

July 18, 1961

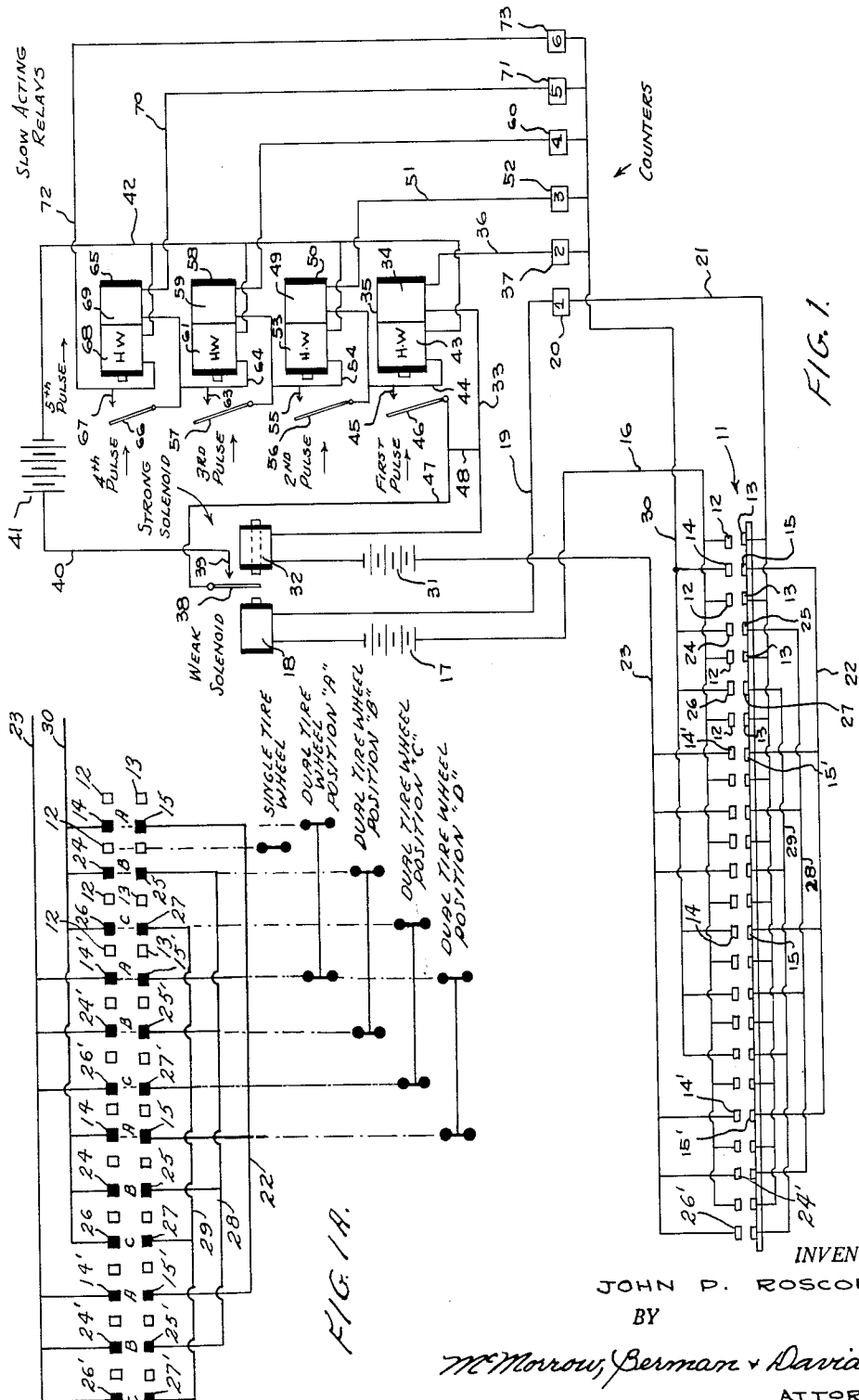
J. P. ROSCOE

2,992,776

TRAFFIC COUNTING DEVICE

Filed Feb. 3, 1956

4 Sheets-Sheet 1



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July 18, 1961

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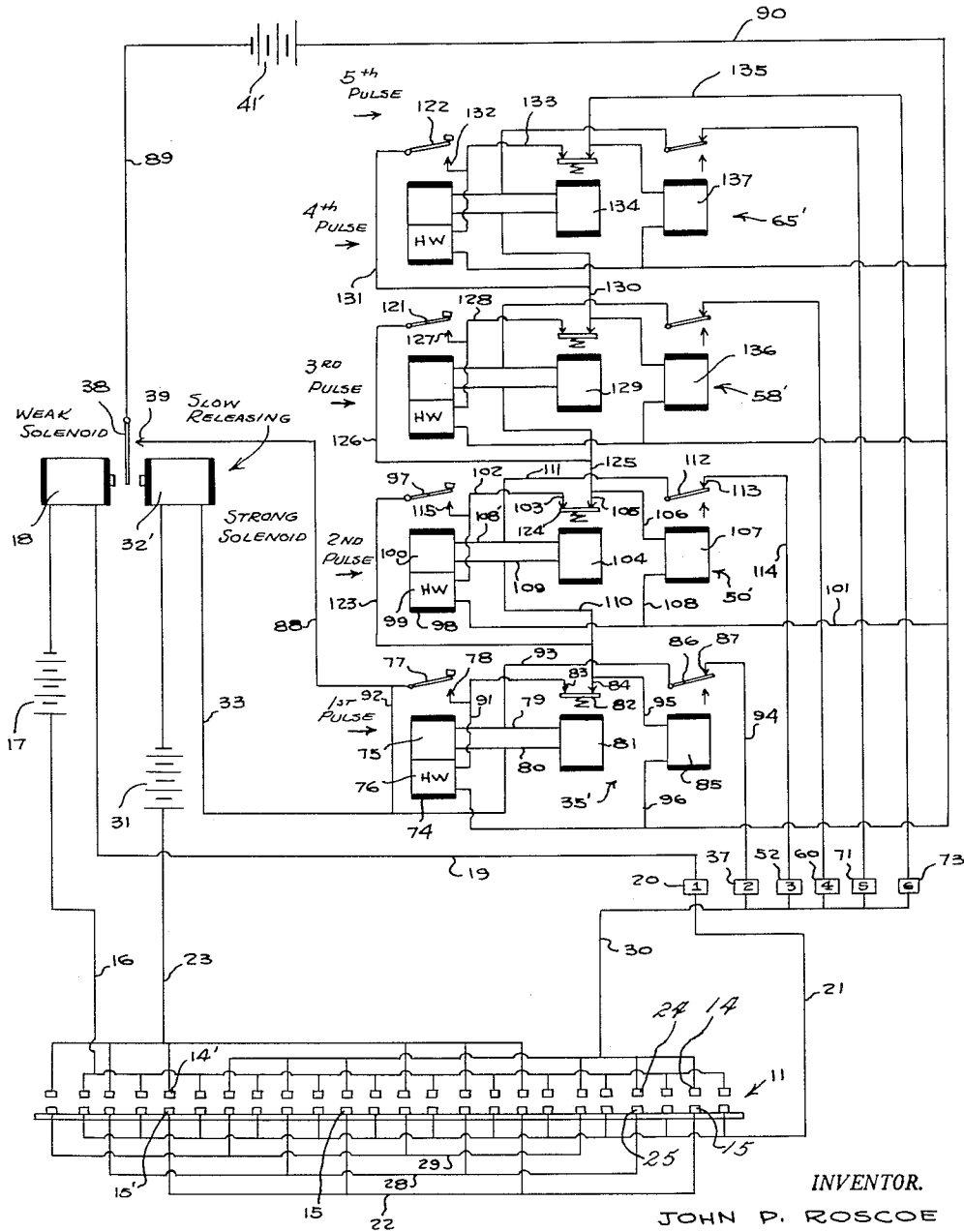
2,992,776

