *Eb* a third time. This closure of the switch *Eb* causes a pulse to be transmitted through the now open AND gate 311 to the close input circuit terminal 340 of the gate control to cause it to again close the AND gate 331. The second and third wheels *WB* and *WC* then move successively past and close the switch *Wa* twice to first cause the gate control to open the AND gate 331 and then cause a pulse to be transmitted through the AND gate 331 to the truck counter and to the close input terminal 333 of the gate control 315. A feedback or reset signal is transmitted to an input terminal or circuit 350 of the truck counter by an appropriate circuit in the car counter 348 by the conductor means 351 each time the truck counter has transmitted a signal to the car counter.

It will now be apparent that the detector system 300 will count each car in a train of cars as it moves therepast re-

gardless of the number of axles or pairs of wheels on the trucks of each car.

Referring now to FIG. 7, the circuit of the detector system 300 is shown in greater detail. The switch *Eb* causes the conductivity of the emitter collector circuit of the first transistor 401 of the squaring amplifier 301 to increase when the switch *Eb* is closed momentarily, and this in turn causes the emitter-collector circuit of the second transistor 402 of the squaring amplifier to become more conductive thus causing a positive going pulse of square waveform to be applied to the input circuit or terminal 310 of the AND gate 311 and to the open input terminal or circuit 314 of the gate control or flip-flop circuit 315. This square wave input causes the emitter-collector circuit of the transistor 404 of the flip-flop circuit 315, if it is conductive, to be rendered nonconductive which in turn causes the emitter-collector circuit of the second transistor 405 of the flip-flop circuit to be rendered conductive. When the emitter-collector circuit 405 of the second transistor is rendered conductive, it applies a biasing potential to the control circuit 317 of the AND gate 311 and to its transistor 406 which permits its emitter-collector circuit to be rendered conductive the next time a positive going pulse is applied to its input terminal 310. When the emitter-collector circuit of the first transistor 406 is rendered conductive, the emitter-collector circuit of the second transistor 407 is rendered more conductive and a positive going pulse is then applied to the close input terminal 340 of the gate control or flip-flop circuit 327 which causes the emitter-collector circuit of its transistor 409 if it has been conducting to be rendered nonconductive which in turn causes the emitter-collector circuit of its transistor 410 to be rendered conductive. The flip-flop circuit 327, whenever its transistor 409 is conductive, causes a biasing voltage to be applied through the control input circuit 342 of the AND gate 331 to its transistor 411 so that the next time a positive going pulse is applied to its input circuit 330, the collector circuit of the transistor will be rendered conductive and in turn render the emitter-collector circuit of its second transistor 412 conductive thus causing a positive going pulse to be transmitted to the input terminal 344 of the truck counter 345 and also to the close input circuit 333 of the gate control 315 to cause the emitter-collector circuit of its transistor 405, if it has been conducting, to be rendered nonconductive.

Similarly, the switch *Wa* when it closes causes the emitter-collector circuit of the transistor 415 of the squaring amplifier 321 to be rendered conductive or more conductive, and this change in conductivity of the emitter-collector circuit of the transistor 415 causes the emitter-collector circuit of the second transistor 416 to be rendered more conductive thus causing a positive going pulse to be applied to the open input circuit 326 of the gate control or flip-flop circuit 327 and also to the input circuit 330 of the AND gate 331.

The truck counter 345, which is also a flip-flop circuit, causes a positive going pulse to be transmitted to the input terminal 347 of the car counter 348 when the emitter-collector circuit of its transistor 420 is rendered nonconductive by a positive going pulse applied to its input circuit 344 which then causes emitter-collector circuit of the second transistor 421 to be rendered conductive. The car counter 348 each time a positive going pulse has been applied to its input terminal 347 completes a circuit which causes a reset potential to be applied to the input circuit 350 of the truck counter which again renders the emitter-collector circuit of the transistor 421 of the car counter circuit 345 conductive which in turn causes the emitter-collector circuit of the other transistor 420 to be rendered nonconductive. It will now be apparent that as the wheels of a single truck of a railroad car, for example, the wheels *WA* and *WB* of the first truck of the first car *RC1* move past and sequentially close the switches *Eb* and *Wa*, the first closure of the switch *Eb* by the movement of the wheel *WA* therepast causes the transistor 404 of the gate control 315 to be rendered nonconductive which then causes the transistor 405 to be rendered conductive. A biasing potential is thus applied to the transistor 406 of the AND gate 311 which will per-

