

March 21, 1967

**B. D. GREENSHIELDS**  
 METHOD AND APPARATUS FOR RECORDING  
 TRAFFIC AND/OR DRIVER BEHAVIOR

**3,310,662**

Original Filed Nov. 20, 1961

4 Sheets-Sheet 1

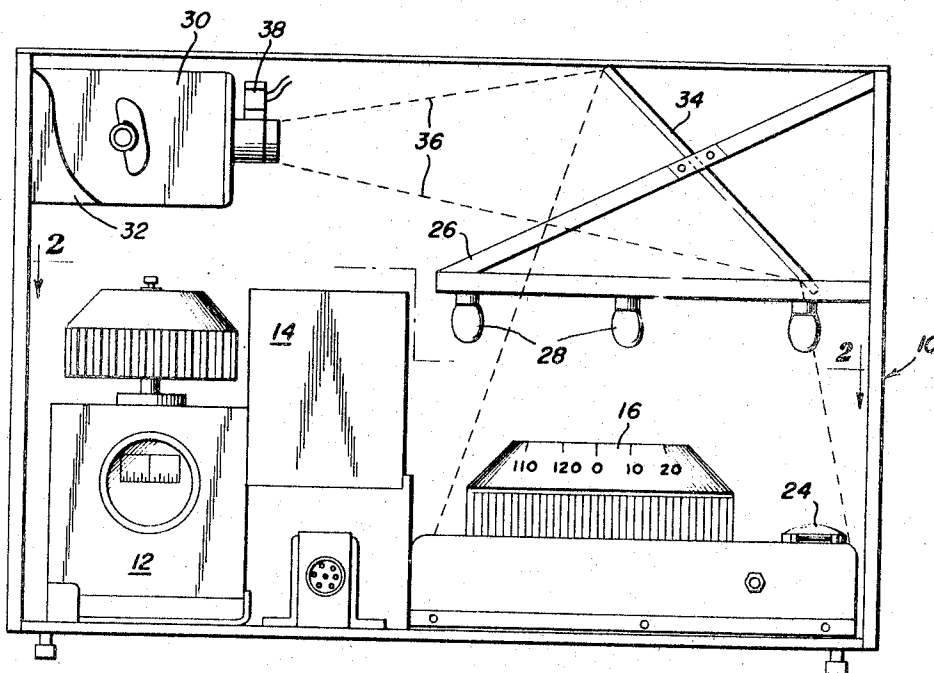


*Fig. 1.*

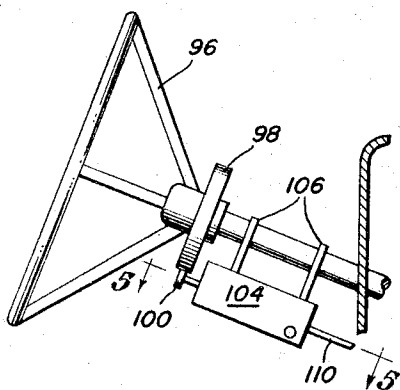


*Fig. 4.*

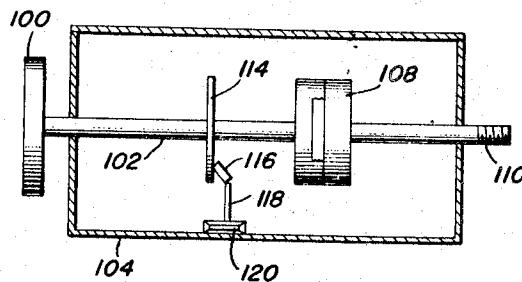


*Fig. 5.*

INVENTOR  
 BRUCE D. GREENSHIELDS  
 BY *Kenneth Palmer, Stuart L. Ketchum*  
 ATTORNEYS