TRAFFIC COUNTING DEVICE

Filed Feb. 3, 1956

4 Sheets-Sheet 2

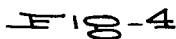
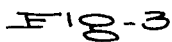
FIG-2



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TRAFFIC COUNTING DEVICE

4 Sheets-Sheet 3



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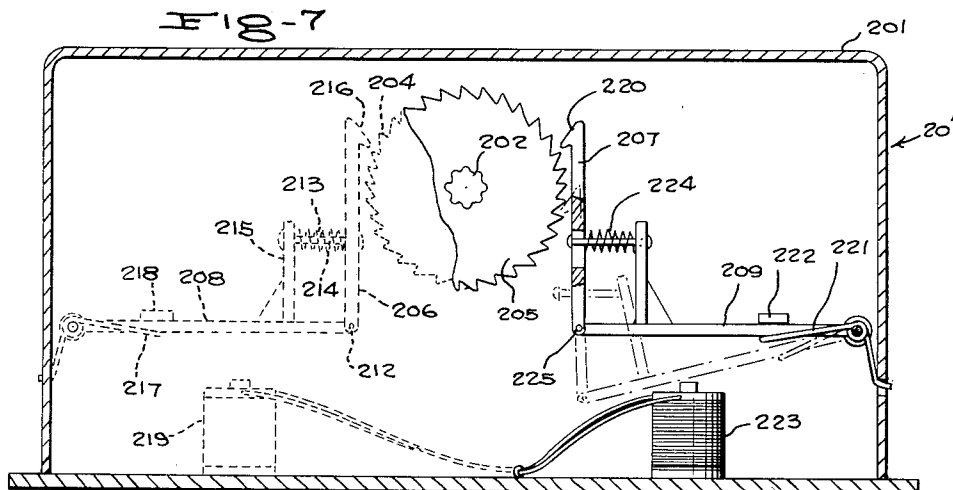
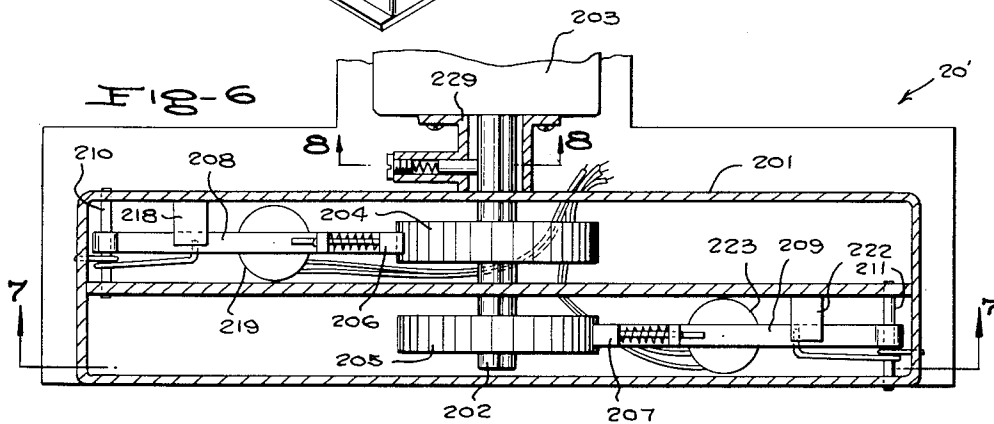
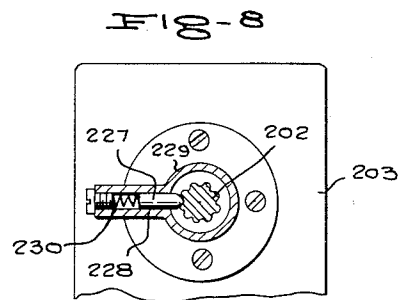
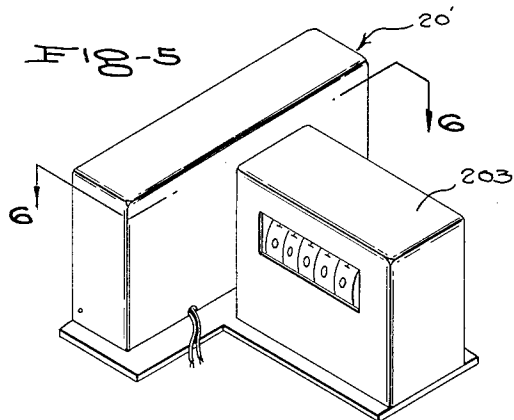
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TRAFFIC COUNTING DEVICE

Filed Feb. 3, 1956

4 Sheets-Sheet 4



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1

2,992,776

TRAFFIC COUNTING DEVICE

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14 Claims. (Cl. 235—99)

This invention relates to traffic counting systems, and more particularly to a traffic counting system which is arranged to distinguish between vehicles having only single tired wheels and vehicles having also dual wheels and to provide accurate tabulations of such vehicles.

A main object of the invention is to provide a novel and improved traffic counting system which involves relatively simple components, which is easy to install, and which provides accurate information as to the number of vehicles passing over a selected portion of a roadway, as well as information with regard to the type of vehicles moving on the roadway, particularly with respect to the quantity of vehicles having respectively, only single wheels, and those having in addition a plurality of axles provided with dual wheels.

A further object of the invention is to provide an improved electrical traffic counting system which is arranged to distinguish between vehicles having only single wheels, such as conventional passenger vehicles, and vehicles having also one or more pairs of dual wheels, the system being arranged to count such vehicles in a manner whereby the total number of each particular type of vehicle may be readily computed from the information obtained by the system.

A still further object of the invention is to provide an improved traffic counting system which involves relatively inexpensive components, which is reliable in operation, and which provides separate tabulations of vehicles having only single tired wheels, vehicles having one set of dual tired wheels, vehicles having two sets of dual tired wheels, and vehicles having respectively different numbers of sets of dual tired wheels, the information obtained by the system being such that it may be readily employed to compute the number of each type of such vehicles passing over the roadway at the point where the detector switch portion of the system is installed.

A still further object of the invention is to provide an improved traffic counting system of the type including a roadway switch having single wheel-responsive switch contacts and dual wheel responsive switch contacts, said system being provided with counting means selectively responsive to the closure of either the single wheel-responsive switch contact alone or the simultaneous closure of both the single wheel-responsive switch contact alone or the simultaneous closure of both the single wheel-responsive switch contacts and the dual wheel-responsive switch contacts, the system including means for separately tabulating vehicles provided with a single pair of dual-tired wheels and various numbers of pairs of dual-tired wheels, the counting circuits of the system being arranged to be sequentially energized responsive to the sequential passage over the detector switch element of the system of additional dual wheels following the passage over said detector element of a first dual wheel, whereby the system is arranged to distinguish between vehicles having only a single set of dual wheels and vehicles having a plurality of sets of dual wheels.

Further objects and advantages of the invention will

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become apparent from the following description and claims, and from the accompanying drawings, wherein:

FIGURE 1 is a schematic wiring diagram of one form of electrical traffic counting system constructed in accordance with the present invention.

FIGURE 1a is a partial schematic drawing showing certain of the electrical connections of the roadway switch employed in the traffic counting device of FIGURE 1 and illustrating the relation of the spaced sets of contacts of the switch with single and dual tired vehicle wheels traveling over various portions of the switch.

FIGURE 2 is a schematic wiring diagram of another form of electrical traffic counting system constructed in accordance with this invention.

FIGURE 3 is a partial schematic wiring diagram showing a modification of the electrical traffic counting system of FIGURE 2.

FIGURE 4 is a partial schematic wiring diagram showing another modification of the electrical traffic counting system of FIGURE 2.