mit the AND gate 311 to transmit a pulse upon the next closure of the switch Eb. As the second wheel WB moves past and closes the switch Eb, before the second wheel WA can close the switch Wa, the second pulse applied to the input circuit 310 of the AND gate 311 causes a pulse to be applied to the close input circuit 340 of the gate control 327 and causes its transistor 409 to be rendered nonconductive when in turn then causes the transistor 410 to be conductive. When the transistor 409 is not conductive the transistor 411 of the AND gate 331 is held nonconductive. As the wheel WA then moves past and closes the switch Wa, the transistor 410 of the gate control 327 is rendered nonconductive so that a biasing potential is applied to the transistor 411 of the AND gate 331. The second closure of the switch Wa due to the movement of the wheel WB therepast will cause a positive outgoing output signal to be applied to the input circuit 344 of the AND gate of the truck counter 345 which will cause the transistor 420 to be rendered nonconductive and the transistor 421 to be rendered conductive. Simultaneously this output pulse transmitted through the AND gate 331 is applied to the transistor 405 of the gate control 315 to render it nonconductive which in turn then causes the transistor 404 to be rendered conductive. This in turn, of course, causes the transistor 406 of the AND gate 311 to be placed in condition where it cannot transmit any pulse. When the transistor 421 of the truck counter is rendered conductive and transmits a pulse to the car counter 348, the car counter transmits a positive going pulse or reset signal to be applied to the transistor 420 to cause it to be rendered conductive which in turn causes the transistor 421 to be rendered nonconductive. The car counter may be of any suitable type which, when two successive pulses have been applied to its input circuit performs a desired function such as counting a car.

The structure and mode of operation of the various squaring amplifiers, the gate controls and the AND gates being well known, these circuits will not be described in greater detail.

Referring now particularly to FIG. 8 of the drawing, the detector system 500 is an electronic equivalent of the detector system 100 illustrated in FIG. 5 and may be used to count and weigh railroad cars which are moving in either direction along the railroad tracks. The detector system 500 includes the switches Eb and Wa which are spaced apart a distance, for example 6 feet 9 inches, greater than the distance between adjacent axles of a truck of a railroad car but shorter than the distance between adjacent axles of adjacent trucks of the same car or of adjacent connected cars. The switches Wb and Ea are similarly spaced apart a distance greater than the distance between the pairs of adjacent axles of the truck of cars, for example 6 feet 9 inches. The switch Ea is positioned between the switches Eb and C for example, 2 feet 9 inches from the switch Eb and 2 feet from the switch C. The switch Wa is similarly positioned between the switches C and Wb and is spaced 2 feet from switch C and 2 feet 9 inches from the switch Wb. The switch C of the detector system is employed to cause the output of sensor devices, such as the strain gauges G1 and G2 which sense the deflection of a pair of weigh rails which constitute sections of the railroad tracks, as each pair of wheels on each axle passes over the weigh rails, to be transmitted to the computer 501 which translates such output into a signal which corresponds to the load or weight imposed by such wheels or the weigh rails and transmits such weight signals to a recorder or printer 502.

The detector system 500 includes AND gates 311a and 331a and their associated gate controls 315a and 327a which are interconnected in the same manner as the AND gate 311 and 331 and the gate controls 315 and 327 of the detector system 300 and accordingly, the elements of these AND gates and their gate controls have been provided with the same reference numerals, to which the subscript a has been added as the corresponding elements of these AND gates 311 and 331 and gate controls 315 and 327 of the detector system 300. At the time of initiation of operation of the system, the AND gate 311a of the detector system is closed and the AND gate

331a is open. The square wave pulse output of the squaring amplifier 504, each time the switch Eb is closed, is transmitted to the open input terminal 314a of the gate control 315a and to the input terminal 310a of the AND gate 311a through an AND gate 505 if it is open and an OR gate 506 to whose input terminal 507 the output of the AND gate 505 is transmitted through a conductor means 508.

Each time the switch Ea is closed, the output of its associated squaring amplifier 509 is transmitted to the open input terminal 326a of the gate control 327a and the input terminal 330a of the AND gate 331a through an AND gate 510 if it is open and an OR gate 511 to whose input terminal or circuit 512 the output of the AND gate 510 is transmitted by the conductor means 513. Each time the switch C is closed, the output of the squaring amplifier 515 is transmitted to the input terminal 501a of the computer 501 through conductor means 501b and causes the computer to translate the load sensed by the strain gauges SG1 and SG2 and transmit it to the input terminal 502a of the recorder 502 through a conductor means 517. The computer adds the weight imposed on the weigh rails by each pair of wheels as they move over the weigh rails and past the switch C and then causes the recorder to print the total weight when a print command or signal is transmitted to the input circuit 518 of the recorder. The recorder each time it prints a weight also transmits a reset to zero pulse or signal, generated an appropriate circuit within the recorder, to the input terminal 519 of the computer through a conductor means 520 to reset the computer to zero.

Each time the switch Wa is closed momentarily, it causes its squaring amplifier 521 to transmit a square wave pulse to the input terminals 326a and 330a of the gate control 327a and the AND gate 331a, respectively, through the AND gate 522 if it is open and the OR gate 511 whose input terminal 523 is connected to the output circuit of the AND gate 522 through the conductor means 524. Each time the switch Wb closes momentarily, the square wave output of its squaring amplifier 526 is transmitted to the input terminals 314a and 310a of the gate control 315a and the AND gate 311a through an AND gate 527 if it is open and the OR gate 506 whose input terminal or circuit 528 is connected to the output terminal or circuit of the AND gate 527 through the conductor means 529 and 530.

