United States Patent [19]

Burke et al.

[11] **Patent Number: 4,710,888**

[45] **Date of Patent: Dec. 1, 1987**

[54] **ELECTRONIC ODOMETER**

[75] Inventors: **Michael J. Burke**, Detroit; **Richard A. Pidsosny**, Canton; **Gerald J. Lehner**, Westland, all of Mich.

[73] Assignee: **Ford Motor Company**, Dearborn, Mich.

[21] Appl. No.: **656,626**

[22] Filed: **Oct. 1, 1984**

[51] **Int. Cl.**[4] **G06F 15/20**

[52] **U.S. Cl.** .... **364/561;** 235/95 R; 324/171; 377/24

[58] **Field of Search** .... 73/490, 491, 506; 324/166, 171; 364/561, 565, 449; 235/95 R; 377/24

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,801,005	4/1974	Pniewski	235/131 R X
3,886,515	5/1975	Cottin et al.	364/449 X
4,158,172	6/1979	Boyer et al.	324/166
4,234,926	11/1980	Wallace et al.	364/138 X
4,236,215	11/1980	Callahan et al.	324/166 X
4,267,569	5/1981	Baumann et al.	364/424 X
4,271,402	6/1981	Kastura et al.	364/424 X
4,284,882	8/1981	Woodward	235/139 R X
4,287,504	9/1981	Simon et al.	340/521 X
4,317,106	2/1981	Hüber	364/561 X
4,409,663	10/1983	Becker et al.	364/561
4,539,641	9/1985	Kawashimo et al.	364/561 X
4,630,293	12/1986	Dubuisson et al.	377/24
4,642,787	2/1987	McCarthy et al.	364/561

OTHER PUBLICATIONS

"7033 336 BIT (21×16) Word Alterable ROM" Spec. Sheets by NCR.

"NC7033 MNOS EAROM 21×16 (336 BIT)" Spec. Sheets by Nitron, Inc.

Primary Examiner—Errol A. Krass

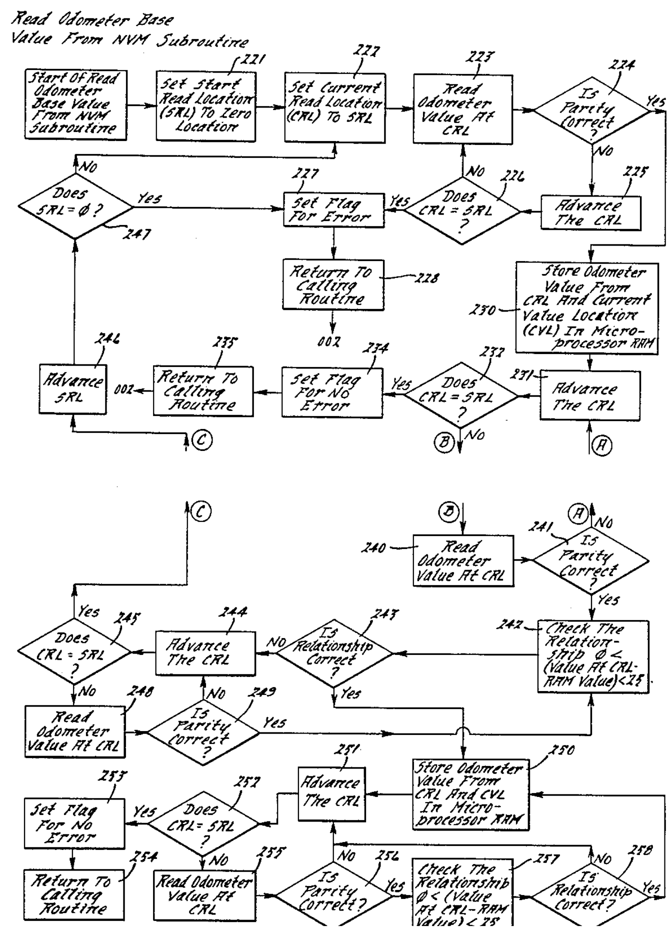
Assistant Examiner—Joseph L. Dixon

Attorney, Agent, or Firm—Paul K. Godwin, Jr.; Clifford L. Sadler

[57] **ABSTRACT**

A system for measuring distance traveled by a vehicle periodically updates the accumulated measurements, displays the updated measurements and electronically stores corresponding accumulations of updated distance data in a non-volatile memory device. The system employs a method of reading through the sequentially ordered storage locations of the non-volatile memory to determine the most recently stored correct data value as a value to be both displayed and used as a base value for subsequent measured distance accumulation.