FIGURE 5 is a perspective view of one of the reversible counting units employed in the modified traffic counting system of FIGURE 4.

FIGURE 6 is an enlarged horizontal cross-sectional view taken on line 6—6 of FIGURE 5.

FIGURE 7 is a vertical cross-sectional view taken on line 7—7 of FIGURE 6.

FIGURE 8 is an enlarged cross-sectional detail view taken on line 8—8 of FIGURE 6.

Referring to the drawings, and more particularly to FIGURE 1, 11 generally designates a vehicle-detecting roadway switch of the type disclosed in and fully described in my copending application Serial No. 438,466, filed June 22, 1954, now Patent No. 2,801,053, the roadway switch 11 having single wheel-responsive switch contacts 12, 13, and having dual wheel-responsive switch contacts 14 and 15, 24 and 25, 26 and 27, 14' and 15', 24' and 25', 26' and 27', spaced in the manner illustrated in FIGURE 1a, each set of contacts 14, 15 and 14', 15', 24, 25 and 24', and 25', and 26, 27 and 26', 27' being spaced apart by the same distance as are the tires of a dual wheel. The roadway switch 11 comprises a suitable supporting means such as a frame or housing which is set in the roadway and which is provided with suitable means for resiliently supporting the movable contact elements 12 and 14 above the stationary contact elements 13 and 15, whereby the movable contact elements 12 and 14 will close with respect to their associated stationary contact elements 13 and 15 responsive to the passage of a vehicle wheel tire thereover, the spacing of the contact elements 14 with respect to the contact elements 12 being such that a dual tired wheel will cause simultaneous closure of contact elements 12 and 14 on their associated stationary contacts 13 and 15.

The contact elements 12 are connected to a common conductor 16 which in turn is connected through a battery 17 to one terminal of a relatively weak solenoid 18. The other terminal of the solenoid 18 is connected by a wire 19 to one terminal of a counter 20. The other terminal of the counter 20 is connected by a wire 21 to the stationary contacts 13 of the roadway switch 11. This defines a simple counting circuit which is closed when one or more pairs of contacts 12, 13 are closed, as by the passage over the roadway switch of a vehicle having single-tired wheels, such as a conventional passenger

vehicle, the spacing of the contact pairs 12, 13 along the roadway switch 11 being such that at least one set of contacts 12 and 13 will be closed when a passenger vehicle or any other vehicle having single wheels passes over the roadway switch. The closure of a set of switch contacts 12, 13 energizes the counter 20 by a circuit comprising the closed contacts 12, 13, wire 16, battery 17, solenoid 18, wire 19, counter 20, and wire 21.

As shown, the stationary contacts 15 and 15' are connected to a common conductor 22 and the movable contacts 14' are connected to a common conductor 23. As shown, there are three sets of contacts 12, 13 spaced between each set of contacts 14, 15 and the next successive set of contacts 14', 15'. Spaced between the respective pairs of intervening contacts 12, 13 are additional pairs of contacts 24, 25 and 26, 27 and 24', 25' and 26', 27'. Of these, the contacts 24, 24', 26 and 26' are movable downwardly into contact with the stationary contacts 25, 25', 27 and 27', respectively. The stationary contacts 25 and 25' are connected to a common conductor 28 and the stationary contacts 27 and 27' are connected to a common conductor 29. The movable contacts 14, 24 and 26 are each connected to a common conductor 30. The movable contacts 24' and 26' are connected to the conductor 23.

The spacing between the respective successive sets of contacts 14, 15 and 14', 15', 24, 25 and 24', 25' and 26, 27 and 26', 27' is substantially the same as the spacing between the tires of a dual wheel, whereby one of said sets of contacts will close when a dual tired wheel passes over the roadway switch, as is fully described in my above identified copending application, in each case closing a circuit between wires 23 and 30.

Wire 23 is connected through a battery 31 to one terminal of a relatively strong solenoid 32, the other terminal of the solenoid 32 being connected by a wire 33 to one terminal of a winding 34 on a double wound, slow-acting relay 35. The remaining terminal of the winding 34 is connected by a wire 36 to one terminal of a counter 37, the opposite terminal of the counter 37 being connected to the wire 30. Thus, the counter 37 will be energized whenever a dual tired wheel passes over the detector switch device 11, by a circuit comprising two successive sets of contacts 14, 15 and 14', 15', 24, 25 and 24', 25', or 26, 27 and 26', 27' and their associated wiring whereby wire 30 is connected to wire 23, battery 31, solenoid 32, wire 33, winding 34, wire 36, counter 37 and wire 30.

As shown in FIGURE 1, the respective solenoids 18 and 32 are coaxially arranged and act on a common armature 38 pivoted between their cores. Since solenoid 32 is relatively strong as compared to solenoid 18, the armature 38 will be attracted by the core of solenoid 32 whenever solenoid 32 is energized, regardless of the energization of solenoid 18. Responsive to the energization of solenoid 32, the armature 38 will thus engage a stationary contact 39. Solenoid 32 is of the slow-releasing type and will hold armature 38 in engagement with stationary contact 39 for a predetermined period after once being energized, but with diminishing strength. Said solenoid 32 is designed to "hold" long enough to allow ample time for a sequence of dual tires belonging to a single vehicle to pass over the detector switch device, even when the vehicle is travelling at a relatively slow speed, whereby armature 38 is kept in engagement with stationary contact 39 during this period. This insures that all the dual tires belonging to a single vehicle will be counted in the same sequence. However, between the time that the rear dual tire on one vehicle and the front dual tire on a following vehicle pass over the detector switch, armature 38 must be disengaged from stationary contact 39. After being energized by the rear dual tire of a vehicle, the holding force of solenoid 32 becomes progressively weaker, and at some point will become weaker than the force of solenoid 18, freshly energized. If solenoid 32 has not allowed armature 38 to disengage

from stationary contact 39 by the time that the front wheel of the following vehicle passes over the detector switch, this front wheel being single, will energize solenoid 18 without at the same time energizing solenoid 32. Solenoid 18, freshly energized, will disengage armature 38 from stationary contact 39 and keep it disengaged until the remaining holding force of solenoid 32 has become dissipated, or until solenoid 32 has been freshly re-energized. Solenoid 18 thus insures that the dual tires of two different vehicles will not be counted in the same sequence.

Contact 39 is connected by a wire 40 to one terminal of a battery 41. The other terminal of the battery is connected to a wire 42. Wire 42 is connected to one terminal of a second winding 43 on the slow-acting relay 35, the second terminal of the winding 43 being connected by a wire 44 to a stationary contact 45 of the relay 35 which is engageable by a pivoted armature 46 at a predetermined time after the relay 35 becomes energized, as by the energization of either of its windings 34 or 43. As shown, armature 46 is connected by a wire 47 to the armature 38, and is connected by a wire 48 to the wire 33.

Wire 44 is connected to one terminal of a winding 49 of a double wound slow-acting relay 50, the other terminal of the winding 49 being connected by a wire 51 to one terminal of a counter 52. The other terminal of the counter 52 is connected to the common counter return wire 30. The remaining winding 53 of the slow acting relay 50 has one terminal thereof connected to the wire 42 and the other terminal thereof connected by a wire 54 to a stationary contact 55 which is engageable by an armature 56 after a predetermined time period following energization of either of the windings 49 or 53, the armature 56 being connected to wire 44.