The AND gates 505 and 522 are held open while the AND gates 510 and 527 are held closed during the movement of a train of railroad cars in one direction, for example from left to right over the railroad tracks, and, conversely, the AND gates 505 and 522 are held closed while the AND gates 510 and 527 are held open during the movement of a train of cars in the opposite direction over the railroad tracks by means of the gate controls 531, 532, 533 and 534 which cause the AND gates 505, 510, 522 and 527 to open or close as required for proper operation of the detector system. As long as no car is moving across the railroad tracks and past the wheel actuated switches of the detector system, a reset pulse which causes the gate control 531 to open the AND gate 505, the gate control 532 to close the AND gate 510, the gate control 533 to close the AND gate 522, and the gate control 534 to open the AND gate 527 is delivered periodically by a reset circuit 539 through a conductor means 540 to the open input terminal 541 of the gate control 531, the close input terminals 542 and 543 of the gate controls 532 and 533, and to the open input terminal 544 of the gate control 534.

The output of the AND gate 505 is applied to the close input terminal 546 of the gate control 534 through the conductor means 508 and 547 and to the open input terminal 548 of the gate control 533, through the conductor means 508, 547 and 549. The output of the AND gate 527 is applied to the open input circuit or terminal 551 of the gate control 532 through the conductor means 530 and 552 and to the close input terminal 553 of the gate control 531 through the conductor means 530.

The reset circuit 539 includes a free running multivibrator 555 whose output is transmitted through five flip-flop circuits

or binary counter stages 556, 557, 558, 559 and 560 to the conductor means 540. The period of oscillation of the multivibrator is so chosen that the last flip-flop circuit 560 will provide positive going output pulses at 30 seconds intervals unless the operation of the reset circuit is interrupted by an input pulse transmitted from the OR gate 506 to the input terminal 561 of a reset generator 562 through the conductor means 563. The output of the reset generator is applied simultaneously to the reset input terminals 564 of the flip-flop circuits to restart the cycle of operation of the reset circuit each time a pulse is transmitted through the OR gate 506 either due to the closure of the switch Eb when the AND gate 505 is open or due to the closure of the switch Wb when the AND gate 527 is open. This periodic operation of the reset generator during the movement of a train of railroad cars past the wheel actuated switches of the detector system prevents any opening or closing of the AND gates 505, 510, 522 and 527 due to the operation of the reset circuit 539 since the speed of travel of the railroad cars is sufficiently great to cause the reset generator to be triggered periodically at intervals of substantially shorter duration than thirty seconds.

The output of the AND gate 331a is transmitted by the conductor means 335a to the input circuit or terminal 344a of a truck counter 345a, which may be a flip-flop circuit and which transmits a pulse or signal through a conductor means 564 to the input circuit or terminal 518 of the recorder to cause it to print after the two trucks of a car have moved past the switch Wa if the car is moving from left to right or past the switch Ea if the car is moving in the opposite direction. The recorder each time it is actuated and prints the weight of the car also transmits a pulse to the close input terminal 350a of the truck counter through the conductor means 565.

In use, if no car has moved past the wheel actuated switches of the detector system during the preceding 30 seconds, an output pulse of the last flip-flop circuit 560 is applied to the gate controls 531—534 causing the AND gate 505 to be open, the AND gates 510 and 522 to be closed and the AND gate 527 to be open immediately. The AND gate 311a is closed and the AND gate 331a is open. If a train of railroad cars is now moved over the tracks R1 and R2 from left to right, as the wheel WA on the first axle of the front truck of the first car RC1 now moves past and momentarily closes the switch Eb, the amplifier 504 produces a square wave pulse which is transmitted through the now open AND gate 505 to the open and close terminals 548 and 546 of the gate controls 533 and 534, respectively, and these gate controls cause the AND gate 522 to open and the AND gate 527 to close. The output pulse is also transmitted through the OR gate 506 to the open input terminal 314a of the gate control 315a which then opens the AND gate 311a. As the car continues to move across the railroad tracks, the wheel WA moves past and closes the switch Ea but the resultant output pulse of the amplifier 509 cannot now pass through the AND gate 510 which is closed. Continued movement of the car now causes the wheel WA to move past and momentarily close the switch C and the square wave pulse of its squaring amplifier 515 causes the computer to translate the output of the strain gauges SG1 and SG2 into a signal corresponding to the load imposed or weight information on the weigh rails by the wheels WA of the first axle, to store this weight signal and also transmit it to the recorder, which may be a suitable in line printer. Further movement of the railroad car then causes a wheel WB on the second axle of the front truck to momentarily close the switch Eb and the square wave output of the amplifier 504 is again transmitted through the AND gate 505, the OR gate 506 and the now open AND gate 311a to the close input terminal 340a of the gate control 327a which causes the AND gate 331a to close. At this time the wheels WA and WB of the first truck of the railroad car are positioned between the switches Eb and Wa. Continued movement of the car now cause the first wheel WA to move past and momentarily close the switch Wa and the output of its squaring amplifier 521 is transmitted through the now open AND gate 522 and the OR gate 511 to open input