18 Claims, 6 Drawing Figures



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4,539,641	9/1985	Kawashimo et al.	364/561 X
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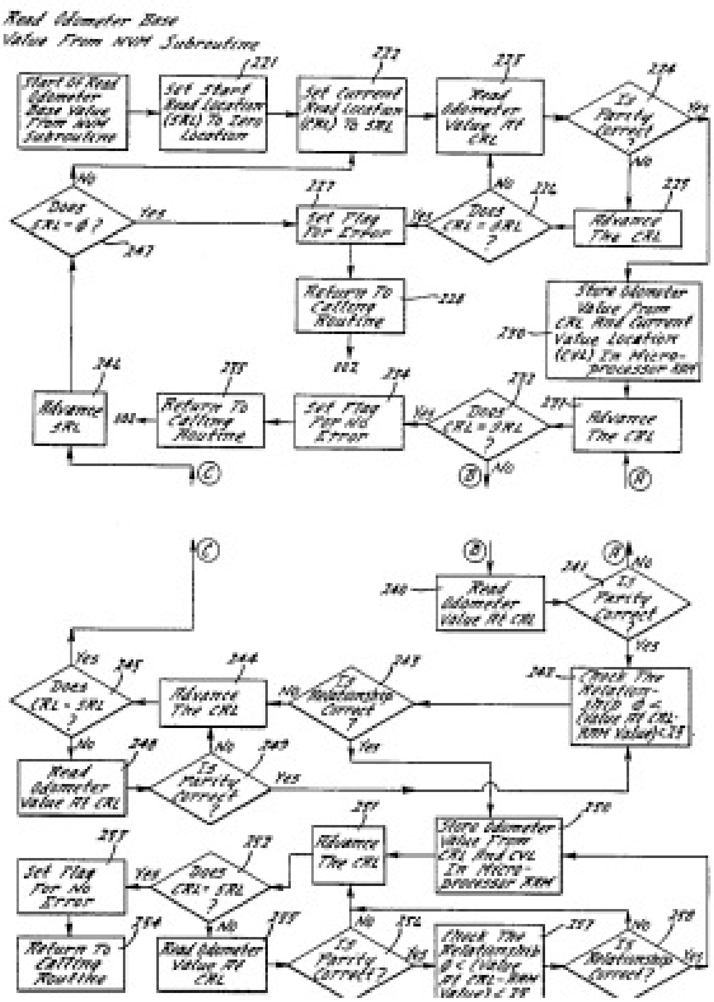
A system for measuring distance traveled by a vehicle periodically updates the accumulated measurements, displays the updated measurements and electronically stores corresponding accumulations of updated distance data in a non-volatile memory device. The system employs a method of reading through the sequentially ordered storage locations of the non-volatile memory to determine the most recently stored correct data value as a value to be both displayed and used as a base value for subsequent measured distance accumulation.

18 Claims, 6 Drawing Figures



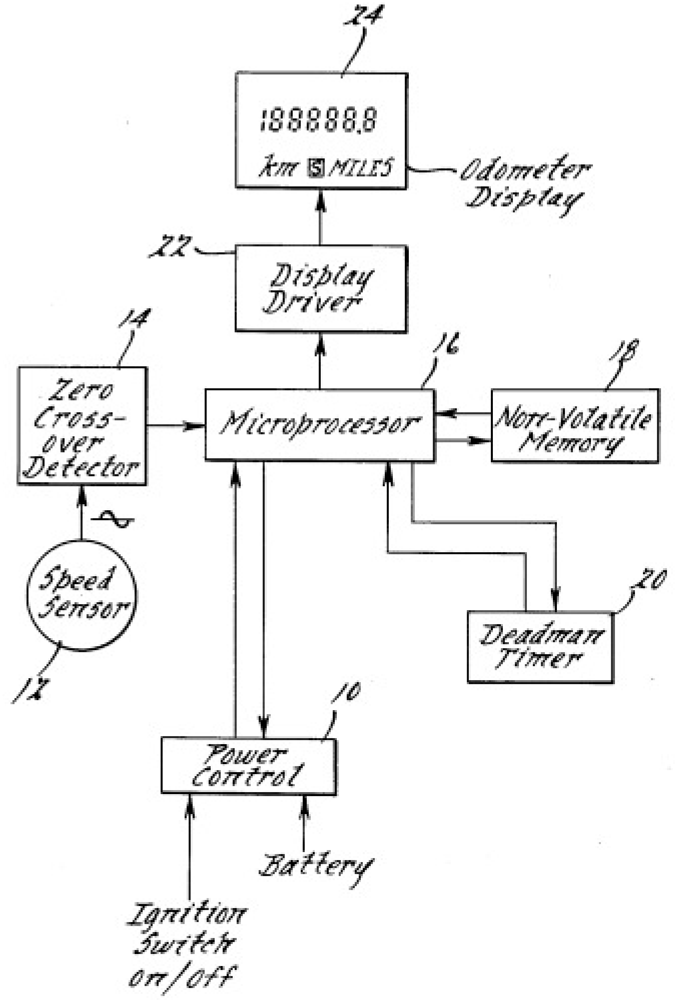

24
188888.8
km S MILES
Odometer Display
22
Display Driver
14
Zero Cross-over Detector
16
Microprocessor
18
Non-Volatile Memory
Speed Sensor
12
20
Deadman Timer
10
Power Control
Battery
Ignition Switch on/off

FIG. 1.