The wire 54 is connected to the armature 57 of a third double wound slow-acting relay 58 and through one of the windings 59 of the relay 58 to a fourth counter 60. The remaining winding 61 of the slow-acting relay 58 has one terminal thereof connected to the wire 42 and the other terminal thereof connected to a stationary contact 63 by a wire 64, the contact 63 being engageable by the armature 57 at a predetermined time period following energization of either of the windings 61 or 59. A fourth slow-acting relay 65 is provided, said relay having the armature 66 which is connected to the wire 64 and is engageable with a contact 67 at a predetermined period following energization of either of its windings 68 or 69. One terminal of the winding 69 is connected to the wire 64, and the other terminal of the winding 69 is connected by a wire 70 to one terminal of a counter 71, the other terminal of the counter 71 being connected to the common counter return wire 30, as shown. The winding 68 has one terminal thereof connected to the wire 42 and has its other terminal connected by a wire 72 to one terminal of a counter 73, the other terminal of the counter being connected to the common counter return wire 30. The contact 67 is also connected to the wire 72, as shown.

As above explained, when a single tired wheel passes over the roadway switch 11, the first counter 20 is energized by a pulse provided by battery 17. When a vehicle having a single set of dual wheels passes over the roadway switch, the counter 37 is energized by a pulse from the battery 31, the current pulse passing through the solenoid 32 and the relay winding 34. Near the end of the pulse the armature 46 engages the contact 45 which establishes an energizing circuit for the second winding 43 of relay 35 comprising battery 41, wire 40, contact 39, armature 38, wire 47, armature 46, contact 45, wire 44, winding 43, and wire 42. This is a holding circuit for relay 35 which will retain armature 46 in engagement with contact 45 if solenoid 32 is immediately again energized by a second pulse of current from battery 31, which would occur if a second set of dual wheels passes over the traffic counting switch 11 immediately following the

passage thereover of the first set of dual wheels. If this occurs, the winding 49 of the second relay 50 is energized and the second pulse of current from battery 31 is furnished to the counter 52 through a circuit comprising the closed traffic detecting contacts 14, 15 and 14', 15', 24, 25 and 24', 25'; or 26, 27 and 26', 27', the wire 23, the battery 31, solenoid 32, wire 33, wire 48, wire 47, armature 46, contact 45, wire 44, winding 49, wire 51, counter 52, and the wire 30. In the absence of a second set of dual wheels passing immediately over the roadway switch, the relay 50 will not be energized, since the armature 46 would disengage from the contact 45 after a relatively short predetermined time, preventing energization of the counter 52.

Counter 52 cannot be energized by the first set of dual wheels, since the time period required for the closure of armature 46 on the contacts 45 is great enough to prevent the first current pulse from battery 31 from passing through the winding 49. Therefore, when a vehicle having two sets of dual wheels passes over the roadway switch, counter 37 will receive two signals and counter 52 will receive one signal.

It will be noted that winding 43 remains energized only so long as armature 38 engages contact 39. However, the relay is sufficiently slow acting that, the armature 46 will continue to engage the contact 45 for a short time which, however, is sufficient to permit the counter 52 to be energized by the second pulse which is developed by passage over the roadway switch of a second set of dual wheels of the same vehicle immediately following the passage thereover of the first set of dual wheels, assuming the vehicle to be traveling above a predetermined minimum speed. The timing of the relay is rapid enough to

solenoid 32, wire 33, wire 48, the wire 47, armature 46, contact 45, wire 44, armature 56, contact 55, wire 54, armature 57, contact 63, wire 64, armature 66, contact 67, wire 72, counter 73, the common counter return wire 30, and the closed roadway switch contacts. Thus, counter 73 will receive one signal, counter 71 will receive two signals, counter 60 will receive three signals, counter 52 will receive four signals, and counter 37 will receive five signals.

Relays 35, 50, 58 and 65 are similar slow-acting relays, and as above described, are controlled in sequence by each other and respectively sequentially energize the counters 37, 52, 60, 71, and 73 in the manner above described, depending upon the number of sets of dual wheels on the vehicle passing over the roadway switch.

The counters with the single exception of counter 73, do not indicate the number of vehicles that have passed over the detector switch, but they do provide data from which the number of vehicles may be determined by a simple tabulation. The derivation involves two successive subtractive processes and may best be explained by an example. Suppose that during a certain period the following vehicles pass over the roadway detector switch:

- 1 6-axle truck
- 3 5-axle trucks
- 1 4-axle truck
- 2 3-axle trucks
- 3 2-axle trucks
- 10 passenger cars (or pickup trucks)

The registrations on the counters are then tabulated in the following manner:

Line	6-axle Counter	5-axle Counter	4-axle Counter	3-axle Counter	2-axle Counter	Passenger Counter	Registration for—
1.....	73	71	60	52	37	20	
2.....	1	2	3	4	5	6	1 6-axle vehicle
3.....		3	6	9	12	15	3 5-axle vehicles
4.....			1	2	3	4	1 4-axle vehicle
5.....				2	4	6	2 3-axle vehicles
6.....					3	6	3 2-axle vehicles
7.....						20	10 passenger vehicles.
8.....	1	5	10	17	27	57	total registrations (2nd cumulative).
9.....	1	4	5	7	10	30	1st cumulative.
10.....	1	3	1	2	3	$\frac{27}{2} = 10$	true count.

distinguish between two successive dual-tired vehicles spaced apart by a reasonable distance.

The relay 58 operates in a similar manner to provide energization of the counter 60 responsive to the passage over the roadway switch of a vehicle having three sets of dual wheels. Under these conditions, counter 60 will receive one signal, counter 52 will receive two signals, and counter 37 will receive three signals.

In a similar manner, the additional relay 65 provides energization of counter 71 when a vehicle having four sets of dual wheels passes over the roadway switch. Under these conditions, counter 71 receives one signal, counter 60 receives two signals, counter 52 receives three signals, and counter 37 receives four signals. When a vehicle passes over the roadway switch having five sets of dual wheels, the counter 73 will be actuated, since the armature 66 of relay 65 will be in engagement with the contacts 67 of said relay whereby the pulse produced by the fifth set of dual wheels will be transmitted to the counter 73 by a circuit comprising wire 23, battery 31,

Lines 1 through 7 above are given only to show how each vehicle would register and to show how the tabulation proves itself. In actual practice, only lines 8, 9 and 10 would appear in the tabulation.

Referring now to the form of the invention shown in FIGURE 2, the solenoid 32 of the previously disclosed form of the invention is replaced by a slow-releasing solenoid 32' and the respective slow-acting sequential relays 35, 50, 58 and 65 are replaced by respective relay circuits designated at 35', 50', 58' and 65', respectively in FIGURE 2. The relay circuit 35' comprises a double wound relay 74 having the respective windings 75 and 76. Relay 74 has the normally open armature 77 which is engageable with a contact 78 when the relay is energized. Connected in parallel with the winding 75, as by conductors 79 and 80 is an auxiliary relay 81 having an armature 82 normally engaging a pair of spaced contacts 83 and 84 and opening said contacts 83 and 84 when the relay 81 is energized. Relay circuit 35' also includes an additional relay 85 having an armature 86 normally

engaging a contact 87 and disengaging from contact 87 when relay 85 is energized.

Armature 77 is connected by a wire 88 to contact 39 of the slow-releasing solenoid 32'. Armature 38 is connected by a wire 89 to one terminal of a holding battery 41'. The other terminal of the battery 41' is connected to a wire 90 which is in turn connected to one terminal of the holding winding 76 of relay 74. The other terminal of the holding winding is connected by a wire 91 to contact 83. Contact 78 is connected to wire 91, as shown. Wire 88 is connected to wire 33 by a wire 92. Wire 33 is connected to wire 80. Wire 79 is connected by a wire 93 to armature 86. Contact 87 is connected by a wire 94 to one terminal of the counter 37. The other terminal of the counter is connected to the counter return wire 30, as in the previously described form of the invention. Contact 84 is connected by a wire 95 to one terminal of relay 85. The other terminal of relay 85 is connected by a wire 96 to the wire 90, whereby relay 85 is energized in parallel with holding winding 76 when armature 82 is released, namely, when relay 81 is deenergized.