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4 Sheets-Sheet 2

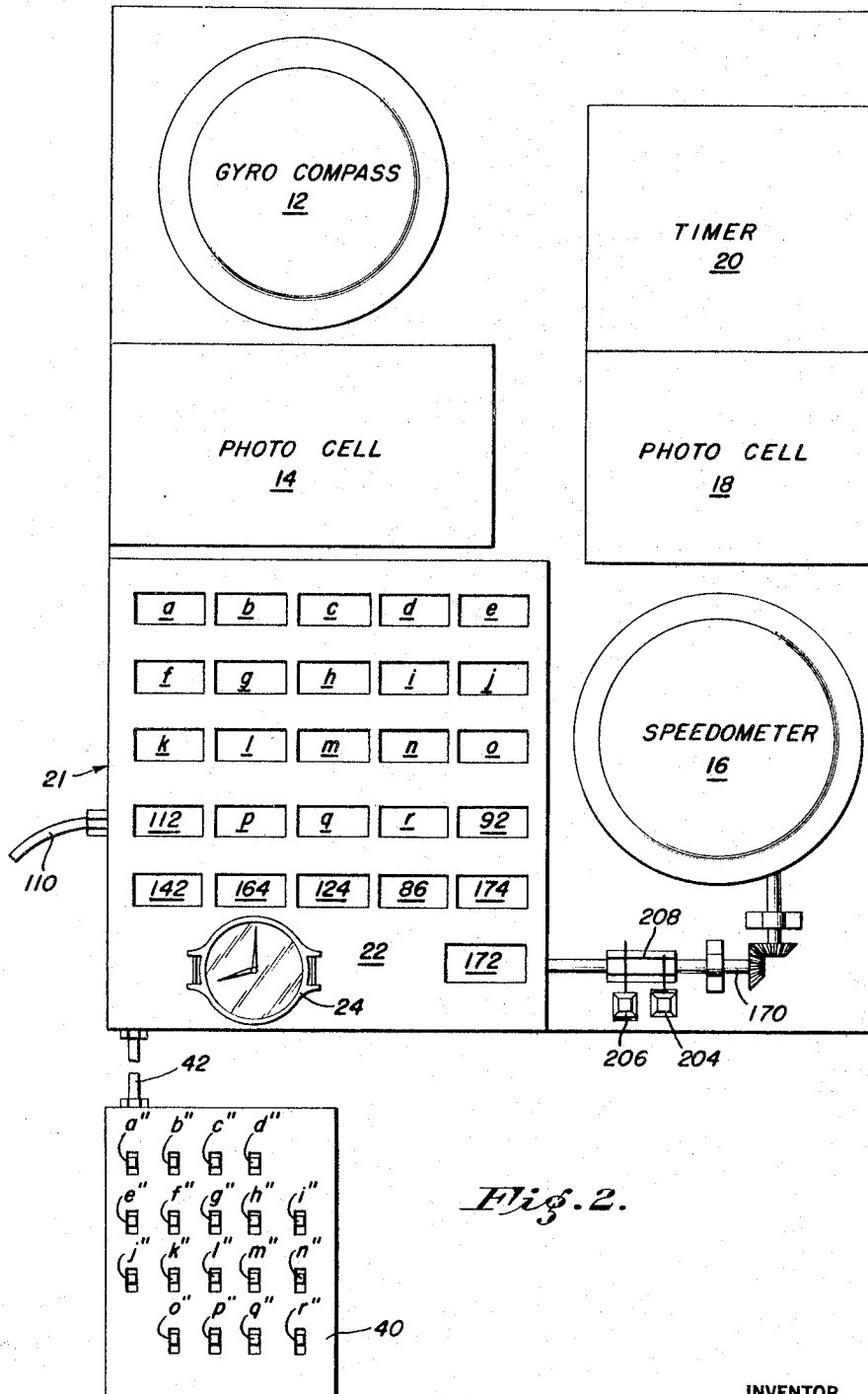


Fig. 2.

INVENTOR  
BRUCE D. GREENSHIELDS  
BY *Kenneth Palmer, Steinert & Ketchum*  
ATTORNEYS

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4 Sheets-Sheet 3

*Fig. 7.*

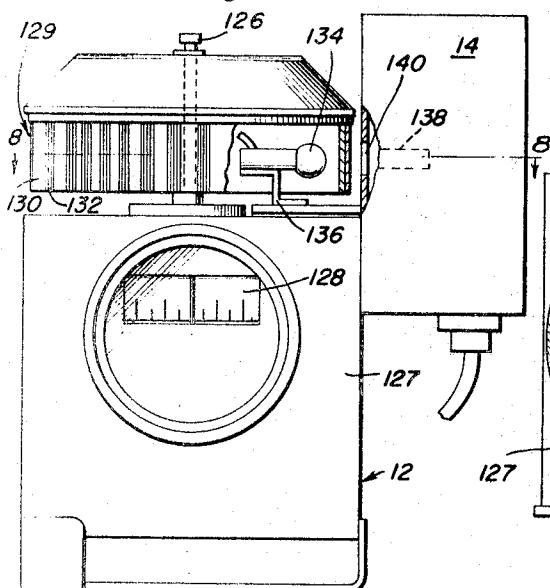


*Fig. 8.*

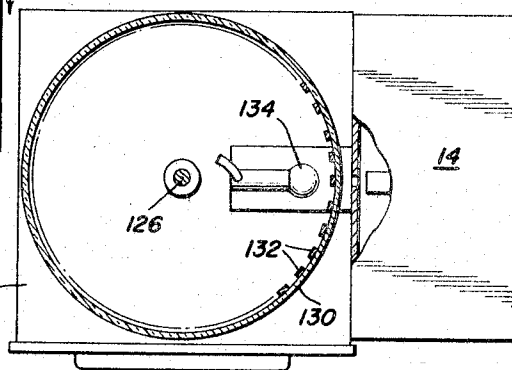


*Fig. 9.*

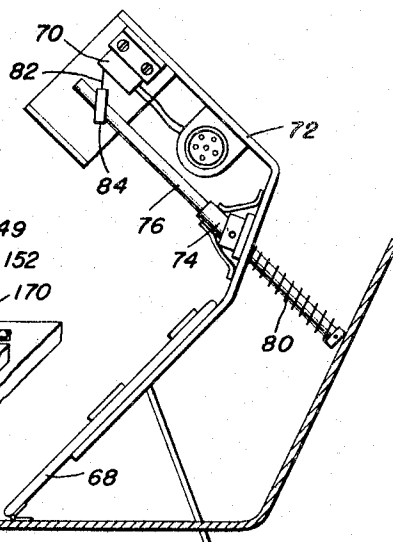
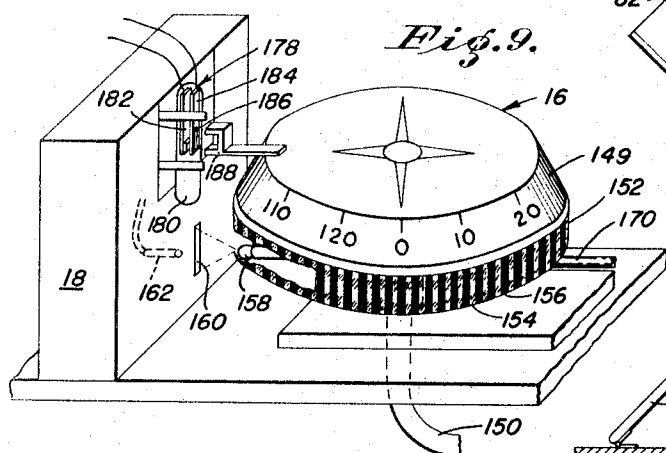
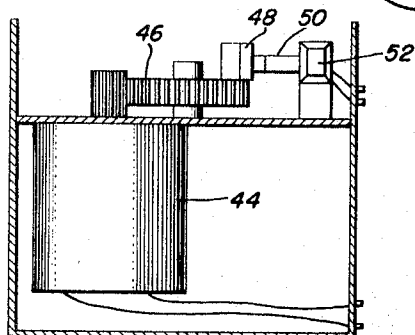


*Fig. 3.*

*Fig. 6.*



INVENTOR  
BRUCE D. GREENSHIELDS  
BY *Kenneth, Palmer, Stewart & Fitch*  
ATTORNEYS