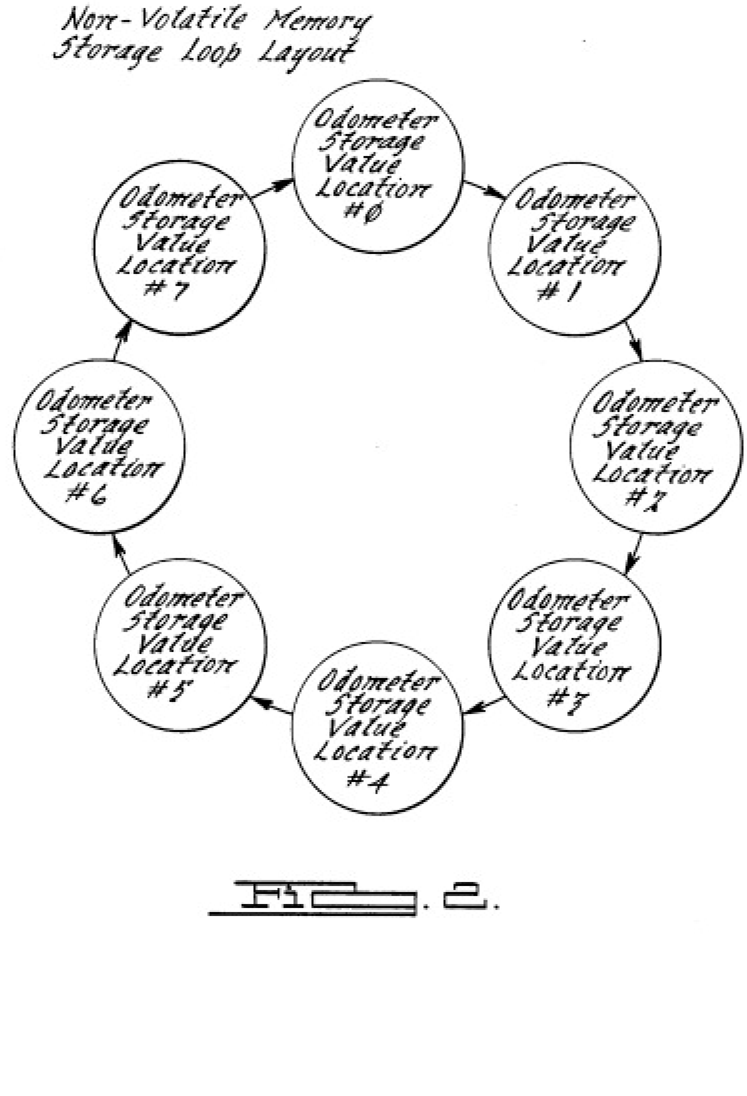
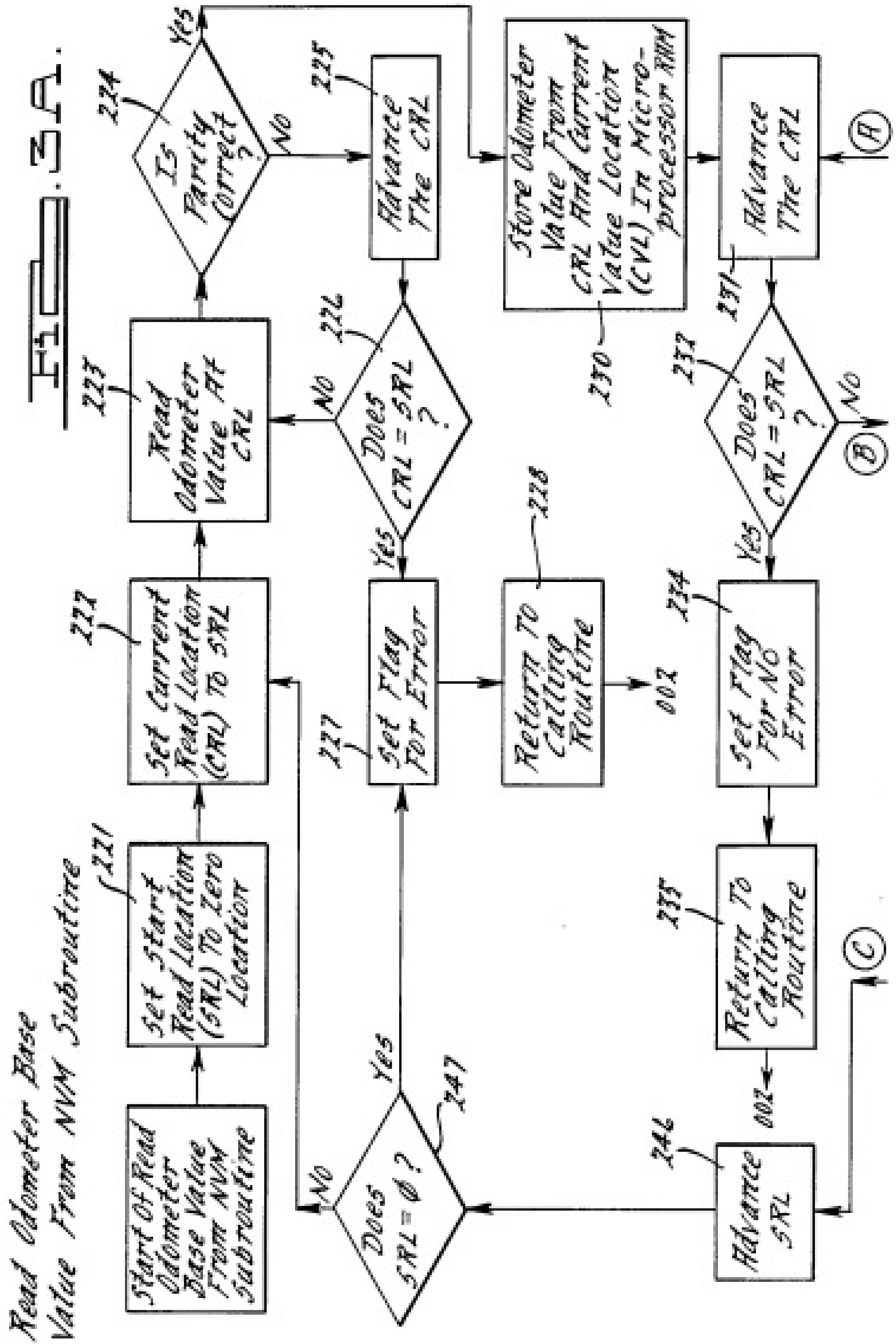
