

- [54] WHEEL SENSING APPARATUS
- [76] Inventors: Stanley Kroll; Michael M. Platzman, both of 541 Green Pl., Woodmere, N.Y.
- [22] Filed: July 1, 1971
- [21] Appl. No.: 158,843
- [52] U.S. Cl. 235/92 TC, 235/92 R, 235/99 A, 200/86, 33/123, 340/38 R
- [51] Int. Cl. G08g 1/065
- [58] Field of Search..... 235/92 TC, 92 PK, 235/99 A; 33/203, 123; 200/86 A

[56] References Cited

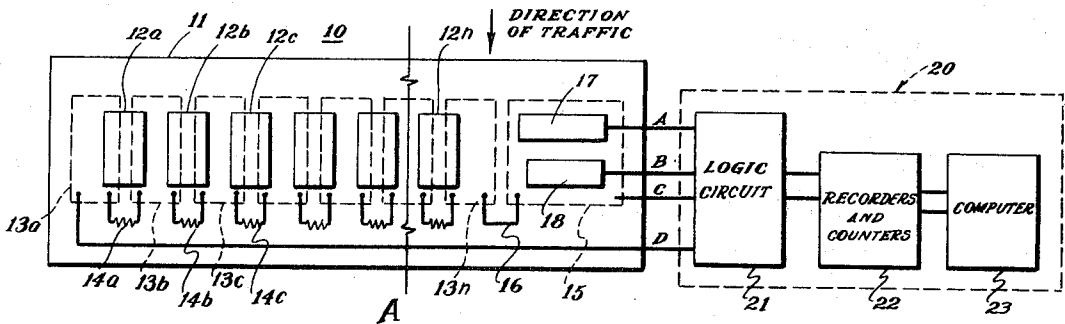
UNITED STATES PATENTS			
3,437,973	4/1969	Mabbett.....	200/86 R
3,126,522	3/1964	Fieser	235/92 TC
3,057,422	10/1962	Cunningham.....	235/92 TC
2,992,776	7/1961	Roscoe	235/92 TC
3,398,397	8/1968	O'Connell	200/86 R
2,617,197	11/1952	Derby	33/123

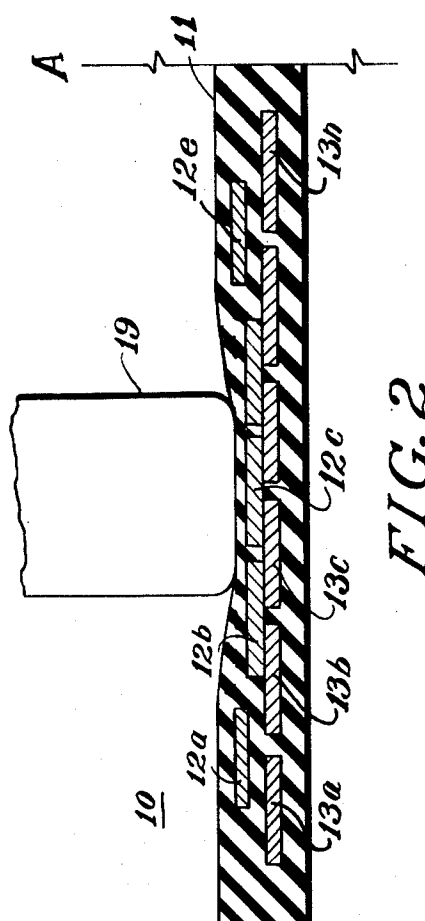
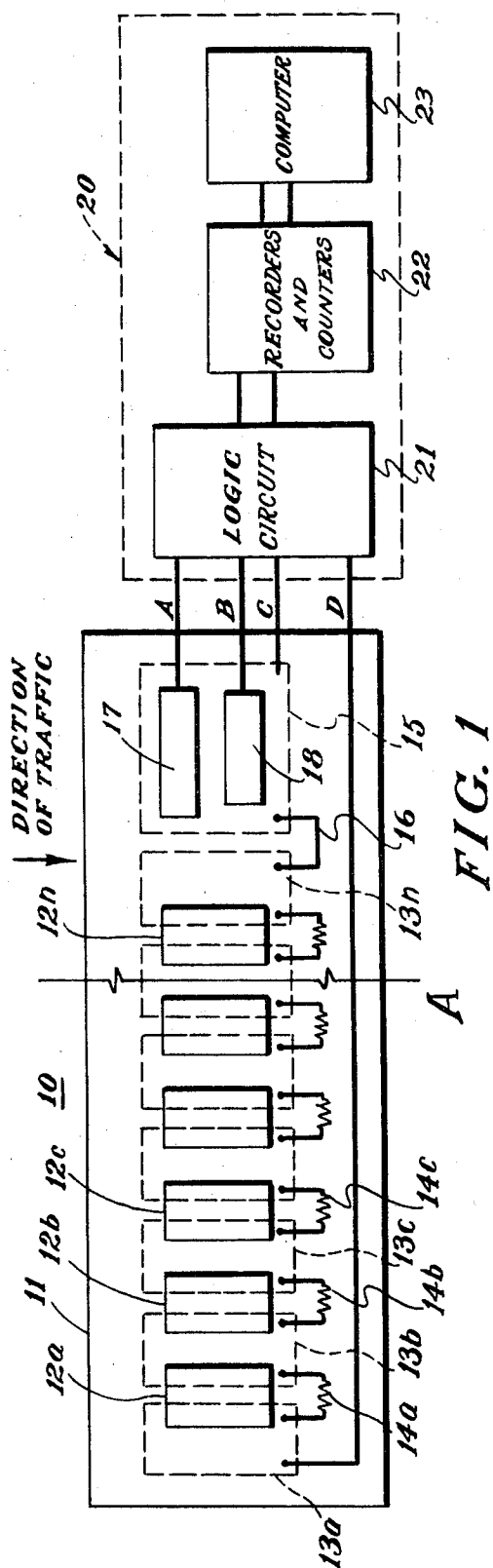
Primary Examiner—Maynard R. Wilbur
Assistant Examiner—Robert F. Gnuse
Attorney—Leonard H. King