terminal 326a of the gate control 327a which causes the gate control 327a to open the AND gate 331a. Continued forward movement of the car may now cause the second wheel WB to move past and close the switch Ea but the output of its squaring amplifier is, of course, not transmitted to the OR gate 511 since its AND gate 510 is closed. The second wheel WB then moves past and closes the switch C and the output of its amplifier 515 causes the computer to translate the output of the strain gauges SG1 and SG2 into a weight signal and cause the weight load imposed by the wheels WB of the second axle of the first truck on the weigh rails to be added to the weight computed by the computer when the wheels of the first axle were on the weigh rails. Further movement of the car then causes the second wheel WB to move past and close the switch Wa and the second pulse output of the amplifier 521 is then transmitted through the open AND gate 522, the OR gate 511 and the now open AND gate 331a to the input terminal 344a of the truck counter 345a. The output of the AND gate 331a also is transmitted to the close input terminal 333a of the AND gate control 315a which closes the AND gate 311a. The continued movement of the car then causes the second wheel to move past and momentarily close the switch Wb but again, since the AND gate 527 is closed, the output signal of its amplifier 526 is not transmitted to the OR gate 506. The wheels of the second truck of the car then move past the switches of the detector system causing this same sequence of operation of these switches and causing the computer to add the weight of the loads imposed on the weight rails by each pair of wheels on each axle as they move thereover and close the switch C to the weight of the loads imposed thereon by the wheels of the first truck and transmit the total weight to the recorder. The closure of the switch Wa by the wheel on the last axle of the rear truck then causes a second pulse to be transmitted through the AND gate 331a to the truck counter 345a which causes the recorder to print the accumulated or total weight which is, or course, the weight of the car. The recorder when actuated prints the weight of the car and also closes an appropriate circuit which cause a signal to be applied to the computer which resets it to zero. The speed of the train and the spacing of the switches is such that the switches Eb will be periodically closed to trigger the reset generator 562 and reset the flip-flop circuits 556—560 to prevent the transmission of a reset signal or pulse to the gate controls 531, 532, 533 and 534 from the reset signal during the movement of a train of cars therepast. The cars in a train of cars moving from left to right over the railroad tracks R1 and R2 will thus be counted and their weights recorded by the recorder 502, it be apparent that each printed weight indicates that one car has passed the detector system.

Once the train of cars has moved past the detector system, and 30 seconds have elapsed after the last closure of the switch Eb by a wheel of the last axle of the rear truck of the last car in the train, the reset circuit 539 will deliver a pulse to the open input terminal 541, the close input terminals 542 and 543, and the open input terminal 544 of the gate controls 531, 532, 533 and 534, respectively, thus causing the AND gate 505 to be open, the AND gates 510 and 522 to be closed, and the AND gate 527 to be open. The detector system is now again in its original condition or state.

If a train of cars moves past the wheel actuated switches in the opposite direction, i.e. from right to left, the switch Wb will be closed as the first wheel on the first truck of the first car moves therepast and the square wave output of its squaring amplifier 526 is transmitted through the open AND gate 527 to the close input terminal 553 of the gate control 531 and to the open input terminal 551 of the gate control 532, causing the AND gate 505 to close the AND gate 510 to open. The output of the amplifier 526 is also transmitted through the OR gate 506 to the open input terminal 314a of the gate control 315a which then opens the AND gate 311a and to the input terminal 561 of the reset generator. The first wheel then moves past and momentarily closes the switch Wa but the output of its square wave amplifier 521 cannot now be trans-

mitted to the OR gate 511 since the AND gate 522 is closed. The movement of the first wheel past the switch C then causes the square wave output of its amplifier 515 to be applied to the input terminal 501a of the computer 501 which functions in the manner described to provide a signal corresponding to the weight imposed on the weigh rails by the wheels on such axle. Continued movement of the car then causes the second wheel on the first truck past the switch C then causes the square wave output of its amplifier 515 to be applied to the input terminal 501a of the computer 501 which functions in the manner described to provide a signal corresponding to the weight imposed on the weigh rails by the wheels on such axle. Continued movement of the car then causes the second wheel on the first truck to move past and momentarily close the switch Wb whereupon a second pulse from the squaring amplifier 526 is transmitted through the open AND gate 527, the OR gate 506 and the now open AND gate 311a to the close input terminal of the gate control 327a which then causes the AND gate 331a to close. The first wheel then moves past and momentarily closes the switch Ea and the square wave output of the squaring amplifier 509 is transmitted through the now open AND gate 510 and the OR gate 511 to the open input terminal 326a of the gate control 327a which then opens the AND gate 331a. The continued movement of the car then causes a wheel on the second axle of the front truck to close the switch Wa but since its associated AND gate 522 is closed, the pulse from its squaring amplifier 521 is not transmitted to the OR gate 511. Continued movement of the car then causes the first wheel to close the switch Eb but the square wave output of its amplifier 504 is not transmitted to the OR gate 506 since the AND gate 505 is now closed. The second closing of the switch Ea by the second wheel of the rear truck then causes a second pulse to be transmitted through the AND gate 510, the OR gate 511 and the now open AND gate 331a to the input terminal 344a of the truck counter 345a. The movement of the wheels of the rear truck of the car past the wheel actuated switches will now cause the same sequence of operations to be repeated and, as the wheel on the last axle of the rear truck moves past and again closes the switch Ea, a second pulse is transmitted through the AND gate 331a to the truck control which now causes the recorder to print the total weight of the car, the computer to be reset to zero, and the truck counter to be reset to zero. Thirty seconds after the last car in the train has moved past the switches of the detector system the reset circuit 539 again causes a pulse to be transmitted to the gate controls 531, 532, 533 and 534 to reset the circuit to its original condition wherein it may again weigh cars moving either from the right or to the left or from the left to the right across the tracks.