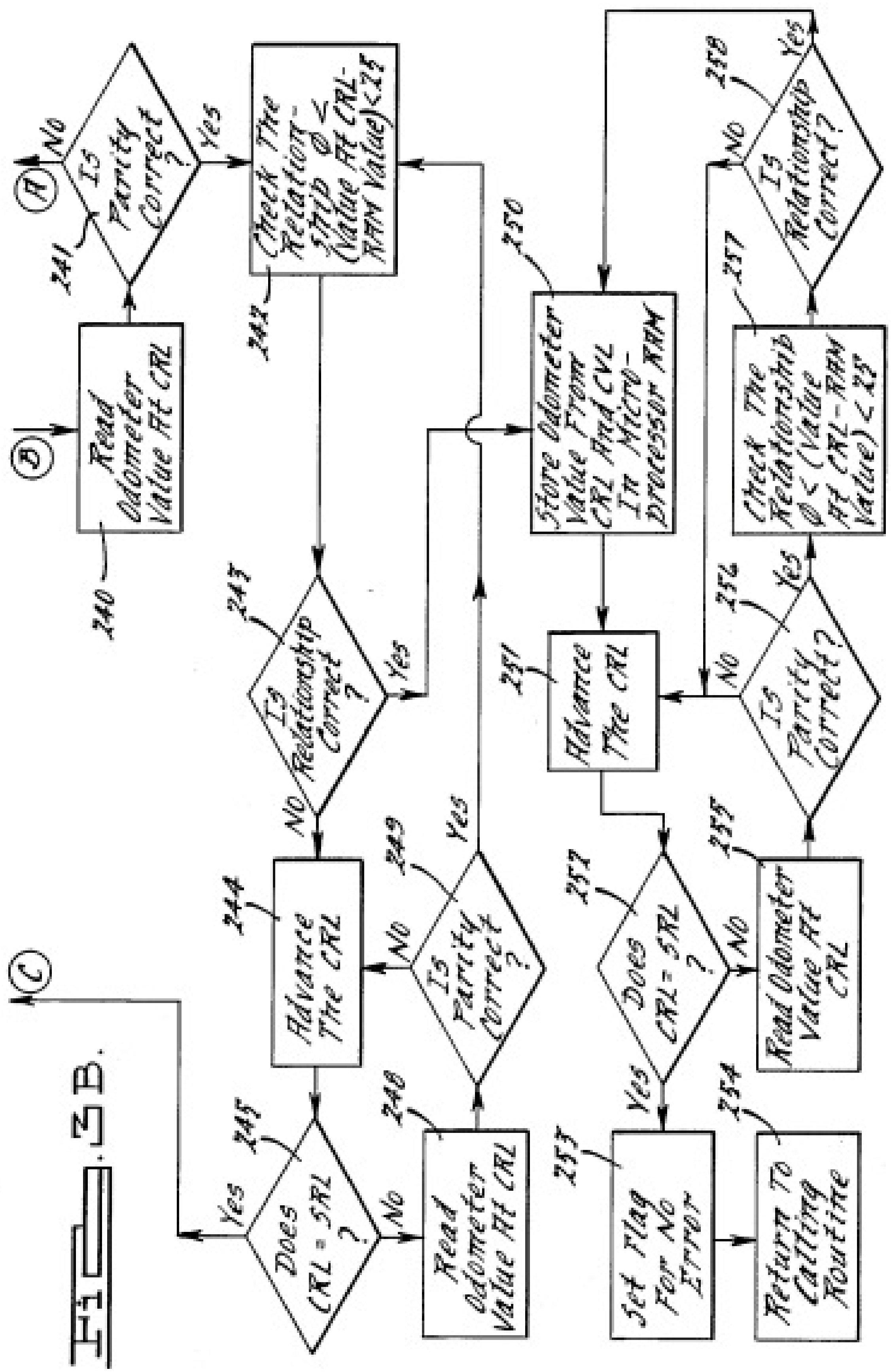