The second relay circuit 50' is wired to the counter 52 in a similar manner, the wire 95 being connected to the armature 97 of the double wound relay 98 of relay circuit 50'. Relay 98 comprises the windings 99 and 100, the winding 99 being a holding winding and having one terminal thereof connected by a wire 101 to the wire 90. The other terminal of winding 99 is connected by a wire 102 to a contact 103 of the auxiliary relay 104. The other contact 105 of relay 104 is connected by a wire 106 to one terminal of the additional relay 107, the other terminal of relay 107 being connected by a wire 108 to the wire 101. Relay 104 is connected in parallel with winding 100 by respective wires 108' and 109, wire 95 being connected to wire 109 by a wire 110. Wire 108' is connected by a wire 111 to the armature 112 of relay 107. The contact 113 of relay 107 is connected by a wire 114 to one terminal of the counter 52, the other terminal of the counter 52 being connected to the common counter return wire 30. The stationary contact 115 of double wound relay 98 is connected to wire 102, as shown.

The counter 20 operates in the same manner as in the previously described form of the invention to register the passage of wheels over the roadway switch 11, providing a complete tabulation of the passage of all wheels over the switch. When a vehicle having dual wheels passes over the roadway switch 11, the solenoid 32' is energized, in the same manner as previously described in connection with the solenoid 32 of FIGURE 1 by the closure of the contact of roadway switch 11 whereby wire 30 is connected to wire 23. The energizing circuit for solenoid 32' comprises the closed contacts of roadway switch 11, wire 23, battery 31, solenoid 32', wire 33, wire 80, the parallel windings 75 and the winding of relay 81, wire 79, wire 93, armature 86, contact 87, wire 94, counter 37, and wire 30. When winding 75 of relay 74 becomes energized, armature 77 engages contact 78, energizing the holding winding 76 through a circuit comprising battery 41', wire 89, armature 38, contact 39, wire 88, armature 77, contact 78, wire 91, winding 76, and wire 90. Since solenoid 32' is slow releasing, contact 39 will be engaged by the armature 38 for a predetermined period of time after the roadway switch contacts are opened. The holding winding 76 of relay 74 will hold armature 77 in engagement with contact 78 during this time period. However, when the roadway switch contacts open, winding 75 will become deenergized, as will winding 81.

When winding 75 becomes initially energized, the winding 81 connected in parallel therewith, also becomes energized, causing armature 82 to disengage from contacts 83 and 84. This prevents the auxiliary relay 85 from becoming energized until winding 75 is deenergized by the opening of the roadway switch contacts. Thus, after the counter 37 has received its impulse and the roadway

switch contacts open, winding 75 becomes deenergized, and winding 81 likewise becomes deenergized, allowing armature 82 to engage the contacts 83 and 84, whereby relay 85 becomes energized in parallel with the holding winding 76. This causes the armature 86 to disengage from contact 87 and opens the circuit to counter 37 as long as holding winding 76 remains energized, namely, for a predetermined time period after the first signal has been given, said period being the time required for armature 82 to disengage from contact 39, assuming there are no more immediate closures of the dual-wheel responsive contacts of the roadway switch 11.

If the vehicle passing over the roadway switch has more than one set of dual wheels, the counter 52 will be actuated, since the second closure of the dual wheel-responsive switch elements of roadway switch 11 will provide a current pulse from battery 31 through solenoid 32', wire 33, wire 92, armature 77, contact 78, wire 91, contact 83, armature 82, contact 84, wire 110, wire 109, the parallel connected relay windings 100 and 104, wire 108', wire 111, armature 112, contact 113, wire 114, counter 52, and return wire 30. As in the case of the relay circuit 35', this establishes energization of the housing winding 99 of relay 98, closing armature 97. As in the previous relay stage, after the counter pulse, the relay 104 becomes deenergized, connecting the auxiliary relay 107 in parallel with the holding winding 99 of relay 98, preventing further energization of the counter 52 by successive closures of the dual-wheel responsive contacts of the roadway switch 11, if such should immediately occur, as where the passing vehicle has more than two sets of dual wheels.

The succeeding relay stages 58' and 65' operate in the same manner to provide distinctive indications on their associated counters 60 and 71 of vehicles having three and four sets of dual wheels respectively. A vehicle having five sets of dual wheels will register on counter 73, since the double wound relays of all of the relay circuits 35', 50', 58', and 65' will all be energized by their holding windings, and their armatures, shown at 77, 97, 121, and 122 will be closed. The fifth pulse from the roadway switch will then travel from battery 31 through solenoid 32', wire 33, wire 92, armature 77, contact 78, wire 91, contact 83, armature 82, contact 84, wire 110, through a wire 123 connecting wire 110 to armature 97, to contact 115, wire 102, contact 103, the armature 124 of relay 104, contact 105, a wire 125, a wire 126 connecting wire 125 to armature 121, the contact 127 associated with armature 121, a wire 128, the closed contacts of the auxiliary relay 129 of relay circuit 58', a wire 130, a wire 131 connecting wire 130 to armature 122, the contact 132 associated with armature 122, a wire 133, the closed contacts of the auxiliary relay 134 of relay circuit 65', and a wire 135 connected to the counter 73, as shown. The fifth pulse will only register on the counter 73, since the circuits of counter 37, 52, 60 and 71 will be opened because the associated holding circuits of the relay stages 35', 50', 58' and 65' are energized, whereby their associated relays 85, 107, 136 and 137, connected in parallel with the holding windings are energized. Thus, the relay stages 58' and 65' have additional relays 136 and 137 similar to the relays 85 and 107, which are energized simultaneously with the holding windings of their associated double wound relays and open their associated counting circuits.

The holding windings of all of the relay stages will become deenergized as soon as armature 38 of the slow releasing solenoid 32' disengages from stationary contact 39, as will occur a short period of time following the actuation of the roadway switch 11.

In order to illustrate the manner in which vehicles are counted by the form of the invention illustrated in FIGURE 2, assume that the same set of vehicles passes over the roadway detector switch, as in the preceding example given above in connection with the description of opera-

tion of the embodiment of FIGURE 1. Then, the tabulated data will be as follows:

Line	6-axle Counter	5-axle Counter	4-axle Counter	3-axle Counter	2-axle Counter	Passenger Counter	Registration for—
1-----	73	71	60	52	37	20	
2-----	1	1	1	1	1	6	1 6-axle truck.
3-----		3	3	3	3	15	3 5-axle trucks.
4-----			1	1	1	4	1 4-axle truck.
5-----				2	2	6	2 3-axle trucks.
6-----					3	6	3 2-axle trucks.
7-----						20	10 passenger cars.
8-----	1	5	10	17	27	57	total registra- tions (2nd cumulative).
9-----	1	4	5	7	10	30	1st cumulative.
10-----	1	3	1	2	3	$\frac{20}{2}=10$	true count.

The actual counter registrations are shown in line 9 (1st cumulative line), except that of counter 20, which is in line 8 (2nd cumulative). The other figures are calculated. It is not actually necessary to calculate the figures in line 8, as the only figures required to be known are those in line 10. These are obtained by subtraction.

The number of passenger cars (including pickup trucks) is calculated as follows:

From the total axle registrations in line 8 (57 axles) subtract the total truck axle registrations in line 9

$$(1+4+5+7+10=27)$$

and the total truck axle calculated registrations in line 10

$$(1+3+1+2+3=10)$$

57 minus 27 minus 10 gives 20, the number of passenger car axles.

20 divided by 2 gives 10, the number of passenger cars. The reason for dividing the number of passenger car axles by 2 is that both the front and rear axles of the passenger cars register, and neither are eliminated by the above subtractive process, which eliminates only the excess registrations of the trucks. On the other hand, each truck axle was made to register in only one of the truck circuits, and when the supernumerary registrations were eliminated, the only registration that remained represented an actual vehicle.