[57] **ABSTRACT**

A treadle consisting of a set of upper contacts electrically separated from a set of lower contacts and placed in staggered arrangement with the lower set. The lower set has a fixed impedance between each contact. As a wheel crosses the treadle, the upper contacts beneath the wheel short out the lower contacts staggered thereunder, thereby reducing the total impedance. A control system detects the reduced impedance value and determines the wheel width. Pulse counting circuitry integral with the control system counts the wheel axles and determines the class of vehicle. Direction sensing and car counting may also be included with the treadle and control system. The weight class of the vehicles, as well as the approximate speed, can also be determined from the information detected.

20 Claims, 9 Drawing Figures





INVENTORS.
STANLEY KROLL
MICHAEL M. PLATZMAN
 BY *Leonard H. King*
 ATTORNEY

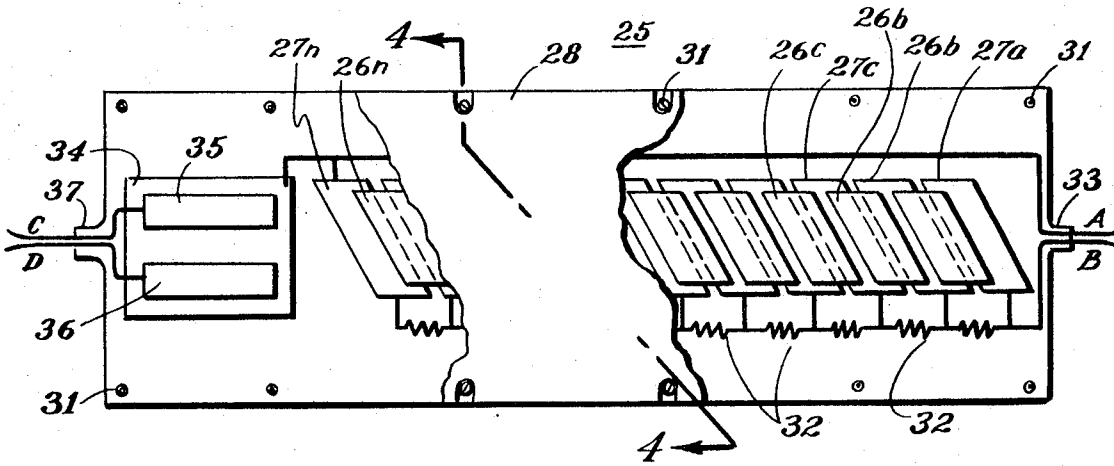


FIG. 3A

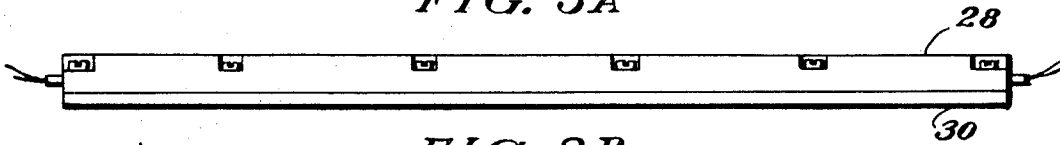


FIG. 3B

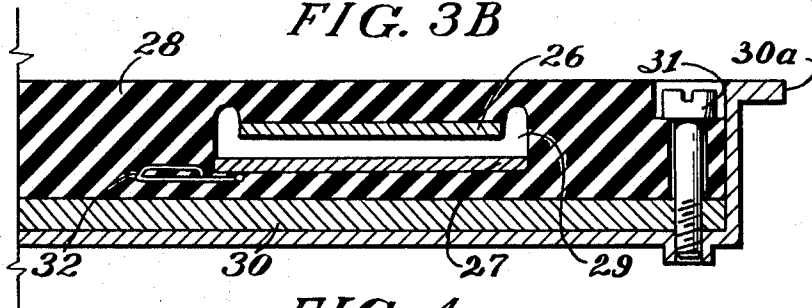


FIG. 4

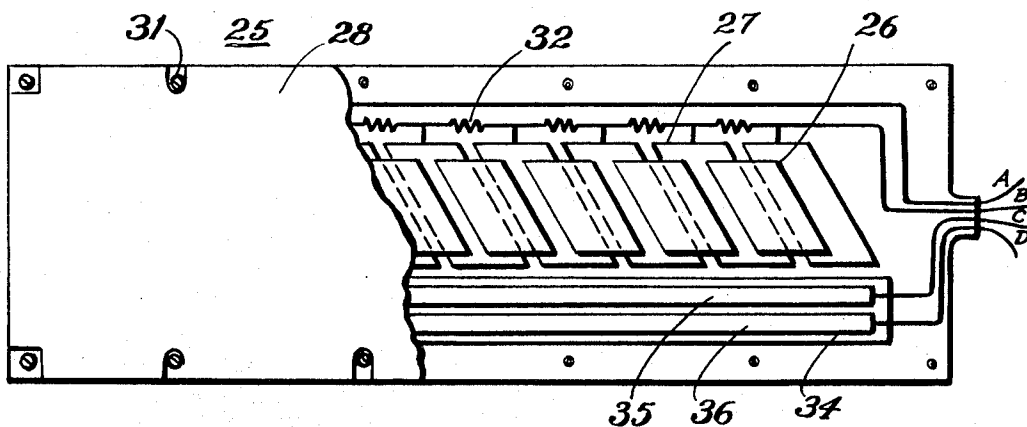


FIG. 5

INVENTORS.
STANLEY KROLL
MICHAEL M. PLATZMAN

BY

Leonard H. King
ATTORNEY

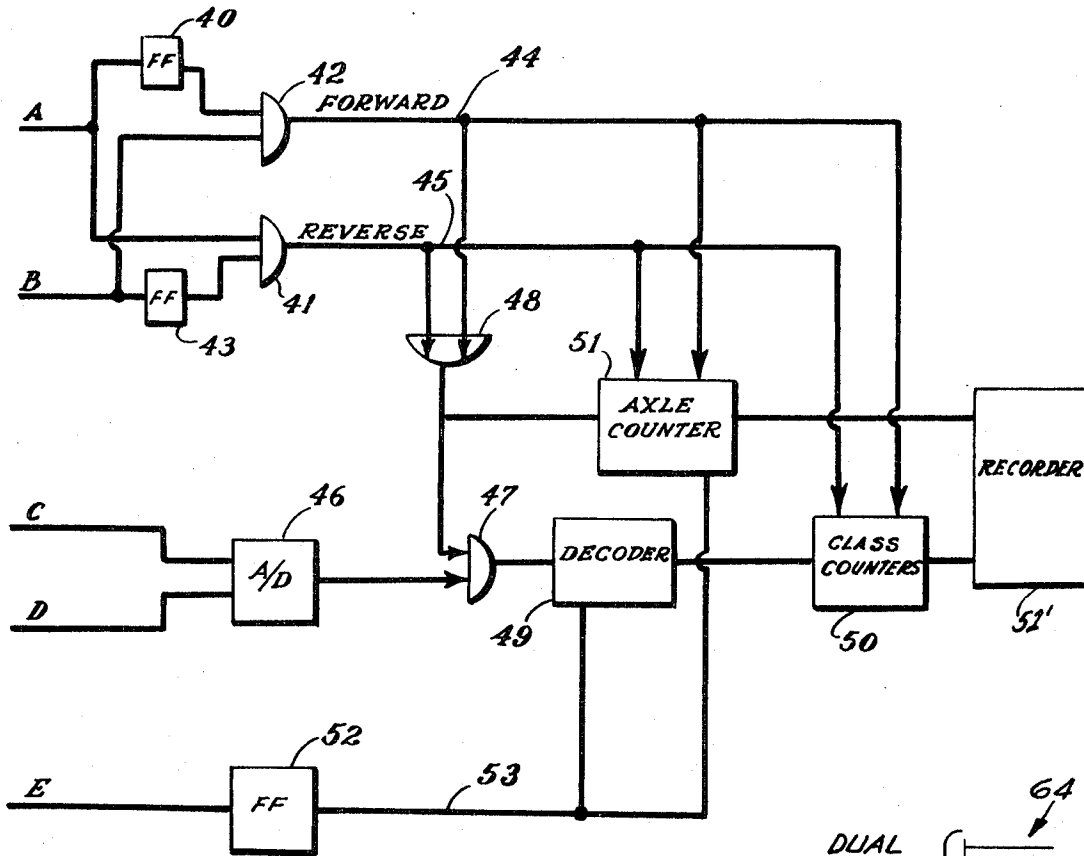


FIG. 6

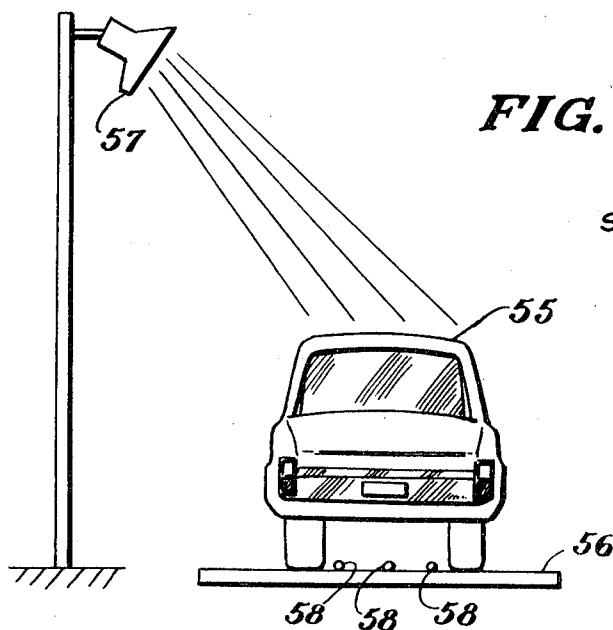


FIG. 7

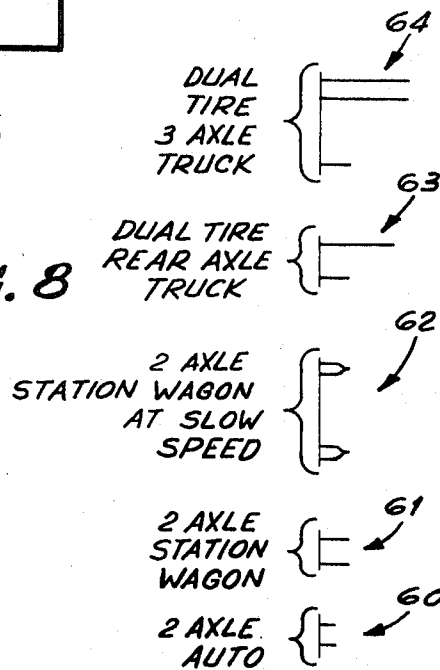


FIG. 8

INVENTOR
STANLEY KROLL
 BY **MICHAEL M. PLATZMAN**
Leonard H. King
 ATTORNEY

WHEEL SENSING APPARATUS

The aforementioned abstract is neither intended to define the invention of the application which, of course, is measured by the claims, nor is it intended to be limiting as to the scope of the invention in any way.