Non-Volatile Memory
Storage Loop Layout
Odometer Storage Value Location #0
Odometer Storage Value Location #1
Odometer Storage Value Location #2
Odometer Storage Value Location #3
Odometer Storage Value Location #4
Odometer Storage Value Location #5
Odometer Storage Value Location #6
Odometer Storage Value Location #7

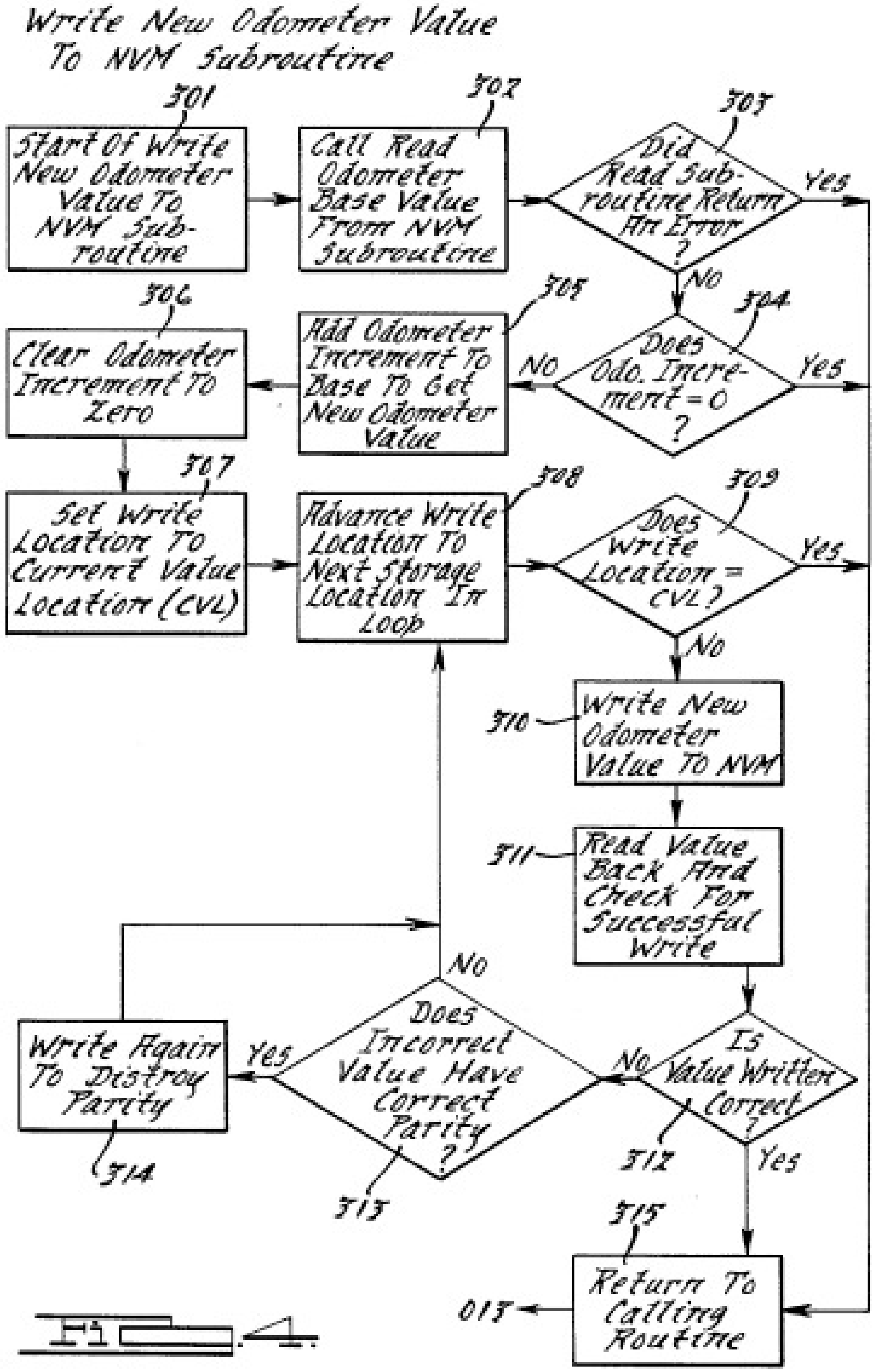
FIG. 2.