In practice, the required calculations are quickly and easily performed by special adding machines, now in common use.

FIGURE 3 illustrates a modification of the system shown in FIGURE 2 wherein the armature 38 of the co-operating solenoids 18 and 32' is connected to the wire 88, leading to the armature 77 of relay 74, and the contact 39 associated with the armature 38 is connected to the wire 89 leading to the battery 41', not shown. Associated with the solenoids 18 and 32' is another stationary contact 18' which is normally engaged by the armature 38, and which is disengaged responsive to the energization of the solenoid 32'. The contact 18' is connected to the wire 21 through a wire 19' including a totalizing counter 290. One of the terminals of the solenoid 18 is connected to the wire 19'. The other terminal of the solenoid is connected through the battery 17 to the wire 16, as in the previously described forms of the invention. The wire 21 is connected to one terminal of the counter 20'. The other terminal of counter 20' is connected to wire 33 by a wire 33'. The respective counters associated with the system are designated at 20', 37', 52', 60', 71' and 73', corresponding to the counters 20, 37, 52, 60, 71 and 73 of the form of the invention shown in FIGURE 2.

Each of the counters shown in FIGURE 3 are of a type provided with means for subtracting a registration therefrom responsive to a registration received by the next succeeding counter, with the exception of the final

counter 73' which is identical with the counter 73 in the form of the invention of FIGURE 2. Thus, as shown in

FIGURES 5 to 8, wherein the counter 20' is illustrated in detail, and wherein the counters 37', 52', 60' and 71' have the same structure, 201 designates the housing of the counter and 202 designates the counting shaft which is journaled in the housing and which is drivingly connected to a conventional counting mechanism 203. Mounted on the shaft 202 are respective toothed wheels 204 and 205, and operatively associated with the toothed wheels 204 and 205 are the respective pawl elements 206 and 207 mounted on respective armatures 208 and 209 pivoted at 210 and 211 in the housing 201 on opposite sides of shaft 202. The pawl element 206 is pivoted at 212 to the end of the armature 208 and is biased into engagement with the toothed wheel 204 by a coiled spring 213 mounted on a pin 214 loosely engaged through the pawl 206 and secured to an upstanding bracket element 215 carried on the lever 208. The pawl 206 has a hook-like top portion 216 which is engageable with the teeth of the toothed wheel 204 to rotate the toothed wheel counterclockwise, as viewed in FIGURE 7, responsive to downward rotation of the lever 208. Lever 208 is biased upwardly by a spring 217, upward movement of the lever being limited by engagement with a stop lug 218 mounted above the lever 208 in housing 201, as is clearly shown in FIGURE 6. Disposed below lever 208 is a solenoid 219 which is connected between the wires 33' and 21 in the circuit of FIGURE 3 and which is energized when wire 21 is connected to wire 16 by the passage of a single tire over the treadle switch 11.

The pawl member 207 is mounted on the pawl lever 209 in a similar manner to the pawl member 206 and has a hook-like top portion 220 extending adjacent the toothed periphery of the wheel 205. The lever 209 is biased upwardly by a spring 221 provided in the housing 201 and acting to urge the lever 209 into contact with a stop lug 222 overlying lever 209, as is clearly shown in FIGURES 6 and 7. A solenoid 223 is disposed below the armature 209 and moves the armature 209 downwardly responsive to the energization thereof, causing the pawl element 207 to engage the wheel 205 and rotate shaft 202 clockwise.

The pawl element 207 is biased toward the wheel 205 by a coiled spring 224, in a manner similar to that described for the pawl member 206. The pawl member 207 is pivoted at 225 to the end of the pawl lever 209. Because of the pivotal connections of the elements 206 and 207 to their associated pawl levers, the pawl members are free to move upwardly to their normal positions when the associated solenoids 219 and 223 become de-energized.

The shaft 202 is splined, and is yieldingly engaged by a spring detent pin 227 slidably mounted in a sleeve 228 forming part of a bracket member 229 rigidly secured to the frame of the counting mechanism 203, as shown in FIGURE 6, the pin 227 being urged into seating engagement with the grooves of the splined shaft 202 by a

spring 230, whereby each step of rotation of the shaft 202 produced by energization of a respective solenoid 219 or 223, causes rotation of said shaft through a predetermined identical angular value. Thus a pulse supplied to the solenoid 219 causes counterclockwise rotation of shaft 202 through one step, whereas energization of solenoid 223 by a pulse causes clockwise rotation of the shaft through the same angle, canceling the effect of the pulse applied previously to the solenoid 219.

As shown in FIGURE 3, the counters 20', 37', 52', 60' and 71' are interconnected so that a pulse applied to the forward counting solenoid of one of the counters will also be applied to the subtracting solenoid of the preceding counter. For example, the subtracting solenoid 223 of the counter 20' is connected in parallel with the adding solenoid of the counter 37' by respective wires 232 and 233 connecting the terminals of the solenoid 223 respectively to wires 94 and 30. Similar subtracting connections are provided for the counters 37', 52', 60' and 71'. This provides automatic subtraction of the registrations of the respective counters in a manner performed by the calculations previously described in connection with FIGURE 2, and eliminates the necessity of performing such calculations.

Therefore, when a vehicle having a sequence of dual tires passes over the roadway treadle switch 11, it will provide a registration only on the counter associated with the particular number of dual tired axles on the vehicle and will not register on any of the other counters with the exception of the totalizer counter 200 which will register the total number of axles passing over the switch, regardless of their nature.

The totalizer device 200 is a conventional counter which merely registers in response to a pulse applied thereto, and which gives a tabulation of the total number of such pulses received thereby. As will be seen from FIGURE 3, the totalizer 200 is connected in the circuit between wires 16 and 21, in series with the solenoid 18, and therefore will respond through the closure of the treadle switch 11 produced by single tired vehicles in the manner previously described in connection with the response of the counter 20 of FIGURE 2. The totalizer 200 will also respond to the passage thereover of dual tired axles, since the treadle contacts 12 and 13 will also be closed by the passage over the roadway switch of dual tired axles, although the circuit responds to the presence of the dual tired axles in the manner previously described in connection with FIGURE 2, to provide the energization of the solenoid 32', and the operation of the counting relays, together with the registration on the counters 20', 37', 52', 60', 71' and 73', as above described. As will be apparent, the counter 20' will register both front and rear single-tired axles, so that the number of vehicles, such as passenger cars, and pickup trucks, detected by counter 20' can be found by dividing the registration on the counter 20' by two.

In the modification illustrated in FIGURE 4, the wire 89 is connected to the contact 39 of the solenoids 18, 32', and the wire 88 is connected to the armature 38, as shown. A wire 19' is connected to one terminal of the solenoid 18, as in FIGURE 3, and is connected through a totalizer 200 to the wire 21. As in FIGURE 3, the remaining terminal of the solenoid 18 is connected through the battery 17 to the wire 16.

The relay 74', corresponding to the relay 74 of FIGURE 2, is provided with the stationary upper contact 235 which is engaged by the armature 77 when the relay 74' is deenergized. The contact 235 is connected to wire 19' by a wire 236. The adding solenoid of the counter 20' has one terminal thereof connected to the wire 21, and has the other terminal thereof connected by a wire 33' to the wire 33. As shown, wire 33 is connected by wire 92 to wire 88, which is in turn connected to armature 77. When the relay 74' is deenergized, armature 77 engages its upper contact 235, and is thus connected by

wire 236 to the wire 19'. This connects the adding solenoid of counter 20' normally in series with the solenoid 18, whereby the counter 20' receives an adding pulse whenever the contacts of the treadle switch 11 close to connect wire 16 to wire 21. However, when relay 74' becomes energized, responsive to the energization of solenoid 32' resulting from the passage over the treadle switch of dual tired vehicles, armature 77 disengages from contact 235, opening the circuit to the adding solenoid of counter 20'. Thus, the counter 20' will receive an adding pulse when the front wheels of a dual tired vehicle pass over the treadle switch, since the front wheels are single tired, but this registration will be canceled by the pulse received by its subtracting solenoid as the dual wheels pass over the treadle switch, causing the energization of the solenoid 32' and the resultant adding pulse applied to the counter 37'. As in the circuit of FIGURE 3, the totalizer 200 will give a direct registration of the total number of axles passing over the treadle switch 11.