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4 Sheets-Sheet 4

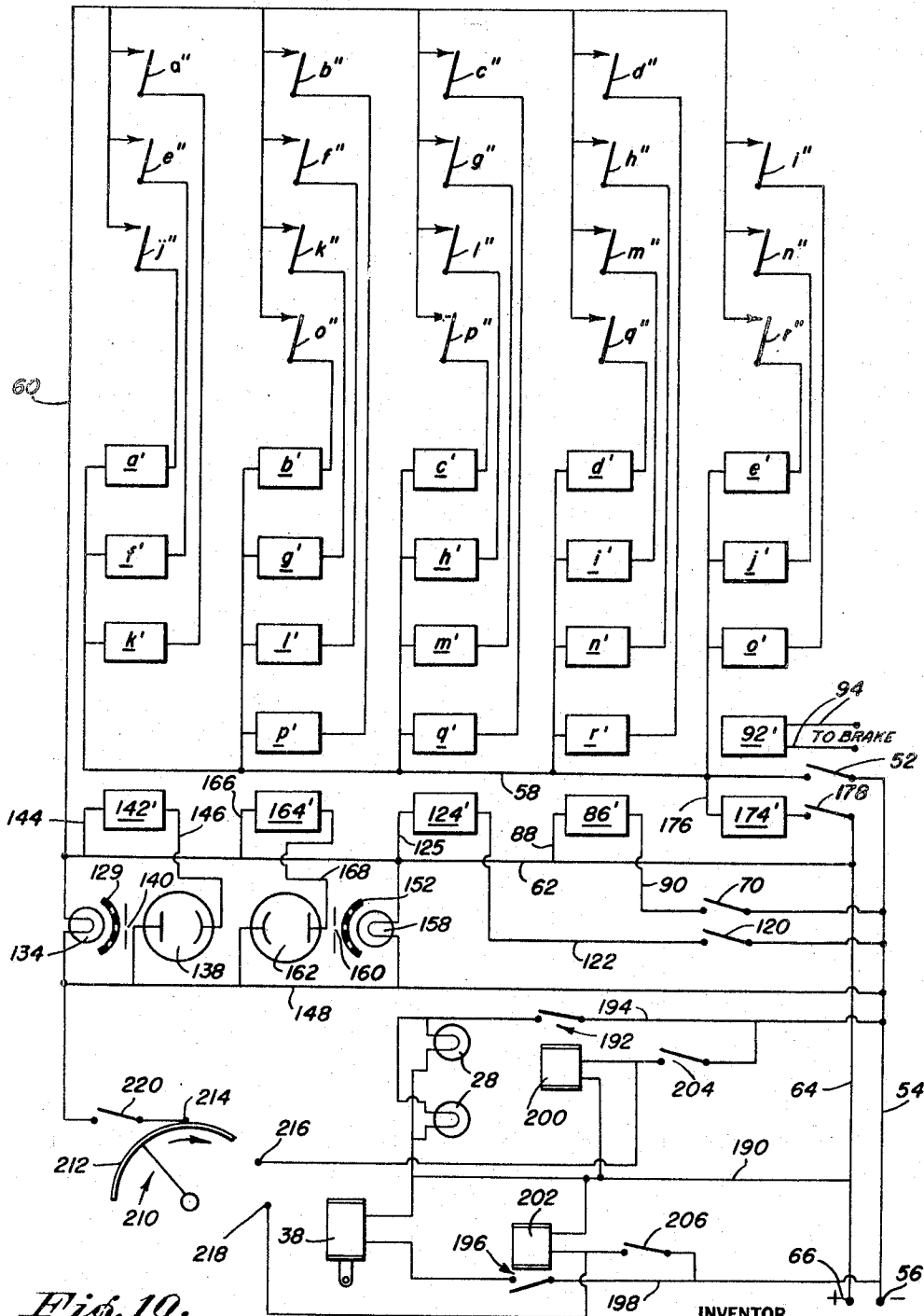


*Fig. 10.*

INVENTOR  
 BRUCE D. GREENSHIELDS  
 BY *Kennedy, Palmer, Stewart & Estabrook*  
 ATTORNEYS

1

3,310,662

## METHOD AND APPARATUS FOR RECORDING TRAFFIC AND/OR DRIVER BEHAVIOR

Bruce D. Greenshields, 1025 Arbordale,  
Ann Arbor, Mich. 48103

Continuation of application Ser. No. 153,346, Nov. 20, 1961. This application May 5, 1964, Ser. No. 365,863  
14 Claims. (Cl. 235—92)

This invention relates to a method and apparatus for recording traffic and/or individual driver behavior together with a recording of the traffic and highway events which influence or are causes of traffic behavior and driver actions. More particularly, it provides a method of obtaining a complete summation in directly usable terms, of (1) driver actions, (2) vehicle motions and (3) traffic and highway events, as well as a new and unique apparatus by which the carrying out of this method is greatly facilitated.

This application is a continuation of my copending application Ser. No. 153,346, filed Nov. 20, 1961, now abandoned.

In my copending application Ser. No. 114,830, filed June 5, 1961, now Patent No. 3,151,235, there is disclosed a method and apparatus for recording such physical characteristics of a road as appearance, geometry and surface conditions by reducing these conditions as sensed by a vehicle traveling thereover to common units, more specifically digital units and recording the information so reduced to provide highway design or maintenance engineers with directly usable data. The present invention is similar in some respects to the invention disclosed in the aforesaid copending application Ser. No. 114,830 but resides in the provision of records having particular utility for analyzing traffic and/or driver behavior. Analyses of this type are useful not only from the standpoint of adoption of needed changes in traffic control, planning for the revision of existing roadways, construction of new roads and the like, but also, they are invaluable for use in studies concerning driver characteristics, traffic safety, and driver training techniques.

As conducive to a clearer understanding of the significance of the present invention, it is to be noted that with the increasing amount of highway traffic, the study of traffic conditions and behavior correspondingly has become more intense and important from the standpoint of obtaining safety and efficiency of traffic flow through planning, traffic control and highway improvement and construction. Also, studies of driver habits and behavior under various traffic and road conditions have become important from the standpoint of gaining a more complete understanding of traffic behavior so that various remedial or preventative measures such as driver training courses and the like, may be taken to alleviate the many problems which now exist in this field. However, there has been no satisfactory apparatus or technique available for obtaining data that could be analyzed to secure needed answers. The solution of any problem as broad and complicated as the safety and efficiency of highway transportation requires an entirety of data that in the past has been if not impossible to obtain, only obtained with an impractical amount of time being spent by experts in examining and coordinating diverse statistical data on which accurate answers may be based. For example, it has been found that information provided by traffic counts furnishes the traffic engineer with but a small portion of data that is required for traffic analysis and correction

2

of problems due to traffic behavior. In the past therefore such data has been supplemented by data observed and recorded by field parties. One approach to making such field observations has been to travel the route under observation in a vehicle and record the characteristic movements of the vehicle as reflecting conditions of traffic behavior. The vehicle used for this purpose may be provided with specialized equipment such as photographic means for recording visually the conditions along the route as well as with various counters or graphs by which movements of the vehicle are recorded and supplementary information as to various other conditions recorded manually by a person riding in the vehicle making notes. While a substantial amount of the necessary information may be recorded in this manner, the terms in which it is recorded are so unrelated that much time and effort is required to compare and correlate these records before a meaningful summation is provided. In other words, such data as photographs taken intermittently over the route, various counts of vehicle movements such as speed, turning, distance, etc., and the information observed by the person riding in the vehicle must be carefully compared and coordinated before any of this data takes on significance from the standpoint of being useful in making the desired analysis. Also, because of the difficulties encountered in coordinating such data, and for practical reasons, the summation thereof has often resulted in discarding portions of the data collected, with resultant waste and possible inaccuracies due to the omission from the summation of such data.