Read Odometer Base Value From NVM Subroutine
Start Of Read Odometer Base Value From NVM Subroutine
221
Set Start Read Location (SRL) To Zero Location
222
Set Current Read Location (CRL) To SRL
223
Read Odometer Value At CRL
224
Is Parity Correct ?
Yes
No
225
Advance The CRL
226
Does CRL = SRL ?
No
Yes
227
Set Flag For Error
228
Return To Calling Routine
002
230
Store Odometer Value From CRL And Current Value Location (CVL) In Microprocessor RAM
231
Advance The CRL
A
232
Does CRL = SRL ?
No
B
Yes
234
Set Flag For NO Error
235
Return To Calling Routine
002
246
Advance SRL
C
247
Does SRL = Ø ?
Yes
No
FIG. 3A.



B
240
Read Odometer Value At CRL
241
Is Parity Correct?
No
A
Yes
242
Check The Relationship Ø < (Value At CRL-RAM Value) < 25
243
Is Relationship Correct?
Yes
No
244
Advance The CRL
245
Does CRL = SRL ?
Yes
C
No
246
Read Odometer Value At CRL
249
Is Parity Correct?
No
Yes
250
Store Odometer Value From CRL And CVL In Micro-processor RAM
251
Advance The CRL
252
Does CRL = SRL ?
Yes
No
253
Set Flag For No Error
254
Return To Calling Routine
255
Read Odometer Value At CRL
256
Is Parity Correct?
No
Yes
257
Check The Relationship Ø < (Value At CRL-RAM Value) < 25
258
Is Relationship Correct?
No
Yes

FIG. 3B.



Write New Odometer Value To NVM Subroutine
301
Start Of Write New Odometer Value To NVM Subroutine
302
Call Read Odometer Base Value From NVM Subroutine
303
Did Read Subroutine Return An Error ?
Yes
No
304
Does Odo. Increment = 0 ?
Yes
No
305
Add Odometer Increment To Base To Get New Odometer Value
306
Clear Odometer Increment To Zero
307
Set Write Location To Current Value Location (CVL)
308
Advance Write Location To Next Storage Location In Loop
309
Does Write Location = CVL ?
Yes
No
310
Write New Odometer Value To NVM
311
Read Value Back And Check For Successful Write
312
Is Value Written Correct ?
No
Yes
313
Does Incorrect Value Have Correct Parity ?
No
Yes
314
Write Again To Distroy Parity
315
Return To Calling Routine
013

FIG. 4.