While certain specific embodiments of an improved vehicle counting system have been disclosed in the foregoing description, it will be understood that various modifications within the spirit of the invention may occur to those skilled in the art. Therefore, it is intended that no limitations be placed on the invention except as defined by the scope of the appended claims.

What is claimed is:

1. A traffic counting system comprising a roadway switch having single wheel-responsive switch contacts and dual wheel-responsive switch contacts, a first counting circuit connected to said first-named switch contacts and including a first solenoid, a second counting circuit connected to said second switch contacts and including a second solenoid, a common armature arranged to be attracted by one or the other of said solenoids, said solenoids being arranged in opposing relationship with respect to said armature, normally open common switch means including said armature and closing responsive to the movement of said armature resulting from the energization of said second solenoid, said second solenoid being constructed and arranged to hold said common switch means closed for a predetermined time after deenergization of said second counting circuit, energizing means for said second counting circuit responsive to the passage of a dual wheel over said dual wheel-responsive switch contacts, whereby to energize said second solenoid and close said common switch means, further switch means, means to close said further switch means responsive to the energization of said second counting circuit, means to maintain said further switch means closed while said common switch means remains closed, a third counting circuit including said further switch means and means energizing said third counting circuit in response to the passage over the roadway switch of a second dual wheel while said common switch means remains closed.

2. A traffic counting system comprising a roadway switch having single wheel-responsive switch contacts and dual wheel-responsive switch contacts, a first counting circuit connected to said first-named switch contacts and including a first solenoid, a second counting circuit connected to said second switch contacts and including a second solenoid, a common armature arranged to be attracted by one or the other of said solenoids, said solenoids being arranged in opposing relationship with respect to said armature, normally open common switch means including said armature and closing responsive to the movement of said armature resulting from the energization of said second solenoid, said second solenoid being constructed and arranged to hold said common switch means closed for a predetermined time after deenergization of said second counting circuit, energizing means for said second counting circuit responsive to the passage of a dual wheel over said dual wheel-responsive switch contacts, whereby to energize said second solenoid and close said common switch means, a plurality of respective ad-

ditional counting circuits, respective further switches in said additional counting circuits, means to sequentially close said further switches responsive to the successive energization of said second and additional counting circuits, means to maintain said further switches closed while said common switch means remains closed, and means including said further switches to energize the respective additional counting circuits in sequence responsive to the sequential passage over the roadway switch of additional dual wheels while said common switch means remains closed.

3. A traffic counting system comprising a roadway switch having single wheel-responsive switch contacts and dual wheel-responsive switch contacts, a first counting circuit connected to said first-named switch contacts and including a first solenoid, a second counting circuit connected to said second switch contacts and including a second solenoid, a common armature arranged to be attracted by one or the other of said solenoids, said solenoids being arranged in opposing relationship with respect to said armature, normally open common switch means including said armature and closing responsive to the movement of said armature resulting from the energization of said second solenoid, said second solenoid being constructed and arranged to hold said common switch means closed for a predetermined time after deenergization of said second counting circuit, energizing means for said second counting circuit responsive to the passage of a dual wheel over said dual wheel-responsive switch contacts, whereby to energize said second solenoid and close said common switch means, a plurality of respective additional counting circuits, respective further switches in said additional counting circuits, respective relays connected in said second and additional counting circuit controlling said further switches and acting to sequentially close said further switches responsive to the successive energization of said second and additional counting circuits, means to maintain said further switches closed while said common switch means remains closed, and means including said further switches to energize the respective additional counting circuits in sequence responsive to the sequential passage over the roadway switch of respective dual wheels while said common switch means remains closed.

4. A traffic counting system comprising a roadway switch having single wheel-responsive switch contacts and dual wheel-responsive switch contacts, a first counting circuit connected to said first-named switch contacts and including a first solenoid, a second counting circuit connected to said second switch contacts and including a second solenoid, a common armature arranged to be attracted by one or the other of said solenoids, said solenoids being arranged in opposing relationship with respect to said armature, normally open common switch means including said armature and closing responsive to the movement of said armature resulting from the energization of said second solenoid, said second solenoid being constructed and arranged to hold said common switch means closed for a predetermined time after deenergization of said second counting circuit, energizing means for said second counting circuit responsive to the passage of a dual wheel over said dual wheel-responsive switch contacts, whereby to energize said second solenoid and close said common switch means, a plurality of respective additional counting circuits, respective further switches in said additional counting circuits, respective relays connected in said second and additional counting circuits controlling said further switches and acting to close said further switches when energized, said further switches being connected in circuit with the respective relays so as to successively energize the relays responsive to the successive energization of said second and additional counting circuits, means to maintain said further switches closed while said common switch means remains closed, and means including said further switches to energize the

respective additional counting circuits in sequence responsive to the sequential passage over the roadway switch of respective dual wheels while said common switch means remains closed.

5. A traffic counting system comprising a roadway switch of the type having first switch contacts constructed and arranged to close responsive to the passage thereof of a vehicle having single wheels and second switch contacts closed simultaneously with said first contacts responsive to the passage of a vehicle thereafter having a set of dual wheels, a first counting circuit connected to said first switch contacts and including a first solenoid and a first source of current, a second counting circuit including said second switch contacts, a second source of current and a second solenoid, a common armature arranged to be attracted by one or the other of said solenoids, said solenoids being arranged in opposing relationship with respect to said armature, normally open common switch means including said armature and closing responsive to the movement of said armature resulting from the energization of said second solenoid, said second solenoid being constructed and arranged to hold said common switch means closed for a predetermined time after deenergization of said second counting circuit, further switch means, means to close said further switch means responsive to the energization of said second counting circuit, means to maintain said further switch means closed while said common switch means remains closed, and a third counting circuit including said further switch means, said second source and said second switch contact and being energized in response to the passage over the roadway switch of a second set of dual wheels while said common switch means remains closed.

6. A traffic counting system comprising a roadway switch of the type having first switch contacts constructed and arranged to close responsive to the passage thereof of a vehicle having single wheels and second switch contacts closed simultaneously with said first contacts responsive to the passage of a vehicle thereafter having a set of dual wheels, a first counting circuit connected to said first switch contacts and including a first solenoid and a first source of current, a second counting circuit including said second switch contacts, a second source of current and a second solenoid, a common armature arranged to be attracted by one or the other of said solenoids, said solenoids being arranged in opposing relationship with respect to said armature, normally open common switch means including said armature and closing responsive to the movement of said armature resulting from the energization of said second solenoid, said second solenoid being constructed and arranged to hold said common switch means closed for a predetermined time after deenergization of said second counting circuit, a third counting circuit connected to said second switch contacts and second source, a further switch, relay means closing said further switch when energized, means to energize said relay means responsive to the energization of said second counting circuit, means to maintain said relay means energized while said common switch means remains closed, and a third counting circuit including said further switch, said second source and said second switch contacts and being energized responsive to the passage over the roadway switch of a second set of dual wheels while said common switch means remains closed.