This invention relates generally to apparatus for sensing the width of a wheel on a vehicle passing a treadle as well as the number of wheels on said vehicle, the number of axles on the vehicle and the direction of travel across the treadle.

BACKGROUND OF THE INVENTION

In numerous vehicle control applications, it is desirable to know the number of wheels passing across a particular station, as well as the type of vehicle passing said station. This information is important, for example, in automatic toll collecting systems wherein the amount of revenue collected is dependent upon the class of vehicle. The vehicle classification is usually based upon the number of wheels, the size of the wheel, the number of axles and the weight of the vehicle. For example, motorcycles having two wheels are of a particular class while regular four wheel automobiles are of a different class. Furthermore, trucks are also classified and rated by the number and size of wheels which they contain as well as the number of axles on the truck and the gross weight of the truck.

In traffic data systems where traffic patterns are plotted for statistical data to plan highways and automatic control of speed and lane traffic, it is also important to know the type and size of vehicles passing a particular location. In such systems, it is not only important to know the number of wheels on the vehicle but frequently the class and type of vehicles are also important. The class of the vehicles are generally related to the number and size of the wheel as well as the number of axles. Small foreign type automobiles have a narrow tire since the weight of these automobiles is less than the standard cars. Also, the weight capacity and size of a truck will depend upon the number and width of its tires and the number of axles. Large heavy duty trucks have dual tires permitting a larger capacity of weight. Also, certain trucks have 3 axle-six tires, or 3 axle-ten tires or even larger combinations.

In prior art systems, the general procedure was limited to counting the number of axles passing a particular station. Although axle counting alone would provide some form of information relative to the type of vehicle, it did not provide sufficient information to determine completely the class of the automobile or the capacity of the truck. Other prior art systems which did sense the wheel size were very complex systems. Much of the complexity resulted from using a large number of sensors which required having an individual set of electrical wires from each of the sensors which were then coupled to a control station. The sensors would detect the approximate tire print width and transmit the information to the control station. The individual set of wires from each sensor would pass through circuit logic and then to a computing system. However, the necessity for the large number of wires and the resulting complexity of the logic made these prior art systems expensive, complex and difficult to maintain.

Accordingly, it is an object of this invention to provide a simple wheel sensing apparatus.

A further object of the invention is to provide a tire width sensing apparatus.

Yet a further object is to provide a tire width sensing apparatus which can differentiate between two and four wheels on each vehicle axle.

A still further object is to provide a vehicle sensing apparatus which can detect the number of axles on the vehicle, the number of tires on each axle and the width of each tire.

Yet another object is to provide a sensing apparatus in conjunction with a control system which can classify vehicles based on the number of axles, the number of tires, the width of the tires or a combination of this information.

Still another object is to provide a tire sensing apparatus which can count the number of wheels on vehicles passing over it.

A further object is to provide a tire width sensing apparatus which requires only two wires to connect the sensor to the control station.

A still further object of this invention is to provide a tire width sensing apparatus which also determines the direction of passage of the vehicle.

Yet another object of this invention is to provide a wheel sensing apparatus which can detect the approximate width of the tire on a vehicle passing over it.

A further object of this invention is to provide a wheel sensing apparatus which differentiates between the passage of a vehicle and a pedestrian.

Another object is to permit automatic classification of vehicles by automatic measurement of tire width.

A still further object of this invention is to provide a multiple wheel sensing apparatus which can detect the presence of both two wheel and four wheel vehicles.

BRIEF DESCRIPTION OF THE INVENTION

In carrying out the foregoing objects, this invention provides for a treadle apparatus having a number of movable contacts and a number of fixed contacts contained therein. In a preferred embodiment, the contacts are metal and are imbedded in a rubber treadle. The two sets of contacts are electrically separated from each other and are arranged in a staggered pattern. Individual contacts in both the upper and lower set are spaced apart from each other. The lower contacts are interconnected by a predetermined value of impedance thereby forming a series circuit arrangement. The passage of a wheel over the treadle causes the upper movable contacts to engage the lower contacts, thereby shorting out the impedance between the adjacent staggered lower contacts. The number of upper contacts which will close is dependent upon the width of the tire passing over the treadle. Two wires connected to opposite ends of the series circuit formed by the interconnected lower set of contacts, are transmitted to a control system. In the absence of a passing vehicle, a fixed amount of impedance will appear across the terminals. As a vehicle passes over the treadle, the upper contacts shorting out sections of the impedance between the lower contacts, will reduce the impedance appearing between the terminals. The impedance value at the terminals will be a direct function of the width of the tire crossing the treadle. This value can be read out directly or converted to a digital value for further computation. Two further contact strips placed transverse to the direction of passage of the vehicle, provide a directional sequential count to determine the forward and reverse direction of passage. Counting means connected to the treadle count the number of axles on the vehicle. A

photoelectric detection circuit separates each vehicle from the next. All the information concerning axle count, number of tires on each axle and tire width is transmitted to a control station which classifies the vehicle. The control station can also use the information to determine the weight class of the vehicle, as well as the approximate speed of the vehicle as it crosses the treadle.