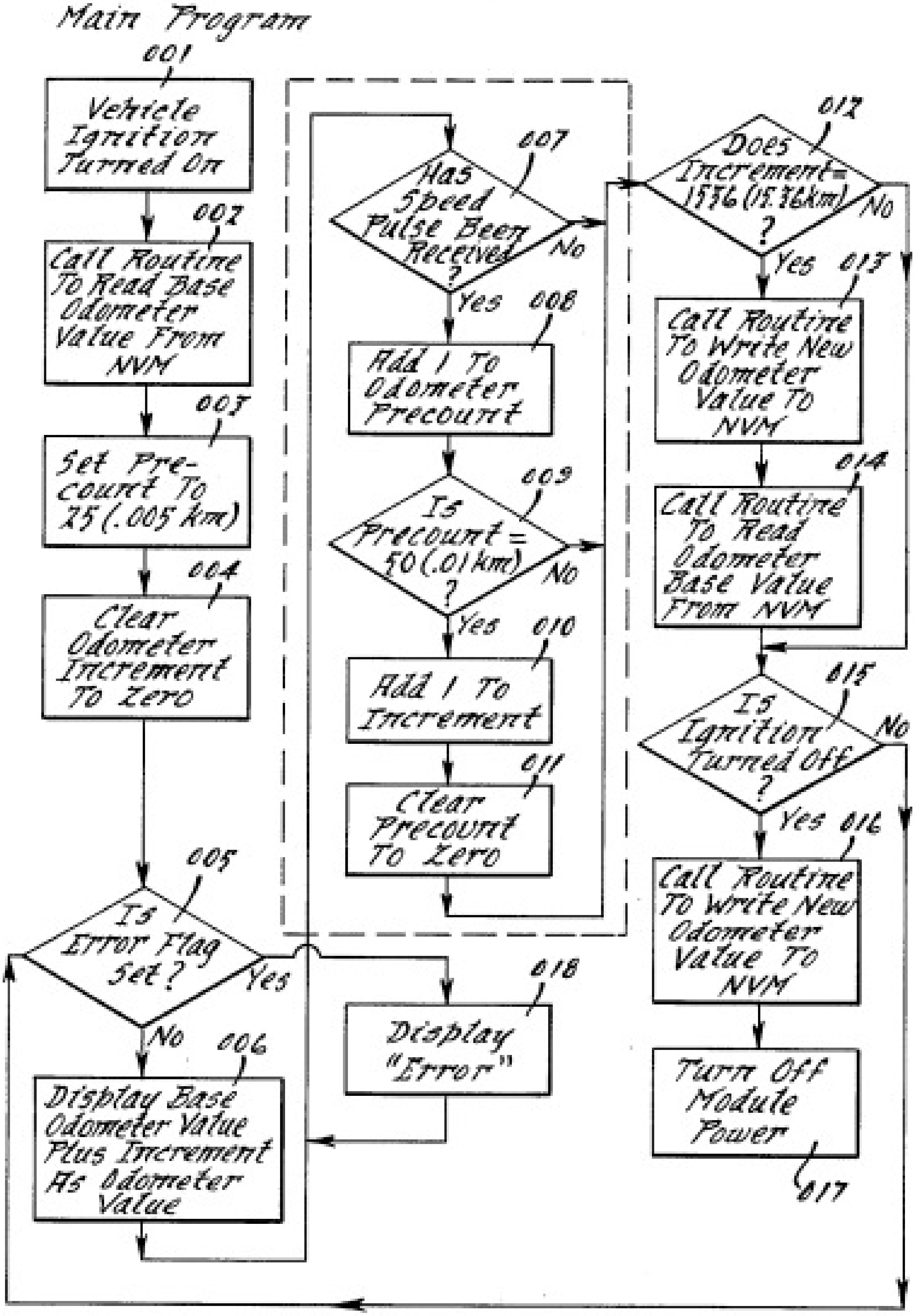

Main Program
001
Vehicle Ignition Turned On
002
Call Routine To Read Base Odometer Value From NVM
003
Set Pre-count To 25 (.005 km)
004
Clear Odometer Increment To Zero
005
Is Error Flag Set?
Yes
No
006
Display Base Odometer Value Plus Increment As Odometer Value
018
Display "Error"
007
Has Speed Pulse Been Received ?
No
Yes
008
Add 1 To Odometer Precount
009
Is Precount = 50 (.01 km) ?
No
Yes
010
Add 1 To Increment
011
Clear Precount To Zero
012
Does Increment = 1536 (15.36 km) ?
No
Yes
013
Call Routine To Write New Odometer Value To NVM
014
Call Routine To Read Odometer Base Value From NVM
015
Is Ignition Turned Off ?
No
Yes
016
Call Routine To Write New Odometer Value To NVM
Turn Off Module Power
017

FIG. 5.

ELECTRONIC ODOMETER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is directed to the field of electronic storage of data and more particularly to that field applied to the area of measuring and storing data reflecting the distance traveled by a vehicle over its life.

2. Description of the Prior Art

Conventional odometers, as used in motor vehicles, have consistently employed mechanical accumulators such as are disclosed in U.S. Pat. Nos. 3,801,005 and 4,284,882. In each of those odometers, a gearing mechanism provides a scaled relationship between the linear distance traveled by a rotating vehicle wheel and the viewable number wheels. The odometer gear train is connected to drive a plurality of number wheels that are interrelated to count and permanently record the number of units (miles or kilometers) of distance traveled by the vehicle.

In more recent years, the trend has been to provide electronically activated digital readouts of critical information in a vehicle in the form of vacuum fluorescent or liquid crystal display systems. A digital speedometer is disclosed in U.S. Pat. No. 4,158,172 in which a pulse generator is employed to provide a known number of pulses per unit of distance traveled by the vehicle. Associated circuitry analyzes the rate at which the pulses are produced and provides appropriate signals to a vacuum flourescent display to provide a visible digital indication of the speed of the vehicle. Continuous sampling allows for the speedometer to update the display when a new speed value is detected and measured over a plurality of consecutive measurements.

In U.S. Pat. No. 4,317,106 an electronic device is indicated in which a similar speed sensing device is employed for measuring the wheel rotational speed of a vehicle and providing information which can be displayed in terms of distance that the vehicle has traveled since the system was reset. However, such a device is only intended as an auxiliary distance measuring device and would not be suitable for use as an odometer that permanently stores the accumulated distance the vehicle has traveled over its life, since there is no facility for permanently storing the distance values as they are accumulated.

SUMMARY OF THE INVENTION

The present invention utilizes a unique configuration to achieve the desired condition of providing the permanent storage of accumulated distance measurements, while providing the desirable display features associated with conventional electronic mileage measuring devices.