7. A traffic counting system comprising a roadway switch of the type having first switch contacts formed and arranged to close responsive to the passage thereof of a vehicle having single wheels, and second switch contacts closed simultaneously with said first contacts responsive to the passage of a vehicle having dual wheels over the switch, a first counting circuit connected to said first switch contacts and including a first solenoid and a first source of current, a second counting circuit including said second switch contacts, a second solenoid opposing said first solenoid, and a second source of current, a com-

mon armature arranged to be attracted by one or the other of said solenoids, said solenoids being arranged in opposing relation with respect to said armature, third switch means including said armature and closing responsive to the movement of said armature resulting from the energization of said second solenoid, said second solenoid being relatively strong as compared to said first solenoid and being constructed and arranged to hold said third switch means closed for a predetermined time after deenergization of said second solenoid, a third counting circuit including said second named source and said second switch contacts, further switch means, means to close said further switch means responsive to the energization of said second counting circuit, means to maintain said further switch means closed while said third switch means remains closed, and a third counting circuit including said further switch means, said second-named source and said second switch contacts and being energized in response to the passage over the roadway switch of a second set of dual wheels on the vehicle while said third switch means remains closed following the passage over the roadway switch of a first set of dual wheels.

8. A traffic counting system comprising a roadway switch of the type having first switch contacts formed and arranged to close responsive to the passage thereover of a vehicle having single wheels, and second switch contacts closed simultaneously with said first contacts responsive to the passage of a vehicle having dual wheels over the switch, a first counting circuit connected to said first switch contacts and including a first solenoid and a first source of current, a second counting circuit including said second switch contacts, a second solenoid opposing said first solenoid, and a second source of current, a common armature arranged to be attracted by one or the other of said solenoids, said solenoids being arranged in opposing relation with respect to said armature, third switch means including said armature and closing responsive to the movement of said armature resulting from the energization of said second solenoid, said second solenoid being relatively strong as compared to said first solenoid and being constructed and arranged to hold said third switch means closed for a predetermined time after deenergization of said second solenoid, a third counting circuit including said second named source and said second switch contacts, a third source of current, relay means connected to said third source of current and third switch means and formed and arranged to energize said third counting circuit responsive to energization of said relay means, and means to energize said relay means in response to the passage over the roadway switch of a second set of dual wheels on the vehicle while said third switch means remains closed following the passage thereover of a first set of dual wheels.

9. A traffic counting system comprising a roadway switch of the type having first switch contacts formed and arranged to close responsive to the passage thereover of a vehicle having single wheels, and second switch contacts closed simultaneously with said first contacts responsive to the passage of a vehicle over the switch having dual wheels, a first counting circuit connected to said first switch contacts and including a first solenoid and a first source of current, a second counting circuit including said second switch contacts, a second solenoid, a relay having slow-acting contacts, and a second source of current, a common armature arranged to be attracted by one or the other of said solenoids, said solenoids being arranged in opposing relation with respect to said armature, third switch means including said armature and closing responsive to the movement of said armature resulting from the energization of said second solenoid, said second solenoid being constructed and arranged to hold said third switch means closed for a predetermined time after deenergization of said second solenoid, a third counting circuit including said slow-acting contacts, said second named source and said second switch contacts, whereby closure

of said third counting circuit is prevented until after said second counting circuit has been energized for at least the period of time required for said relay to close its contacts, a holding winding on said relay, and means energizing said holding winding through said slow-acting contacts and said third switch means.

10. A traffic counting system comprising a roadway switch having single and dual wheel-responsive switch contacts and dual wheel-responsive switch contacts, a first counting circuit connected to said first-named switch contacts and including a source of current and a first counter actuated additively responsive to a pulse of current caused by wheel-actuated closure of said first-named contacts, current-responsive means in said first counter constructed and arranged to actuate said first counter subtractively, a second counting circuit connected to said second-named switch contacts and including a source of current and a second counter actuated additively responsive to a pulse of current caused by dual wheel-actuated closure of said second-named contacts, and means connecting said second counter in parallel with said current-responsive means, whereby a registration is subtracted from said first counter responsive to a registration received by the second counter.

11. A traffic counting system comprising a roadway switch having single and dual wheel-responsive switch contacts and dual wheel-responsive switch contacts, a first counting circuit connected to said first-named switch contacts and including a source of current and a first counter actuated additively responsive to a pulse of current caused by wheel-actuated closure of said first-named contacts, current-responsive means in said first counter constructed and arranged to actuate said first counter subtractively, a second counting circuit connected to said second-named switch contacts and including a source of current and a second counter actuated additively responsive to a pulse of current caused by dual wheel-actuated closure of said second-named contacts, means connecting said second counter in parallel with said current-responsive means, whereby a registration is subtracted from said first counter responsive to a registration received by the second counter, a third counting circuit connected to said second switch contacts and said second-named current source and including a third counter, means actuating said third counter additively responsive to a further dual wheel-actuated closure of said second-named contacts, current-responsive means in said second counter constructed and arranged to actuate said second counter subtractively, and means connecting said third counter in parallel with said second-named current-responsive means, whereby a registration is subtracted from said second counter responsive to a registration received by said third counter.

12. In a traffic counting system, a roadway switch having single and dual wheel-responsive switch contacts and dual wheel-responsive switch contacts, a first counting circuit connected to said first-named switch contact and including a source of current and a current-responsive counter, means to actuate said counter additively responsive to wheel-actuated closure of said first-named contacts, a plurality of additional counting circuits connected to said second-named switch contacts and including a source of current and respective additional current-responsive counters, means to actuate said additional counters additively responsive to dual wheel-actuated closure of said second-named switch contacts and successively in accordance with the number of dual wheels of a vehicle passing in sequence over the roadway switch, current-responsive subtracting means in each counter constructed and arranged to actuate the counter subtractively responsive to a current pulse received thereby, and means connecting the subtracting means of each counter in parallel with the additive actuating means of the next succeeding counter, whereby additive actuation of each counter is accompanied by subtractive actuation of the proceeding counter.

13. A traffic counting system comprising a roadway

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switch of the type having first switch contacts formed and arranged to close responsive to the passage thereover of a vehicle having single wheels, and second switch contacts closed simultaneously with the first contacts responsive to the passage of a vehicle over the switch having dual wheels, a first counting circuit connected to said first switch contacts and including a first solenoid and a first source of current, a second counting circuit including said second switch contacts, a second solenoid, a relay, and a second source of current, a common armature arranged to be attracted by one or the other of said solenoids, said solenoids being arranged in opposing relation with respect to said armature, third switch means including said armature and closing responsive to the movement of said armature resulting from the energization of said second solenoid, said second solenoid being constructed and arranged to hold said third switch means closed for a predetermined time after deenergization of said second solenoid, pulse-responsive switch means controlled by said relay and closing responsive to a pulse of current received by said relay when a first pair of dual wheels passes over the roadway switch, and a third counting circuit including said pulse-responsive switch means, said second-named source and said second switch contacts.

14. A traffic counting system comprising a roadway switch of the type having first switch contacts formed and arranged to close responsive to the passage thereover of a vehicle having single wheels, and second switch contacts closed simultaneously with the first contacts respon-

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sive to the passage of a vehicle over the switch having dual wheels, a first counting circuit connected to said first switch contacts and including a first solenoid and a first source of current, a second counting circuit including said second switch contacts, a second solenoid, a relay, and a second source of current, a common armature arranged to be attracted by one or the other of said solenoids, said solenoids being arranged in opposing relation with respect to said armature, third switch means including said armature and closing responsive to the movement of said armature resulting from the energization of said second solenoid, said second solenoid being constructed and arranged to hold said third switch means closed for a predetermined time after deenergization of said second solenoid, pulse-responsive switch means controlled by said relay and closing responsive to a pulse of current received by said relay when a first pair of dual wheels passes over the roadway switch, and a third counting circuit including said pulse-responsive switch means, said second-named source and said second switch contacts, said pulse-responsive switch means including a pair of contacts, a holding winding controlling said contacts, a third source of current, and circuit means connecting said holding winding to said third source of current through said last-named pair of contacts and said third switch means.

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