An object of this invention is therefore to provide a new and unique method and apparatus for recording traffic and/or driver behavior by which the aforementioned problems are substantially and effectively overcome.

Another object of this invention is to provide a novel and highly effective method of recording traffic and/or driver behavior by which complete data is obtained by traveling a route for which information relative to traffic and/or driver behavior is desired both as to events directly reflected by traffic conditions and as to events which might effect or cause the conditions of traffic, which data is recorded in related terms so as to be useable directly for analysis purposes without excessively complex, time consuming, coordinating procedures.

A further object of this invention is to provide a novel apparatus for recording traffic and/or driver behavior which may be mounted in a vehicle and driven over a route to record in one recording, or in each of a series of recordings, complete information in interchangeable, related units relative to driver movements affecting control of the vehicle, movements of the vehicle reflecting traffic conditions, and events which may have an effect on the control movements exercised by the driver, traffic conditions, or both.

Another object of this invention is the provision of an apparatus of the type referred to by which all factors reflecting traffic and/or driver behavior over a route such as unit changes in direction and speed of travel, number of changes in direction and speed of travel, time units of travel progress, duration of time of travel over the route, and distance traveled are accumulatively registered on counters together with accumulative totals of unit time intervals during which diverse events having an effect on traffic behavior are incurred, which counters are arranged so that the numbers registered thereon may be conveniently recorded periodically such as by photographing.

3

A further object of this invention is to provide an apparatus of the type referred to with extremely effective means for sensing and recording unit changes in vehicle direction and speed of travel.

A further object of this invention is the provision of an extremely effective means by which events affecting traffic and/or driver behavior observed by a person riding in the vehicle may be conveniently recorded in terms of duration of such events per unit time intervals and the registering thereof in a manner so that the occurrence of these events are immediately correlated with traffic and/or driver behavior.

Other objects and further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. It should be understood, however, that the detailed description, while indicating preferred embodiments of the invention, is given by way of illustration only, since it will become apparent to those skilled in the art from this description that various changes and modifications can be made without departing from the true spirit and scope of this invention.

In general, the aforementioned objects are accomplished by traveling a route along which information relative to traffic and/or driver behavior is desired and simultaneously recording in digital units, the characteristics of travel reflected by traffic behavior and/or driver behavior together with the occurrence of events effecting such behavior. The apparatus for carrying out the invention preferably takes the form of a chassis which may be mounted in an automobile or other such vehicle having steering and speed control means and included in the chassis is a panel on which a plurality of counters are mounted so as to be exposed to a suitable recording means such as a camera. The camera, in turn, is arranged to photograph the numbers registered on the counters at predetermined intervals of time or distance traveled to record various characteristics directly as digital units. Certain of the counters are associated with means for sensing various movements of the vehicle and thus reflecting characteristic traffic conditions such as unit changes in vehicle speed and direction, number of changes in vehicle direction and speed, time units during which the vehicle is traveling, distance traveled and the like. Others of the counters are arranged to be actuated by manual switches under the control of a timing mechanism by which these counters are actuated once per each unit of time that the switch is closed, the switch representing an event which might have an effect on traffic behavior. Also, certain others of the counters are arranged to be actuated by movements of the vehicle control means by the driver, such as for example, movements of the accelerator, brake and steering wheel. In this manner, each of the counters registers accumulatively in digital units, the various movements, events and the like which occur during travel of the vehicle over the route.

A more complete understanding of the present invention and its method of use may be had by reference to the accompanying drawings in which:

FIG. 1 is a side elevation illustrating the general arrangement of components and supporting chassis which is adapted to be carried in an automobile or other vehicle having steering and speed control means;

FIG. 2 is a schematic plan view as seen from line 2—2 of FIG. 1 with the addition of a switch panel located exteriorly of the chassis;

FIG. 3 is a fragmentary side elevation illustrating the accelerator movement sensing device of this invention;

FIG. 4 is a fragmentary side elevation illustrating the steering wheel of the vehicle including the steering wheel movement sensing device;

FIG. 5 is an enlarged, partial, cross-sectional view taken along line 5—5 of FIG. 4;

FIG. 6 is a partial cross-sectional view in side elevation illustrating the timing device of this invention;

4

FIG. 7 is an enlarged fragmentary view illustrating the direction sensing means of this invention;

FIG. 8 is a cross-section taken along line 8—8 of FIG. 7;

FIG. 9 is a fragmentary perspective view illustrating the speedometer of the present invention; and

FIG. 10 is a circuit diagram showing the electrical connection of the various components of the present invention.

Referring now particularly to FIGS. 1 and 2 of the drawings wherein the general arrangement of a preferred form of the present invention is illustrated, a chassis is designated generally by the reference numeral 10, which chassis is adapted to be carried, for example, on the rear seat of a conventional automobile. As shown, the chassis supports a direction sensing means or gyro compass 12, a photocell 14 adjacent the gyro compass, a speedometer 16, a photocell 18 positioned adjacent the speedometer, a timer 20, and a counter panel 21 having an upwardly presented face 22. A watch 24 or other suitable time keeping device is presented on the exposed face 22 of the counter panel and positioned above the panel is a bracket 26 suitably supported in the chassis and carrying a plurality of lamps 28 to provide sufficient illumination for photographing the upper face of the panel with a camera 30. The camera 30 is supported by way of a bracket 32 on the chassis and a mirror 34 is mounted on the bracket 26 to deflect the optical field 36 of the camera at right angles so as to include substantially all of the presented face 22 of the counter panel. The camera 30 may be conventional movie camera equipped with a solenoid 38 for operating the shutter thereof periodically in a manner which will be described more fully hereinafter.