If the trucks of the railroad car each have three axles instead of two, the AND gate 311a will be open and the AND gate 331a will be closed after the wheels of the first two axles of the car have moved to positions between the switches Eb and Wa if the car is moving from left to right or between the switches Wb and Ea if the car is moving from right to left. Continued movement of the car will then cause the AND gate 331a to be opened by the closure of the switch Wa if the car is moving from left to right and of the switch Ea if the car is moving from right to left by a wheel on the front axle of the truck. Before a wheel on the next axle can close such switch Wa or Ea, a wheel on the third axle again closes the switch Eb or Wb and the AND gate 331a is closed so that the switch Wa or Ea must be closed twice in succession by wheels on the second and third axles as they move therepast before a pulse is transmitted. It will be apparent therefore that the detector system 500 operates in a manner similar to the detector system 300 to transmit a signal to a controlled device, such as the truck counter, each time a truck moves past the wheel actuated switches regardless of the number of axles mounted on such truck. The squaring amplifiers, the AND gates and the gate controls of the detector 500 may be identical with the squaring amplifiers, the AND gates and the gate controls of the detector system 300 whose circuits have been illustrated sche-

matically in FIG. 7, and accordingly, are not shown or described in further detail.

Referring now particularly to FIG. 9 which shows the portion of the detector system 500 which comprises the OR gate 506 and the reset circuit 539. The OR gate 506 includes a first transistor 601 whose emitter-collector circuit is normally conductive and which is rendered nonconductive each time a pulse is applied to either of the input terminals 507 or 528 thereof and a second transistor 602 whose normally nonconductive emitter-collector circuit is rendered conductive when the emitter-collector circuit of the first transistor is rendered nonconductive. The reset generator 562 includes a first transistor 604 whose emitter-collector circuit is normally conductive and which is rendered nonconductive each time a positive going pulse is transmitted to the reset generator by the OR gate 506 and a second transistor 605 whose emitter-collector circuit is rendered conductive when the emitter-collector circuit of the first transistor 604 is rendered nonconductive. The positive going pulse output of the reset generator is applied simultaneously to each of the flip-flop circuits 556—560 to render the emitter-collector circuit of the first transistor 606 of each of the flip-flop circuits conductive, if it was not conductive at the time of such positive going pulse is received from the reset generator. When the emitter-collector circuit of the first transistor 606 of any of the flip-flop circuits is rendered conductive, the emitter-collector circuit of the second transistor 607 of such flip-flop circuits is rendered nonconductive.

The multivibrator 555, whose period of oscillation is determined by the capacitance of the capacitors 608 and 609, periodically transmits a positive going pulse to the first flip-flop circuit 556 to render the emitter-collector circuit of its first transistor 606 nonconductive if it was conductive which thereafter causes the emitter-collector circuit of the second transistor to be rendered conductive if it was nonconductive. Each time the second transistor of the first flip-flop circuit is rendered conductive it in turn causes the emitter-collector circuit of the first transistor 606 of the second flip-flop circuit 557 to be rendered nonconductive if it was conductive which then causes the emitter-collector circuits of its second transistor 607 of the second flip-flop circuit to be rendered nonconductive if it was conductive. The second flip-flop circuit when its second transistor is rendered conductive causes a similar operation of the third flip-flop circuit 558, the operation of the third flip-flop circuit causes a similar operation of the fourth flip-flop circuit 559 which in turn causes such operation of the fifth flip-flop circuit 560. The fifth flip-flop circuit then transmits a positive going pulse to the gate controls 531—534.

It will be apparent that the periods of oscillation of the multivibrator and the operation of the flip-flop circuits is such that a predetermined period of time, for example, 30 seconds, elapses after the last flip-flop circuit 560 produces a positive going pulse before it produces the next positive going pulse and that any time that a positive going pulse is transmitted through the OR gate 506 this sequence of operation of the flip-flop circuits, due to an output pulse having been produced by the multivibrator, is interrupted since the first transistor of each of the flip-flop circuits is then rendered conductive. Each such interruption causes a new predetermined period of time to elapse before the last flip-flop circuit 560 produces a positive point pulse.

The various subcircuits of the squaring amplifiers, detector systems 300 and 500 and their mode of operation being well known, they will not be described in greater detail.

It will now be seen that a new and improved detector system has been illustrated and described for detecting movement of groups of objects, such as the wheels on the axles of a truck of a railroad car, along a predetermined path, such as that provided by a pair of railroad tracks, which includes a pair of operator means, such as the pair of switches Eb and Wa or the pair of switches Wb and Ea, which are spaced along the tracks a distance greater than the distance between any pair of ad-

adjacent axles of a truck but shorter than the distance between adjacent axles of a pair of adjacent trucks of either a single railroad car or of adjacent trucks of a pair of coupled cars, and means which are responsive to the sequential actuation of the switches during the movement of wheels on the axles of each truck and which provide a signal, as by closing an electric circuit or by transmitting a voltage pulse, each time the switches are actuated by the movement of the wheels on the axles of a single truck.