The foregoing object are brought about by the above brief description of this invention which will hereinafter be more fully explained in connection with the accompanying figures.

BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 is a sketch of one embodiment of this invention showing the treadle and a block diagram of the control system.

FIG. 2 shows a tire crossing over the treadle constructed in accordance with this invention.

FIGS. 3a and 3b show a plan and elevation view of another embodiment of the treadle in accordance with this invention.

FIG. 4 shows a sectional view of the treadle taken along lines A—A'.

FIG. 5 shows a further embodiment of a treadle in accordance with this invention.

FIG. 6 is a logic diagram of the control system.

FIG. 7 is a pictorial view of the photoelectric detection system useful in conjunction with the treadle.

FIG. 8 is a recording of the output of the apparatus of the invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1 there is shown a treadle 10 having an upper surface 11 across which the vehicles pass. Imbedded within the upper surface are contacts 12a, 12b, 12c . . . 12n. These contacts are spaced apart from each other and are capable of being depressed by the application of pressure on its surface. The contacts are made of a stiff and strong substance such as metal and are placed on the treadle which is constructed of a distortable substance such as rubber. In the embodiment of FIG. 1, the upper contacts are on the surface of the treadle. As will be shown hereinafter, these could also be embedded within the treadle material. On the lower surface of the treadle are fixed contacts 13a, 13b, 13c . . . 13n, shown in dotted lines. The lower contacts are embedded within the treadle and spaced apart from each other. The lower contacts are staggered with respect to the upper contacts. Both sets of contacts are electrically conductive. Interconnecting each two adjacent lower contacts is an impedance 14. Between lower contacts 13a and 13b, there is connected impedance 14a. Between lower contacts 13b and 13c, there is placed impedance 14b. Similarly, for the other lower contacts. After the last lower contact, there is placed a further contact plate 15. Contact plate 15 is connected electrically by means of line 16 to the last of the lower contacts 13n. Lead terminal wire D is connected to the first lower contact 13a and brought out externally from the treadle. Lead terminal wire C is connected to the lower contact plate 15 and is also brought out externally from the treadle.

Contacts 17 and 18 are embedded in the upper surface 11 and spatially placed over the lower contact 15. Contacts 17 and 18 are longitudinal strips placed transverse to the direction of traffic as shown by the arrow.

Contacts 17 and 18 are constructed of metal and are electrically separated from the lower contact 15. Lead terminal wire A is connected to upper contact 17 and brought out externally from the treadle. Lead terminal wire B is connected to upper contact 18 and is also brought out externally from the treadle.

The four external wires A, B, C and D are electrically connected to a control panel shown generally at 20. The control panel is placed at a central station and comprises logic circuitry 21, recorders and counters 22, and can serve as information input to a computer 23.

The operation of the treadle apparatus shown in FIG. 1 will now be explained in conjunction with FIG. 2 wherein like parts are similarly numbered. The treadle is placed transverse to the direction of traffic. As a tire 19 passes over the treadle 10, the force of the tire upon the upper contacts pushes the upper contacts downward to engage the lower contacts. Each upper contact when lowered, shorts out the two adjacent lower contacts which are staggered beneath it. For example, when upper contact 12b is lowered, it interconnects lower contacts 13b and 13c. The impedance of the upper contacts are made much less than the impedance 14. Therefore, the upper contacts effectively short out the impedance between the two lower contacts. The number of upper contacts which will be pushed downward, depends upon the width of the tire 19. In FIG. 2, the tire 19 is shown as depressing three upper contacts. It will be noted that the tire shape is slightly distorted because of the weight of the vehicle and the tire print is used as the measurement of the tire width.

Prior to the passage of a vehicle across the treadle, there will be a fixed amount of impedance between lines C and D representing the total impedance of the interconnected series of lower contacts. For example, if each of the impedances 14 represent a 1K resistor and there are twenty resistances, there will be a total of 20K ohms between C and D. If the tire of the vehicle crossing the treadle shorts out three of the resistors, the resistance between C and D will be 17K ohms.

In addition to providing an input representative of the width of the tire, the treadle of FIG. 1 also detects the direction in which the vehicle is crossing. When the vehicle passes in the normal forward direction of traffic, as indicated in the figure, one of the tires will cross the contacts 12 while the tire at the opposite side of the vehicle will cross the contacts 17 and 18.

When moving in a forward direction of traffic, the contact 17 will be closed prior to the contact 18. Should the vehicle be crossing in a reverse direction, the contact 18 will close prior to the contact 17. As each of the contacts 17, 18 are closed onto lower contact plate 15, a pulse appears on the lines A, B respectively. If the vehicle passes in a forward direction of traffic, the first pulse will appear on line A, followed by a pulse on line B. When crossing in a reverse direction, the pulse in line B will appear before that of line A. The logic circuit 21 is arranged to register the inputs from lines A and B which sense the crossing of a vehicle as well as the direction of the crossing. The normal sequence of pulses will be AB, while the reverse crossing will generate a sequence of BA. The impedance value between terminals CD will be converted to a digital value by the control system. In order to differentiate between the crossing of a vehicle and the passing of a person who might accidentally depress certain of the

contacts, the signals from lines AB and CD are arranged to be applied concurrently such that both are required for operation of the system.

The impedance value on lines CD is applied to the recorders and counters 22. Based upon the value of the impedance, it is easy to determine the number of contacts which were depressed and the total width of the tire crossing the treadle. Generally, tire widths are limited to certain minimum and maximum values. Based upon the total width measured, the number of tires crossing the treadle and the width of the tires can be determined.