For registering accumulative totals of unit time durations of events observed by one riding in the vehicle, a plurality of counters, *a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r*, are mounted in the panel 21 and presented in the face 22 thereof. Each of these counters *a-r* are of the digital type and adapted to be driven by solenoids *a'-r'* illustrated schematically in the circuit diagram of FIG. 10 under the control of a plurality of manually actuated switches (*a''-r''*) mounted on a switch panel 40 connected electrically to the counter panel 21 by a flexible cable 42. As shown in FIG. 6, the timer includes a synchronous motor 44 arranged to drive through gearing 46 a cam 48 into and out of engagement with the actuating lever 40 of a microswitch 52. Desirably, the speed of the motor as reduced by the gearing 46 is such that the microswitch is closed once every unit interval of time or once each second though intervals of any desired length may be employed merely by changing the speed of the motor or the speed reduction factor of the gearing. As shown in FIG. 10, the microswitch 52 is positioned in a line 54 connected to the negative terminal 56 of a direct current power supply which conveniently may be the battery of the vehicle by a suitable connection to the cigarette lighter socket thereof. The other terminal of switch 52 is connected to a line 58 to which one side of each of the solenoids (*a'-r'*) are connected. The other side of the solenoids are connected through switches *a''-r''* to a line 60 connected by way of a line 62 to a line 64 extending from the positive terminal 66 of the current supply. Thus, it will be seen that when each of the switches *a''-r''* is closed, the counters *a-r* will be driven by the respective solenoids to count the unit time intervals or seconds during which the switches are closed, the intervals being established by the timer 20 and microswitch 52 therein.

To sense movements of the vehicle accelerator pedal shown schematically at 68 in FIG. 3, a microswitch 70 is carried on a bracket 72 which also pivotally supports in a collar 74 a rod 76 spring biased in the direction of the vehicle floor under the influence of helical compression spring 80. The actuating arm 82 of the microswitch

5

70 is retained in frictional engagement with the post 76 by a friction pad 84 so that each time the accelerator pedal 68 is depressed, and the microswitch carried downwardly therewith relative to the post 76, the actuating arm 82 is retained by its frictional engagement with the post to effect closing of the microswitch 70. Similarly, the frictional engagement of the arm 82 with the post 76 will operate to open the microswitch 70 when the accelerator pedal is lifted so that each reversal of the accelerator pedal is accompanied by one closure of the switch 70. Thus, in addition to detecting reversal movements of the accelerator pedal, it will be noted that since each acceleration of the vehicle is accompanied by a downward movement of the accelerator pedal, the switch 70 will be closed once during each positive change of speed undertaken by the vehicle. For registering such accelerator pedal reversals and changes in speed, a counter 86 is presented from the face 22 of the panel 21 and as shown in FIG. 10, a solenoid illustrated schematically at 86' is connected to the positive terminal 66 by a lead 88 connected to the line 62. The microswitch 70 is located in a line 90 extending from the other side of the solenoid 86' through line 54 to the negative terminal 56. Thus, each time the accelerator 68 is depressed or correspondingly, each time the vehicle undergoes a positive change of speed or an acceleration, the microswitch 70 is closed thereby actuating the counter 86 through solenoid 86' to register the change.

The number of times during which the vehicle brake (not shown) is depressed (and the vehicle thus decelerated) is registered on a counter 92 presented from the face 22 of the counter panel. The counter 92 also is adapted to be driven by a solenoid 92' and as shown in FIG. 10, is connected by way of leads 94 to the conventional brake lighting system of the automobile in which the apparatus of this invention is used. Thus, when this lighting system operates to light the tail lamp of the vehicle each time the brake is depressed, the connection of the solenoid 92' thereto will operate to trip the counter 92 each time the brake is depressed to register accumulatively the number of times the vehicle is decelerated by braking.

The means by which movements of the vehicle steering control are sensed and registered may be understood by reference to FIGS. 2, 4, 5 and 10 of the drawing. As shown in FIGS. 4 and 5, the steering wheel 96 is equipped with a friction wheel 98 in engagement with a friction wheel 100 fixed to a shaft 102 from a housing 104 supported from the steering wheel shaft by suitable brackets 106. The shaft 102 is connected through a one-way clutch 108 to a cable 110 connected directly to a counter 112 mounted in the panel 21 with the counters aforementioned. Because the steering wheel of the vehicle is returned to center each time the vehicle is turned, the one-way clutch will operate to drive the cable 110 and thus the counter 112 to provide an accumulative total of angular units through which the steering wheel is turned to change the direction of the vehicle. Also, the shaft 102 carries a disc 114 against which a friction pad 116 carried by the actuating arm 118 of a microswitch 120 engages. The microswitch 120 is disposed (FIG. 10) in a line 122 leading from the line 54 and negative terminal 56 to one side of a solenoid 124' for actuating a counter 124. The circuit of the solenoid is completed by a lead 125, lines 62 and 64 to the positive terminal 66 so that each time the steering wheel 96 is reversed, the microswitch will be closed to generate a pulse and register on the counter 124 the accumulative total of number of steering wheel reversals and number of changes in direction made by the vehicle. It is contemplated that under some circumstances, a second more sensitive microswitch and corresponding counter (not shown) may be used with the switch 120 to register minute movements of the steering wheel which do not affect appreciably vehicular change in direction. Such minute movements

6

are useful from the standpoint of measuring the driver's skill or mental state. The second switch would be similar to switch 120 except that the actuating lever thereof would be shorter than the arms 118. Also, similar arrangement could be employed to register minute movements of the accelerator which do not have any substantial effect on vehicle speed but which indicate the nature of driver actions alone.

The manner in which the gyro compass 12 and photocell 14 cooperate to sense unit changes in vehicle direction may be understood by reference to FIGS. 2, 7 and 8 of the drawings. As shown in these figures, the gyro compass 12 is provided with an upstanding post 126 arranged for rotation with relation to the housing 127 thereof and fixed with respect to the indicating dial 128 held stationary in the conventional manner by gyroscopic element (not shown) in the housing 127. Non-rotatably fixed to the post 126 is a depending, generally cylindrical skirt 129 having alternately transparent and opaque strip-like portions 130 and 132 respectively. A lamp 134 is supported within the skirt 129 on a bracket 136 in turn supported on the housing 127 of the gyroscope; the lamp being in alignment with a light sensitive cell 138 and a slot 140 in the casing of the photocell 14. Thus, since the skirt 129 is held stationary by the gyroscopic component of the gyro compass 12, as the vehicle in which the gyro compass is carried changes direction, the path of light from the lamp 34 through the slot 140 to the light sensitive cell 138 will be interrupted by the opaque portions 132 once during each angular unit of turning as established by the width of the alternatively transparent and opaque portions of 130 and 132.