It will further be seen that the detector system may include an additional means responsive to the generation of successive pairs of such signals for providing a control signal each time a car has moved past the switches and that such control signal may be moved to operate a car counting device and the like.

It will also be seen that if the detector system, such as the detector system 500, includes two pairs of switches, one pair of which functions with the means which are responsive to the actuation of either pair of the switches when the train of railroad cars is moving in one direction along the tracks and the other of which cooperates with such responsive means when the train is moving in the opposite direction, the system includes means for blocking one pair of switches from the responsive means when the train is moving in one direction for blocking the other pair when the train is moving in the opposite direction.

It will further be seen that the detector system includes means for periodically resetting the blocking means to block one pair of switches from the responsive means, such as the switches W_b and E_a , in order that accidental actuation of any of the switches will not cause erroneous operation of the responsive means when a railroad car next moves past the switches.

It will also be seen that while the distance a between each pair of adjacent axles of the trucks of the illustrated cars are shown to be equal, the described and illustrated detector systems will function in the described manner even if the distances between adjacent pairs of axles of the same truck or of different trucks are different, as long as the each such distance a between any pair of adjacent axles of any truck is less than the distance d between the switches E_b and W_a or W_b and E_a and the distances c and a between adjacent axles of adjacent trucks are greater than the distance d .

It will also be seen that if the detector system embodying the invention is to be used to detect cars each having a different number of trucks then two, i.e., a single truck or more than two trucks. The truck counter will be designed to provide an output signal each time such number of trucks moves past the wheel actuated switches and that such truck counter could include one or more flip-flop circuits and controls therefor.

The foregoing description of the invention is explanatory only, and changes in the details of the construction illustrated may be made by those skilled in the art, within the scope of the appended claims, without departing from the spirit of the invention.

I claim:

1. A detector system for detecting movement of groups of objects along a predetermined path, the distance between any pair of adjacent objects in a group of objects being shorter than the distance between adjacent objects of any pair of adjacent groups of objects, said detector system including: a pair of operator means spaced along the path of movement of said objects a distance greater than the distance between any adjacent pair of objects in a group but shorter than the distance between adjacent objects of any pair of adjacent groups of objects, said operator means being actuated by the movement of the objects therepast; and means responsive to the actuation of the operator means during the movement of each group of objects therepast for providing a signal each time a group of objects moves past that operator means.

2. A detector system for detecting movements of groups of objects along a predetermined path, the distance between any adjacent pair of objects in a group being shorter than the distance between adjacent objects of any pair of adjacent

groups of objects, said detector system including: a pair of operator means spaced along the path of movement of said objects a distance greater than the distance between any adjacent pair of objects in a group but shorter than the distance between adjacent objects of any pair of adjacent group of objects, said operator means being actuated by the movement of the objects therepast; means responsive to the actuation of said operator means during the movement of each group of objects therepast for providing a signal each time a group of objects moves past said operator means; and means responsive to each pair of successive signals produced by said last-mentioned means for producing a signal each time a pair of groups of objects moves past said operator means.

3. A detector system for detecting movement of groups of objects in either direction along a predetermined path, the distance between any pair of adjacent objects of a group being shorter than the distance between adjacent objects of any pair of adjacent groups of objects, said detector system including: a pair of operator means spaced along the path of movement of said objects a distance greater than the distance between any adjacent pair of objects of a group but shorter than the distance between adjacent objects of any pair of adjacent groups of objects, said operator means being actuated by the movement of the objects therepast; and means responsive to the actuation of said operator means during movement of each group of objects therepast in either direction along the predetermined path for providing a signal each time a group of objects moves past said operator means.

4. A detector system for detecting movement of groups of objects in either direction along a predetermined path, the distance between any adjacent pair of objects in a group being shorter than the distance between adjacent objects of any pair of adjacent groups of objects, said detector system including: a pair of operator means spaced along the path of movement of said objects a distance greater than the distance between any adjacent pair of objects in a group but shorter than the distance between adjacent objects of any pair of adjacent groups of objects, said operator means being actuated by the movement of the objects therepast; means responsive to the actuation of said operator means during the movement of each group of objects therepast in either direction along said predetermined path for providing a signal each time a group of objects moves past said operator means; and means responsive to each pair of successive signals produced by said last-mentioned means for producing a signal each time a pair of groups of objects moves past said operator means.

5. A detector system for detecting movement of railroad cars over a pair of railroad tracks, said detector system including: a pair of switch means spaced longitudinally along the railroad tracks a distance greater than the distance between any adjacent pair of axles of a truck of a railroad car but shorter than the distance between adjacent axles of any pair of adjacent trucks of the railroad cars, said switch means being actuated by wheels on the axles of the railroad cars during the movement of the wheels therepast; and means responsive to the sequential actuation of said switch means during the movement of the wheels on the axles of each truck therepast for providing a signal each time a truck of a railroad car moves past said switch means.