Each time a wheel crosses the plates 17, 18, a pulse is generated and the pulses are counted. These pulses represent the number of axles on the vehicle. Photodetectors are used to separate each vehicle from the next one. The signal from the photodetectors cause the axle counters to start their count, such that there will be an axle count for each vehicle crossing the treadle.

This information, including the number of axles, the number of tires on each axle and the width of the tires, is recorded and also sent to a computer 23. The computer determines the class of vehicle from a table look-up stored in memory. The information can then be used for further computations such as toll collecting, or traffic control.

Referring to FIGS. 3 and 4, there is shown another embodiment of the treadle of this invention. FIG. 3a shows a partially cut-away view of treadle 25 having upper contacts 26a, 26b, . . . 26n, electrically isolated from lower contacts 27a, 27b, . . . 27n. Both sets of contacts are arranged on parallel diagonal center lines and are staggered with respect to each other. Both the upper and lower contacts are constructed of metal and are both embedded within the treadle 28 which is of a distortable substance such as rubber. As can be seen from FIG. 4, an air space 29 exists between the upper contacts 26 and the lower contacts 27. The rubber treadle 28 is mounted on a supporting base 30 by means of counterbored mounting bolts 31. Base 30 is of a strong material such as steel. The entire treadle rests within a steel frame 30a.

The lower set of contact 27 are each serially interconnected by equal impedances 32. Terminal lines A, B, are connected respectively to the first and last of the set of lower contacts 27 and are available for external connections through post 33.

An additional lower contact plate 34 and two upper contacts 35, 36, spatially and electrically separated from lower plate 34 are embedded in the rubber 28 at one end of the treadle 25. The contacts 34, 35 and 36 are all constructed of conducting material and an air gap is left between the upper and lower contacts. Lines C and D are connected from upper plates 35, 36, respectively, and are available through post 37 for external connection.

The embodiment shown in FIGS. 3 and 4 functions similar to that hereinbefore described in connection with FIG. 1. As a vehicle crosses the treadle 25, the tires on one side cross plates 35, 36 to provide signals on lines C and D, indicative of the direction of crossing, and the number of axles. The set of tires on the opposite side of the car cross the contacts 26, 27 to provide signals on lines A and B, indicative of the number of tires and the width of the tires.

By placing the contacts 26, 27 on a diagonal axis, there is greater contact reliability between the upper

contacts and the lower contacts as the tires cross the treadle. Also, by embedding both upper and lower contacts in the rubber treadle with an air gap therebetween, the contacts will not be damaged and a more accurate contact will be obtained.

FIG. 5 shows a further embodiment of this invention which permits the treadle sensing apparatus to be used with vehicles having one and two wheels, such as motorcycles and motorbikes. In FIG. 5, wherein like parts are numbered as in FIGS. 3 and 4, the longitudinal strips 34, 35 and 36 are placed across the entire length of the treadle 25 transverse to the direction of traffic. Plates 35 and 36 are spaced above plate 34 and are electrically isolated from it. All three plates are embedded in the rubber 28 with an air gap separating the upper plates 35, 36, from the lower plate 34. In this embodiment, the same tire which causes the upper contacts 26 to close onto the lower contacts 27 thereby detecting the size of the tire, also crosses the direction sensing contacts 35 and 36. The four outputs, A, B, C and D are applied to a control panel as was hereinbefore described. This embodiment will, therefore, be able to detect classes of vehicles having a single wheel per axle. The direction sensing contacts 35, 36 could be spaced on either side of contacts 26 for bi-directional counting.

Referring to FIG. 6, there is shown one embodiment of a control system which will accomplish the desired objectives of this invention. The inputs to the system are lines A and B from the direction sensing contacts, lines C and D from the tire size contacts and a further input on line E from a separator detector as will herein-after be described.

The pulse on line A triggers flip flop 40 and also serves as an input to AND gate 41. The output from flip flop 40 is an enabling pulse to AND gate 42. The pulse on line B triggers flip flop 43 and also serves as an input to AND gate 42. The output from flip flop 43 enables gate 41. As a car passes in a forward direction, the sequence of pulses is AB. The first pulse which appears on line A triggers flip flop 40 which then enables gate 42. The pulse to AND gate 41 does not pass there-through since AND gate 41 is not enabled. The second pulse on line B will trigger flip flop 43 which enables gate 41. The B pulse will also be sent to AND gate 42 which is now enabled by the preceding A pulse. AND gate 42 will, therefore, provide a "forward" signal on line 44. The enabling signal to gate 41 will be removed as the flip flop 43 returns to its original state. Similarly, gate 42 will no longer be enabled as flip flop 40 returns to its original state.

In the event that a car crosses the treadle in a reverse direction, the sequence of pulses will be BA in which case a pulse will first appear on the B line followed by the A pulse. The B pulse will be sent to gate 42 which has not been enabled and will, therefore, not pass through it. The B pulse will also trigger flip flop 43 which will enable AND gate 41. The A pulse appearing subsequently will trigger flip flop 40 and enable gate 42. However, there will be no pulse through it. The A pulse sent to AND gate 41 will pass therethrough since gate 41 is enabled. A "reverse" signal will appear on line 45.

Lines C and D connect to the first and last of the lower contacts on the treadle and measure the series impedance through the entire set of lower contacts. As tires cross the treadle and depress the upper contacts

onto the lower contacts, some of the impedance is shorted out and the impedance between lines CD decreases. The impedance will be a direct function of the width and number of tires crossing the treadle. The analog impedance value is converted to a digital value in A to D converter 46. The digital output is an input to AND gate 47. The enabling signal for AND gate 47 is the output from OR gate 43 whose inputs are the "reverse" signals from lines 44 and 45. With this arrangement, AND gate 47 will pass the digital value of the impedance only when there is concurrent with it a direction crossing signal.