Referring again to FIGURES 2 and 10 of the drawing, a counter 142 is arranged in the panel 21 to be actuated by a solenoid 142'. One side of the solenoid is connected to the positive terminal 66 by way of a lead 144, line 62 and line 64 while the other side thereof is connected by way of a lead 146 and the light detecting cell 138 to a line 148 leading to line 54 and the negative terminal 56. In this manner, each time light is passed from the lamp 134 through a transparent portion 130 of the skirt 128 to the light sensitive cell 138, the circuit to the solenoid 142 is closed and the counter 142 is actuated to register accumulative totals of unit direction changes made by the vehicle while traveling over the route.

The means for sensing unit changes in vehicle speed is similar to the arrangement of the gyro compass 12 described above. In this instance, however, the speedometer 16, having an indicator dial 149 of the conventional truncated cone variety driven by a cable 150, is also provided with a depending, generally cylindrical skirt 152 having alternately transparent and opaque portions 154 and 156 respectively. A lamp 158 is supported beneath the indicating dial 149 of the speedometer and behind the depending skirt 152 thereof in alignment with a slot 160 and a light sensitive cell 162 in the photocell 18. As with the gyrocompass, a counter 164 (FIG. 2) is presented from the face 22 of the panel 21 and adapted to be driven by a solenoid 164' illustrated in FIG. 10. Also, the solenoid 164' is connected on one side to the positive terminal 66 by lead 166, line 62, and line 64 while the other side thereof is connected to the negative terminal 56 through a lead 168, the light sensitive cell 162, line 148 and line 54. Thus, it will be seen that the counter 164 will be actuated to register unit changes in vehicle speed by interruption of the light path between the lamp 158 and cell 162 each time a unit change in speed is incurred as established by the width of the alternately transparent and opaque portions 154 and 156.

As shown in FIG. 2, the speedometer is provided with a conventional odometer drive shaft means 170 for driving a counter 172 displayed in the face 22 of the panel 21 for purposes of registering the accumulative total of unit distances traveled by the vehicle. Also, a counter 174

is provided to register the accumulative number of unit time intervals during which the vehicle is in motion. To actuate the counter 174 a solenoid 174', illustrated in FIG. 10, is connected on one side by a lead 176 to the negative terminal 56 by way of line 58, timing micro-switch 52 and line 54. The other side of the solenoid 174' is connected to the positive terminal 166 by way of a switch 178 and line 64. As shown in FIG. 9, the switch 178 is supported within a dielectric capsule 180 mounted on the photocell 18 and is formed having a rigid contact member 182 and a flexible or pivoted contact member 184 normally engaging the contact 182 and carrying an armature 186. A permanent magnet 183 is carried on the indicating dial 149 of the speedometer 16 so that each time the speedometer registers zero, or the vehicle is stopped, the magnet is positioned adjacent the armature 186 to draw the contact 184 out of engagement with the contact 182 thereby opening the switch. In this manner, the switch 178 will be held closed so long as the speedometer indicates the vehicle to be in motion and the solenoid 174' will trip the counter 174 once during each time the microswitch 52 is closed or once during each unit interval of time as established by the timer 20. On the other hand, when the vehicle is stopped, the magnet 183 will operate to open the switch 178 so that the timer switch 52 will have no effect on the solenoid 174'.

The manner in which the camera 30 is operated by solenoid 38 and the lamps 28 operated to illuminate the face 22 in which each of the aforementioned counters are presented may be understood by reference to FIGS. 2 and 10 of the drawings. As shown, one side of both the lamps 28 and the camera solenoid 38 is connected to the positive terminal 66 by way of a line 190 and line 64. The other side of the lamp 28 is connected to the negative terminal 56 by way of a relay switch 192, line 194 and line 54, while connection of the solenoid 38 to the negative terminal is by way of the relay switch 196 and a line 198. The switches 192 and 196 are adapted to be closed by solenoids 200 and 202 respectively which in turn are actuated upon the closing of switches 204 and 206 respectively. The switches 204 and 206 are illustrated in FIG. 2 of the drawings as microswitches having their actuating arms in contact with a hexagonal cam 208 mounted non-rotatably on the odometer drive shaft means 170. Preferably the switch 204 which brings about energization of the lamps 28 is advanced on the cam 208 so that the lamps are energized slightly before the switch 206 is closed to energize the camera solenoid 38. In this manner, it is assured that the lamps 128 will have reached peak illumination by the time the solenoid 38 operates to open the shutter of the camera 30. Moreover, because the cam 208 is driven by the odometer drive by the odometer drive shaft means the lamps 28 and the camera 30 will be operated periodically at predetermined unit distances of travel. If desired, the camera may be actuated during predetermined time, rather than distance, intervals by placing the solenoid 38 in a circuit with the timer switch 52. Also, the optic field of the camera could be split, as in my aforesaid patent application, to include with the counters a photograph of the route at time or distance intervals related to the totals registered on the counters. Or, if desired, an additional camera, so connected, may be employed separately to obtain a pictorial recording of the route and traffic at respective points of time or distance intervals. The separate camera is the better arrangement from the standpoint of obtaining a more complete view. By mounting this camera back of the rear seat of the car and attaching a larger rear view mirror to the back of the right front seat, it is possible to obtain both a front and rear view of the roadway or street. In this arrangement, the lower part of the split-level view shows the rear view as reflected through the mirror and the upper part shows the forward view.

For purposes of operating the lamps 28 and the camera solenoid 38 manually, the light and camera relays 200 and 202 are arranged in a circuit with a manually actuated rotary switch 210 having a conductive arcuate bar 212. The terminals of the switch 210, namely, 214, 216 and 218 are arranged to be engaged by the bar 212 in such a manner that the relay switch 192 is closed in advance of the relay switch 196 when the switch is rotated in the direction of the arrow thereby assuring peak illumination by the lamps 28 prior to actuation of the camera solenoid 38. Also, a control switch 220 is provided in series with the switch 210 to render it operative or inoperative as desired.