6. A detector system for detecting movement of railroad cars over a pair of railroad tracks, said detector system including: a pair of switch means spaced longitudinally along the railroad tracks a distance greater than the distance between any adjacent pair of axles of a truck of a railroad car but shorter than the distance between adjacent axles of any pair of adjacent trucks of the railroad cars, said operator means being actuated by wheels on the axles of the railroad cars during the movement of the wheels therepast; means responsive to the sequential actuation of said switch means during the movement of the wheels on the axles of each truck therepast for providing a signal each time a truck of a railroad car moves past said switch means; and means responsive to each pair of successive signals produced by said responsive means for

producing a signal each time two trucks of a railroad car have moved past said switch means.

7. A detector system for detecting movement of railroad cars of a train of railroad cars over a pair of railroad tracks, said detector system including: a first pair and a second pair of switch means, the switch means of each of said pair of switch means being spaced longitudinally along the railroad tracks a distance greater than the distance between any pair of adjacent axles of a truck of a railroad car and shorter than the distance between adjacent axles of any pair of adjacent trucks of the railroad cars, one switch means of each pair of switch means being spaced between the switch means of the other pair of switch means, said switch means each being individually momentarily actuated by wheels on the axles of the trucks of the railroad cars during the movement of the wheels therepast; and means responsive to the sequential actuation of one pair of said switch means during the movement of the wheels on the axles of each truck therepast in one direction along said railroad track and responsive to the sequential actuation of the switch means of the other pair of switch means during the movement of the wheels on the axles of each truck therepast in the opposite direction along said railroad tracks for providing a signal each time a truck of a railroad car moves past said switch means.

8. A detector system for detecting movement of railroad cars of a train of railroad cars over a pair of railroad tracks, said detector system including: a first pair and a second pair of switch means, the switch means of each of said pair of switch means being spaced longitudinally along the railroad tracks a distance greater than the distance between any pair of adjacent axles of a truck of a railroad car and shorter than the distance between adjacent axles of any pair of adjacent trucks of the railroad cars, one switch means of each pair of switch means being spaced between the switch means of the other pair of switch means, said switch means each being individually momentarily actuated by wheels on the axles of the trucks of the railroad cars during the movement of the wheels therepast; and means responsive to each pair of successive signals produced by said responsive means for producing a signal each time all trucks of a railroad car move past said switch means.

9. A detector system for detecting movement of railroad cars over a pair of railroad tracks, said detector system including: a first switch means; a second switch means spaced longitudinally from said first switch means along the railroad tracks in the direction of movement of the railroad cars over the tracks a distance greater than the distance between any pair of adjacent axles of a truck of a railroad car but shorter than the distance between adjacent axles of any pair of adjacent trucks of the railroad cars, said switch means being momentarily actuated by wheels on the axles of the railroad cars during the movement of the wheels therepast to provide an electric signal each time each of said switch means is actuated; a truck counter; gate means for transmitting the signals produced by the momentary closure of said switch means; and gate control means operatively associated with said gate means and said switch means for preventing the transmission of a signal to said truck counter during the actuation of the said first switch means and of the actuation of said second switch means by wheels on axles of a truck other than the last axle of the truck and permitting the transmission of the signal produced by the actuation of said second switch means to said truck counter last by a wheel on the last axle of the truck.

10. A detector system for detecting movement of railroad cars over a pair of railroad tracks, said detector system including: a first switch means; a second switch means spaced longitudinally from said first switch means along the railroad tracks in the direction of movement of the railroad cars over the tracks a distance greater than the distance between any pair of adjacent axles of a truck of a railroad car but shorter than the distance between adjacent axles of any pair of adjacent trucks of the railroad cars, said switch means being momentarily actuated by wheels on the axles of the railroad cars

during the movement of the wheels therepast to provide an electrical signal each time each of said switch means is actuated; a truck counter; gate means for transmitting the signals produced by the momentary closure of said switch means; and gate control means operatively associated with said gate means and said switch means for preventing the transmission of a signal to said truck counter during the actuation of the said first switch means and of the actuation of said second switch means by wheels on axles of a truck other than the last axle of the truck and permitting the transmission of the signal produced by the actuation of said second switch means to said truck counter by a wheel on the last axle of the truck; and a car counter operatively associated with said truck counter, said truck transmitting a control signal to said car counter upon transmittal of two successive signals to said truck counter through said gate means.

11. A detector system for detecting movement of railroad cars over a pair of railroad tracks, said detector system including: a first switch means; a second switch means spaced longitudinally from said first switch means along the railroad tracks in the direction of movement of railroad cars over the tracks a distance greater than the distance between any adjacent pair of axles of a truck of a railroad car but shorter than the distance between adjacent axles of any pair of adjacent trucks of the railroad cars, said switch means being momentarily actuated by wheels on the axles of the trucks of the railroad cars during the movement of the wheels therepast to provide an electric signal each time each of said switch means is actuated; a truck counter; a first AND gate for transmitting signal produced by said first switch means and a first control means for controlling the condition of said first AND gate operatively associated with said first switch means, said first AND gate being initially closed; and a second AND gate for transmitting signal produced by said second switch means and second control means for controlling the condition of said second AND gate operatively associated with said second switch means, said second AND gate being initially opened, said second AND gate being operatively associated with said first control means and said truck counter and when open transmitting signal to said truck counter and to said first control means to cause said first control means to close said first AND gate; said first AND gate when open transmitting signals to said second control means to cause said second control means to close said second AND gate, said first gate control opening said first AND gate when said first switch means is momentarily actuated and said second gate control opening said second gate means when said second switch means is momentarily closed.