The digital value of the impedance is decoded by decoder 49 to determine the width and number of tires which cross the treadle and cause the reduction in impedance. The decoded value is sent to a class counter 50 which counts the number of vehicles of each particular class which cross the treadle.

The output from OR gate 48 is also sent to axle counter 51. The "forward" signal on line 44 and the "reverse" signal on line 45 are also applied to the axle counter 51 and the class counters 50.

In operation, as a vehicle passes the treadle, a direction crossing input on lines A and B provides the "forward" or "reverse" signal and the tire width contacts provide the digital value of the impedance on lines C and D. Only when a direction crossing signal, either forward or reverse, is concurrent with the impedance signal, will the impedance be recorded. Also, each time an axle crosses the treadle, a new direction crossing signal is detected and determined. Using up-down counters, and applying the "forward" and "reverse" signals to the counters, it is possible to keep a separate count of the class of vehicle crossing in the forward as well as the reverse direction. The information relating to the class of the vehicle is sent to recorder 51' where a permanent record is made. In addition, further computations involving the number of axles, size of tires and number of wheels can be achieved through the use of computers.

Since the axle counter and decoder react to each crossing of a set of tires, it is necessary to reset the counters for each vehicle crossing the treadle. A vehicle separation detection device, such as a proximity detector, photoelectric beam detector or other suitable gating device is employed. Upon passing of the vehicle, the separation device emits a signal for each vehicle crossing the treadle. This signal, on line E, triggers flip flop 52 which sends a reset signal on line 53 to the decoder 49 and axle counter 51. Thus, as a vehicle crosses, the control system counts axles and tires for that vehicle. When the vehicle has completely passed the treadle, a signal in line E resets the system before the next vehicle approaches. The counters will then give the count for that vehicle independent of the preceding or subsequent vehicle.

One type of vehicle detection system is shown in FIG. 7, wherein a car 55 is shown crossing treadle 56. Photo-emitters 57 are located over the crossing path and photo-detectors 58 are placed within the treadle. As the car crosses the treadle, it intercepts the light path from the emitters to the detectors and causes a signal to be sent to the control system. After the passage of the vehicle out of the detection zone, the light from the emitters is again detected by the detectors which causes the control system to reset the counters and be ready for counting the next approaching vehicle.

It will be appreciated that although a specific control system was described, any type of logic circuit could be used in conjunction with the treadle sensor of this invention. Similarly, various mechanical constructions could be used to form the structure of the treadle.

The total number of upper contacts and lower contacts as well as the spacing of the contacts from each other will depend upon the desired accuracy of the system and the type of wheels expected to cross the treadle. The spacing can be decreased such that a large number of contacts will be depressed for a given tire size or the spacing can be increased to reduce the number of contacts required for a given tire size. Also, the direction sensing contacts can be spread apart such that it would be impossible for a human to step on the two contacts within sufficiently fast time to actuate the control system.

Referring to FIG. 8, there is shown a recording on graphic printout paper of sample vehicles crossing the treadle hereinbefore described. The printout comprises a series of strokes recorded on time advancing graph paper. The magnitude of the strokes represents the magnitude of the impedance detected and is, therefore, a measure of the width of the tires crossing the treadle. The number of strokes per vehicle is a measure of the number of axles on the vehicle. Furthermore, the spacing between strokes is an indication of both the spacing between the axles on the vehicle, as well as of the speed of the vehicle. Since the graph paper advances with respect to time, when a vehicle crosses the treadle slowly, more paper will have advanced between strokes than when the vehicle crosses fast. In the latter instance, the strokes would appear in rapid succession. In addition, the density and width of the strokes are also a measure of the speed of the vehicle, since the paper advances more during the course of the actual printing of the stroke as the vehicle moves slowly across the treadle.

As shown in FIG. 8, the first series of strokes 60, consists of two short, thin rapidly successive strokes, indicating a two-axle auto moving with normal speed. The second series of strokes 61, consists of two longer strokes, which are also thin and appear further apart. This indicates a two-axle vehicle, with wider tires than a standard auto. The wider space between the strokes could indicate either slow moving vehicle or a wider distance between axles on the vehicle. However, since the strokes are thin, the speed is not slower than normal, and the wider spacing indicates a longer vehicle. In this case, the strokes represent a two-axle station wagon crossing the treadle.

The next series of pulses 62, consist of two strokes equal in length to that of series 61 but of greater density and width and spaced further apart. The number of axles and the size of the tires is, therefore, the same as that of series 61. However, the width of each stroke as well as the spacing between the strokes indicate a slow moving vehicle, in this case a two-axle station wagon at slow speed.

The next series of pulses 63, consist of two thin strokes; the first shorter than the second and spaced apart a greater distance than a standard auto. The width of the strokes indicate a vehicle crossing with normal speed. The unequal length and the spacing of the strokes indicate a truck having two axles with dual tires on the rear axle.

The last series of pulses 64, consist of three thin strokes, the first shorter than the other two, with a

wider spacing between the second and third strokes. This series indicates a three-axle truck with dual tires on the rear two axles.

It is understood that other means of recording could be used to detect the vehicles crossing, including digital encodings or alphanumeric displays. Whichever recording means are used, the information could also serve as the input to a computer for further processing.

By establishing standards of measurement indicative of the tire widths associated with vehicles of various classes or types one can readily determine the number of wheels represented by the tire width information. This data may be fed to computers for processing. The data could be used for data analysis, computing charges and like purposes.

The apparatus can detect at a high rate and is therefore independent of the speed of the passing vehicle.