In use, having mounted the chassis 10 in an automobile or other suitable vehicle and having connected the various components to the steering wheel, accelerator pedal, etc., as described above, the vehicle is taken to the beginning of a route for which information as to traffic and/or driver behavior is desired and the various components placed into operation. The vehicle is then driven over the route and in the manner described above, the counters 86, 92, 112, 142, 164, 172 and 174 will be operated to register respectively, accumulative totals of the number of positive changes in vehicle speed as established by movements of the accelerator 68; the number of decelerations as established by depression of the vehicle brake pedal (not shown); the number of angular units through which the steering wheel 96 is rotated; the number of reversals of the steering wheel 96 or number of changes in vehicle direction as sensed by the microswitch 120; the number of angular units of vehicle direction change as established by the gyrocompass 12; the number of unit changes in vehicle speed as detected by the speedometer 16 and photocell 18; the number of unit distances traveled; and number of unit time intervals during which the vehicle is in motion. The numbers registered on these counters will, as described, be recorded intermittently by the camera 30 once during each predetermined distance of vehicle travel as established by the cam 208 and microswitches 204 and 206. In addition, each of the records produced by the camera 30 will include the numbers registered on the counters *a-r* which may be adapted in any desirable fashion to indicate the number of unit time intervals during which various events which might effect a traffic behavior when observed by a person operating the switchboard 40. To illustrate, the counter *a* and corresponding switch *a''* might be used to register the number of unit time intervals during which a car is approaching from the rear; the counter *b* and switch *b''* used to indicate the number of unit time intervals during which the vehicle is following another car or vehicles; the counter *c* and switch *c''* set up to register the number of unit time intervals during which pedestrians are impeding travel of the vehicle; and the remaining switches and counters *d* to *r* used similarly for other diverse events of this nature. Other criterion may be registered on the counters *a-r* as desired for each situation. For example, these counters may be used not only to register various traffic events of the type referred to but also various conditions of the road on which the vehicle travels such as, for example, unit intervals of time during which the vehicle is traveling on a road having curb and gutter, or such criterion as number of unit time intervals the vehicle is held up due to traffic signals or the like. In any event each time the operator observes such events he merely closes the corresponding one of the switches *a''-r''* so that the timer 20 will operate to register the unit time intervals on the appropriate counter. In this manner, a complete record of information will be produced on film not only as to movements of the vehicle control devices such as the steering wheel and accelerator and movements of the vehicle such as the changes in direction and the like but also the diverse events observed will appear in digital form.

Having the records before him the traffic engineer may

obtain various indices of traffic and/or driver behavior merely by transplanting the numbers on the records into various formulae. While all the possible indices of traffic behavior and actual manners in which the records produced by the present invention are not yet known, the following example will serve to illustrate the manner in which the present invention may be applied.

Assuming that an index relative to the desirability or undesirability of driving is wanted, it is reasoned that the higher the average speed, the greater satisfaction to the driver or desirability of driving and the greater the change of speed and direction, the lesser the satisfaction to the driver or desirability of driving. Thus, the following empirical formula was derived:

$$Q = \frac{S_a}{(1 + \Delta_s)(1 + \Delta\theta)}$$

wherein Q equals index of quality of driving or traffic flow,  $S_a$  equals average speed,  $\Delta_s$  equals change of speed per mile and  $\Delta\theta$  equals change of direction per mile preferably in dimensionless radians. To achieve the functions of this formula from the record produced by the present invention, it will be noted that  $S_a$  may be arrived at merely by dividing the reading on the counter or odometer 172 by the time lapse indicated on the watch 24 whereas  $\Delta_s$  and  $\Delta\theta$  may be taken directly from the counters 164 and 142 respectively. Also, it will be noted that if it is desired to use running time rather than total time, the running time in seconds may be read directly on counter 174.

While the foregoing illustrates only one manner in which the records of the present invention may be used to provide an index of traffic behavior, it will be appreciated that many other indices are possible because substantially all of the functions of traffic behavior are recorded directly in digital form. For example, from the counts of traffic and highway events, the following events density index E may be written:

$$E = \frac{S \times P}{D}$$

wherein S equals average speed, P equals average number of events in the perceptual space field and D equals the depth of the perceptual field. The depth of the perceptual field must be estimated. This is not difficult since it has been found to vary directly as the speed, being about 500 feet at 20 m.p.h. and 1800 at 60 m.p.h. The events index is a measure of the relative time a driver has to react to the changing traffic and highway situations. This is a very important concept and measure to be used in the problem of driving simulation. Also, if desired, the camera 30 may be arranged to photograph a split image as described in my co-pending application Ser. No. 114,830 to provide, in addition to the digital functions aforementioned, an image of route during each distance interval. Or, as noted above, a separate camera may be employed to obtain both a rear and forward view of the route.

In addition, the present invention has application to the field of driver training. In this respect, the numbers registered on the counters would be invaluable from the standpoint of grading or rating the performance of a driver over a given route. For example, the numbers registered on the counters 86, 92, 112 and 124 and perhaps additional counters to register different degrees of sensitivity, would have a direct correlation to the manner in which the student driver exercised control over the vehicle. Also, the numbers registered on the counters 142 and 164 can be used to indicate the ability of the driver to conform the speed and direction of motion of his vehicle to the changing traffic and highway events-environment. The traffic and highway events-environment would be recorded on counters a-r through the

switch panel 40 by an instructor riding in the vehicle to register various observations made by the instructor in terms of duration in unit time totals of the observed events.

Thus, it becomes apparent that the above mentioned objects are completely fulfilled by the described embodiment of this invention, and since many possible changes may be made in this invention, it is to be understood that the foregoing description is illustrative only and not limiting. Accordingly, the true spirit and scope of this invention is to be determined by the appended claims.

I claim:

1. A method of recording, simultaneously, driver actions, vehicle motions and the environmental traffic and highway events comprising the steps of:

traveling a route along which information relative to traffic behavior is desired;  
registering the accumulative total of unit changes in direction and speed of travel;  
registering the respective accumulative totals of direction and speed control reversals;  
registering the accumulative total of time units of travel progress;  
timing the duration of travel over the route;  
measuring the distance of travel; and  
periodically recording said registered totals.

2. The method recited in claim 1 including further the steps of:

registering the accumulative total of unit time intervals during which events having and affect on traffic behaviors are incurred.

3. Apparatus adapted for use in a vehicle to record traffic and/or driver behavior by traveling a route with the vehicle, said apparatus comprising:

means for sensing unit changes in vehicle direction and speed;

means for measuring unit time duration of vehicle movement during travel over the route;

switch means selectively operable to a condition during the occurrence of diverse events affecting traffic behavior;

means responsive to said condition for measuring unit time duration of said diverse events;

a plurality of counters operable in response to said means respectively to register accumulative totals of unit changes in vehicle direction and speed, unit time intervals of vehicle movement and duration of said diverse events; and

means for periodically recording the totals registered on said counters.