12. A detector system for detecting movement of railroad cars over a pair of railroad tracks, said detector system including: a first switch means; a second switch means spaced longitudinally from said first switch means along the railroad tracks in the direction of movement of railroad cars over the tracks a distance greater than the distance between any adjacent pair of axles of a truck of a railroad car but shorter than the distance between adjacent axles of any pair of adjacent trucks of the railroad cars, said switch means being momentarily actuated by wheels on the axles of the trucks of the railroad cars during the movement of the wheels therepast to provide an electric signal each time each of said switch means is actuated; a truck counter; a first AND gate for transmitting signals produced by said first switch means and a first control means for controlling the condition of said first AND gate operatively associated with said first switch means, said first AND gate being initially closed; and a second AND gate for transmitting signal produced by said second switch means and second control means for controlling the condition of said second AND gate operatively associated with said second switch means, said second AND gate being initially opened, said second AND gate being operatively associated with said first control means and said truck counter and when open transmitting signal to said truck counter and to said first control means to cause said first control means to close said first

AND gate; said first AND gate when open transmitting signals to said second control means to cause said second control means to close said second AND gate, said first gate control opening said first AND gate when said first switch means is momentarily actuated and said second gate control opening said second gate means when said second switch means is momentarily closed; and a car counter operatively associated with said truck counter, said truck counter actuating said car counter upon transmittal of two successive signals to said truck counter through said second AND gate.

13. A detector system for detecting movement of railroad cars of a train of railroad cars over a pair of tracks, said detector system including: a first pair of switch means and a second pair of switch means, the switch means of each of said pair of switch means being spaced longitudinally along the tracks a distance greater than the distance between any pair of adjacent axles of a truck of a railroad car and shorter than the distance between adjacent axles of any pair of adjacent trucks of the railroad cars, one switch means of each pair of switch means being spaced between the switch means of the other pair of switch means, said switch means each being individually momentarily actuated by wheels on the axles of the trucks of the railroad cars during the movement of the wheels therepast; a first AND gate for transmitting signals produced by the switch means of each pair of switch means which is not positioned between the switch means of the other pair of switch means; first control means for controlling the condition of said first AND gate; a second AND gate for transmitting signals produced by said switch means of each of the pairs of switch means which are positioned between the switch means of the other pair of switch means; second control means for controlling the condition of said second AND gate; third control means between said switch means and said first and second AND gates and their control means for controlling transmission of signals from said switch means to said first and second AND gates and their control means; and means for periodically resetting said third control means to a condition wherein said third control means prevents transmission of signals from said second pair of switch means to said first and second AND gates and their control means and permits transmittal of signals from said first switch means to said first and second AND gates and their control means when the railroad cars are moving in one direction on the tracks, said third control means being responsive to the closure of the switch means of said second pair of switch means which is not positioned between the switch means of said first pair of switch means when said railroad cars are moving in the opposite direction on the tracks to block the transmittal of signals from said first pair of switch means to said first and second AND gates and their control means and to permit transmittal of signals from

said second pair of switch means to said first and second AND gates and their control means; and a truck counter; said first AND gate being initially in closed condition and said second AND gate being initially in open position, said second AND gate being operatively associated with said first control means and said truck counter and when open transmitting signals to said truck counter and to said first control means to cause said first control means to close said first AND gate, said first AND gate being operatively associated with said second control means and when open transmitting signals to said second control means to cause said second control means to close said second AND gate, said first gate control being operatively associated with the switch means of said first pair of switch means which is not between said second pair of switch means and opening said first AND gate when the railroad cars are moving in said one direction and the switch means of said first pair of switch means is actuated, said second control means opening said second AND gate when the switch means of said first switch means which is between the said second pair of switch means is momentarily actuated when the railroad cars are moving in, said one direction, said first control means being operatively associated with the switch means of said second pair of switch means which is not between said first pair of switch means and opening said first AND gate when the railroad cars are moving in a direction opposite said one direction and the switch means of said second pair of switch means which is not disposed between the said first pair of switch means is momentarily actuated, said second control means opening said second gate means when the switch means of said second pair of switch means which is between said first pair of switch means is actuated when the railroad cars are moving in the direction opposite said one direction.

14. The detector system of claim 13, and a car counter operatively associated with said truck counter and actuated by said truck counter each time two successive signals are transmitted to said truck counter by said second AND gate.

15. The detection system of claim 14, and controlled means operatively associated with said car counter and operable by said car counter each time said car counter is actuated.

16. The detector system of claim 14, and weighing means for weighing the load supported by the wheels on each axle, and moving over said track means for operating said weighing means each time a pair of wheels moves over said weighing means to provide a signal which varies in accordance with said load; and means operatively associated with said last-mentioned means and said truck counter for adding the loads supported by the wheels of each car after the wheels on the last axle of the last truck of each car move past said switch means.

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