The device can distinguish between a loaded and unloaded vehicle.

It should be noted that the separation device referred to earlier may be other than a photoelectric device and may be a proximity detector, ultrasonics sensor, etc.

The essence of this invention is that a treadle consists of a set of upper contacts electrically isolated from a set of lower contacts and placed in a stagger arrangement with the lower contacts. The lower set of contacts have a fixed impedance between each adjacent contact. The impedance can be either resistances, as described, or various combinations of inductances and capacitances. As the tire crosses the treadle, the upper contacts short out the adjacent lower contacts staggered beneath them, thereby reducing the total impedance. The width and number of tires crossing the treadle determines the number of upper contacts closing onto the lower contacts. A control system detects the reduced impedance value and thereby determines the size and number of the tire crossing the treadle. Direction sensing contacts determine the direction of crossing and the number of axles on the vehicle. This information is transmitted to a control system which determines the class of vehicle crossing the treadle. The information is recorded and is available for further processing.

There has been disclosed heretofore the best embodiment of the invention presently contemplated. However, it is to be understood that various changes and modifications may be made by those skilled in the art without departing from the spirit of the invention.

What we claim as new and desire to secure by Letters Patent is:

1. A wheel sensing apparatus comprising:
 - a. a resilient member;
 - b. a plurality of movable contact means spaced from each other and integral with said member;
 - c. a plurality of fixed contact means spaced from each other and spaced from said plurality of movable contact means, said movable contact means being electrically isolated from said fixed contact means and each of said movable contacts being capable of engaging a unique combination of at least two of said fixed contact means different from each combination from the other movable contacts;
 - d. a plurality of impedance means each electrically coupled between adjacent ones of said fixed contact means;
 - e. first and second terminal means connected, respectively, to the first and last fixed contact means;
 - f. energizing means connected to said terminals; and

g. readout means connected to said terminals and responsive to a change in impedance between said terminals, whereby as a wheel passes over said resilient member, said movable contact means affected by said wheel, engage the unique combination of fixed contact means associated therewith and effectively short out the impedances connected to said last mentioned fixed contact means thereby changing the impedance value between said terminals.

2. An apparatus as in claim 1 further comprising third and fourth contact means spaced from each other and transverse to the movement of the wheel, said third and fourth contact means located integral with said member and capable of engaging at least one of said fixed contact means when affected by said wheel, third and fourth terminals coupled respectively to said third and fourth contact means, and recognition means coupled to said third and fourth terminals capable of identifying the sequence through which the wheel affects the third and fourth contact means.

3. An apparatus as in claim 2 wherein said readout means includes forward and reverse counting means.

4. An apparatus as in claim 3 wherein said recognition means in response to one sequence produces a pulse causing said forward counting means to count and in response to the other sequence, produces a pulse causing said reverse counting means to count down.

5. An apparatus as in claim 2 wherein said third and fourth contact means extend across the full length of said resilient member and said movable and fixed contact means are spaced along said length.

6. An apparatus as in claim 2 and further comprising coincidence means receiving the impedance value and the sequence as inputs thereto and providing an output to said readout means only when both inputs occur.

7. An apparatus as in claim 2 and further comprising axle counting means for counting each of said sequences.

8. An apparatus as in claim 7 and further comprising vehicle detection means capable of detecting the presence of a vehicle in the vicinity of said apparatus.

9. An apparatus as in claim 8 wherein said vehicle detection means resets said axle counting means each time a vehicle passes out of said vicinity.

10. An apparatus as in claim 9 wherein said vehicle detection means comprises photoelectric devices.

11. Apparatus as in claim 1 wherein said plurality of fixed contact means are located beneath said plurality of movable contact means in a staggered arrangement with them.

12. An apparatus as in claim 11 wherein said fixed and movable contact means are both embedded within said member and wherein an air gap separates the fixed and movable contacts.

13. An apparatus as in claim 12 wherein said fixed and movable contact means are constructed of steel and said member is constructed of rubber.

14. An apparatus as in claim 13 further including a metal frame beneath said member and coupled to it.

15. An apparatus as in claim 1 wherein said plurality of movable contact means and said plurality of fixed contact means are placed diagonally to said member.

16. An apparatus as in claim 1 wherein said plurality of impedance means comprise a plurality of identical resistors.

17. An apparatus as in claim 1 wherein said movable contact means are electrical switches.

18. An apparatus as in claim 1 wherein said fixed and movable contact means are constructed from conducting material.

19. An apparatus as in claim 1 wherein said readout means further includes display means for recording the impedance values as strokes on a moving tape wherein the length of said strokes is a measure of the width of the tires, the spacing between said strokes is a measure of the speed of the vehicle and the number of strokes is a count of the number of axles on the vehicle.

20. A wheel sensing apparatus for vehicles crossing a treadle, including in combination, means for detecting the presence of a vehicle in the vicinity of the treadle; means for detecting the number of axles on the vehicle crossing the treadle; means having only 2 wires extending externally therefrom for detecting the width

of the tires crossing the treadle; and means for detecting the direction of crossing, wherein said treadle comprises:

- a. a resilient member;
- b. a plurality of movable contact means spaced from each other and integral with said member;
- c. a plurality of fixed contact means spaced from each other and spaced from said plurality of movable contact means, said movable contact means being electrically isolated from said fixed contact means and each of said movable contacts being capable of engaging a unique combination of at least two of said fixed contact means different from each combination from the other movable contacts; and
- d. a plurality of impedance means each electrically coupled between adjacent ones of said fixed contact means.

* * * * *

20

25

30

35

40

45

50

55

60

65