4. Apparatus adapted for use in a vehicle to record traffic behavior by traveling a route with the vehicle, said apparatus comprising:

a chassis;

a panel supported on said chassis, said panel having an exposed face;

a plurality of counters carried on said panel and presented from the exposed face thereof;

a speedometer mounted on said chassis, said speedometer including:

odometer drive shaft means operatively connected to a first of said counters, and

detection means for sensing unit changes in vehicle speed, said detection means being operatively connected to a second of said counters;

direction sensitive means mounted on said chassis for detecting unit changes in vehicle direction of travel, said direction sensitive means being operatively connected to a third of said counters;

means operatively connected to a fourth of said counters for registering the number of reversals of vehicle directional control means;

means operatively connected to a fifth of said counters for registering the number of reversals of vehicle speed control means;

an electric circuit for operating at least the remaining of said counters;  
 timing means operative to open and close said circuit during each unit interval of time;  
 switch means for connecting each of said remaining counters with said circuit, at least one of said switch means being operated by said speedometer to be closed when the vehicle is moving and open when the vehicle is stopped to register on a corresponding one of said remaining counters the accumulative time units of vehicle movement; and  
 recording means on said chassis for providing a record of the totals registered on said counters.

5. Apparatus adapted for use in a vehicle to record traffic behavior by traveling a route with the vehicle, said apparatus comprising:  
 a panel having an exposed face;  
 a plurality of counters carried on said panel and presented from the exposed face thereof;  
 a speedometer including:  
   odometer drive shaft means operatively connected to a first of said counters, and  
   detection means for sensing unit changes in vehicle speed, said detection means being operatively connected to a second of said counters;  
 direction sensitive means for detecting unit changes in vehicle direction of travel, said direction sensitive means being operatively connected to a third of said counters;  
 means operatively connected to a fourth of said counters for registering the number of reversals of vehicle directional control means;  
 means operatively connected to a fifth of said counters for registering the number of reversals of vehicle speed control means;  
 an electric circuit for operating at least the remaining of said counters;  
 timing means operative to open and close said circuit during each unit interval of time;  
 switch means for connecting each of said remaining counters with said circuit, at least one of said switch means being operated by said speedometer to be closed when the vehicle is moving and open when the vehicle is stopped to register on a corresponding one of said remaining counters the accumulative time units of vehicle movement;  
 and recording means for providing a record of the totals registered on said counters.

6. The apparatus recited in claim 5 wherein said recording means includes:  
 a photographic camera;  
 and means for periodically actuating said camera at predetermined distance intervals of vehicle travel.

7. A recording apparatus for a vehicle equipped with steering and speed control devices, said apparatus comprising:  
 means for sensing movements of the vehicle control devices;  
 first counter means for registering accumulative totals of diverse movements of the control devices sensed by said movement sensing means;  
 a directional responsive means for sensing changes in direction of vehicle travel;  
 second counter means actuated in response to said directional responsive means for registering cumulative totals of vehicle direction changes;  
 speed responsive means for sensing changes of vehicle speed;  
 third counter means actuated in response to said speed responsive means in register cumulative totals of vehicle speed changes;  
 means for registering cumulative totals of time units during which the vehicle is subject to diverse operating conditions, said last mentioned means including:  
 manual control means,

a timing device, and  
 fourth counter means periodically actuated by said manual control means and said timing device;  
 fifth counter means connected to said timing device for registering the accumulative total of time intervals sensed by said timing device;  
 means connected to said speed responsive means for de-energizing said fifth counter means when vehicle is stopped,  
 a panel for supporting said counter means; and  
 means for simultaneously reading said counter means to produce a record of the items registered thereon.

8. In a vehicle having a steering wheel, brake applying means and a speed controlling device, apparatus to indicate driver behavior during travel of the vehicle, said apparatus comprising:  
 means connected to the steering wheel for sensing steering wheel movement and for producing a signal corresponding to each steering wheel reversal;  
 a counter display panel adapted to be mounted in the vehicle;  
 a first counter on said panel and connected to said steering wheel movement sensing means to register the accumulative total of steering wheel reversals;  
 means for producing a signal once during each unit time interval of vehicle travel; and  
 a second counter on said panel and connected to said last-mentioned means for registering the accumulative total of unit time intervals of vehicle travel, whereby a continuous reading is displayed on said panel of steering wheel reversals per unit time of travel.

9. The apparatus recited in claim 8 including further:  
 a speedometer to be connected to the vehicle to provide a signal corresponding to vehicle speed; and  
 means connected to said speedometer for de-energizing said second counter when said speedometer indicates the vehicle to be stopped.

10. The apparatus recited in claim 9 including further:  
 means for sensing each brake application and each reverse movement of said speed controlling device; and  
 third and fourth counters on said panel for registering the cumulative totals of brake applications and speed controlling device movements as determined by said sensing means.

11. A method of recording driver behavior during travel of a vehicle having a steering wheel, brake applying means and an accelerator comprising the steps of:  
 registering the accumulative total of steering wheel movements, brake applications and accelerator movements;  
 registering the accumulative total of unit time intervals of vehicle travel; and  
 displaying said registered totals in digital form to provide an indication of driver actions relative to time of travel.

12. The method recited in claim 11 including further the step of:  
 registering the accumulative total of vehicular speed change increments.

13. In an automotive vehicle having a steering control element, apparatus for recording the behavior of a driver operating the vehicle to travel a route, said apparatus comprising:  
 a pulse generator actuated by steering control element reversals including those reversals that have an insignificant effect on vehicle steering movements and irrespective to the steering control element position at which the reversals occur;  
 timing means operative only during vehicle travel; and  
 output means connected to said timing means and said

**13**

pulse generator, said output means being operative to provide an indication from which the number of steering control element reversals per unit time duration of vehicle travel can be determined.

14. The apparatus recited in claim 13 in which said output means comprises: 5

a counter connected to said pulse generator to register the accumulative total of steering element reversals; and

a further counter connector to said timer to register the accumulative total of unit time intervals of vehicle travel. 10

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DARYL W. COOK, *Acting Primary Examiner.*

JOHN F. MILLER, MAYNARD R. WILBUR, G. J. MAIER, *Assistant Examiners.*