A non-volatile memory device is used which has the ability of storing charge in addressable bit cell locations that are arranged in a repeatable sequential loop. A microprocessor is at the heart of the system and functions to read a speed sensor input, provide frequent updates of distance increments to a digital display and provide less frequent updates to the non-volatile memory device at periodic accumulations of distance increments. In addition, a power control circuit is associated with the microprocessor which provides power to the microprocessor when the vehicle ignition is switched from on to off. In this manner, the microprocessor is allowed time to update the non-volatile memory with any accumulated measurement values since the last update.

In order to obtain the correct value from the non-volatile memory that indicates the accumulated distance traveled by the vehicle each time the vehicle is turned on, the microprocessor is programmed so as to read the data values contained in each of the storage locations of the non-volatile memory. Each read value is assessed to first determine if the read value has correct parity and to secondly determine the quantity relationship of the read value to other values read from other locations in the non-volatile memory. Once the correct value is read from the non-volatile memory and meets all the criteria, it is used as a base value for subsequent adding of measured distance increments and display of the accumulated odometer value. In the present invention, the display of the base odometer value is incremented for each predetermined portion of a unit ("0.1" kilometer or "0.1" mile) after the distance sensor has provided a sufficient number of pulses to indicate the increment has been measured.

In order to preserve the life of the nonvolatile memory, the number of the erase/write cycles has been minimized by providing updates to the non-volatile memory that correspond to increases of 15.36 km (approximately 10 miles) through a write method which will be described in detail later. The write method is structured so as to avoid erasing the value of data stored in the non-volatile memory location corresponding to that location from which the base value was read. In addition, the write method provides for error checking whereby each new odometer value written to the non-volatile memory is read and compared with that which was written into that storage location. In the event the comparison indicates an inequality, and the associated parity value indicates an equality, the method attempts to write an erroneous value and an erroneous parity into that location so that it will not be mistakenly read as valid value during the read method.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram illustrating the relationship of the various elements employed in the present invention.

FIG. 2 is a conceptional diagram illustrating the storage location loop of the non-volatile memory employed in the present invention.

FIGS. 3*a* and 3*b* together form a flow diagram illustrating the sub-routine used to read the odometer base value from the non-volatile memory (NVM) in the present invention.

FIG. 4 is a flow diagram illustrating the subroutine used to write each new odometer value to the NVM in the present invention.

FIG. 5 is a flow diagram illustrating the main program as utilized in the microprocessor of the present invention.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

The electronic odometer of the present invention is illustrated in FIG. 1 as including a speed sensor 12 which is implemented as a conventional transmission mounted variable reluctance sensor that produces a sine wave calibrated to be approximately 8,000 cycles per mile (1.6 km). This is equivalent to approximately one cycle for every eight inches (20.3 cm) of vehicle travel.

The sine wave output from the speed sensor **12** is connected to a zero crossover detector **14** which converts the sine wave to a square wave of approximately 16,000 cycles per mile (1.6 km). A microprocessor **16** is programmed to provide output data to a display driver **22** that formats the data to activate specific elements of an odometer display **24**. The odometer display **24** includes six 7-segmented digits and one 2-segmented digit to provide a display of accumulated distance up to 199999.9 units (kilometers or miles). The odometer display **24** also includes indicia to reflect the measurement units being displayed. A service symbol of an "S" surrounded by a rectangle is also provided to indicate a substitution of the non-volatile memory element **18** for that which accompanied the vehicle from the manufacturer.

The non-volatile memory (NVM) element employed in the described preferred embodiment is a metal-nitride oxide semiconductor (MNOS) designated as an NC7033 EAROM by its manufacturer—NCR Corporation. Data retention is defined as the time data will remain valid in the NVM between erase/write cycles. It has been found that the data retention is inversely related to the number of erase/write cycles performed and that an excessive number of such cycles will overstress the nitride layer and diminish this particular NVM's ability to retain data.

Data retention is typically 8 to 12 years when erase/write cycles are less than 5,000. With less than 12,000 erase/write cycles, the retention is typcially 4 to 6 years. Data retention is not predictable when erase/write cycles exceed 10,000.

Given the considerations of the particular NVM used in the preferred embodiment, the present invention is constructed to minimize the number of erase/write cycles over the life of the vehicle in order to maximize the data retention. This also insures that even with failure of some other component in the electronic odometer, the measured distance between erase/ write cycles will not be so excessive as to lose a significant measurement of distance.

The microprocessor **16** is implemented in the preferred embodiment in the form of an MC6805/R2 available from Motorola, Inc. The microprocessor **16** is programmed to process the input signals from the zero crossover detector **14**, to compute the accumulated measurement values for the odometer display and provide measurement updates to the non-volatile memory at predetermined increments. The microprocessor **16** is also programmed to utilize the non-volatile memory **18** as a backup device with respect to its internal random access memory (RAM).

A deadman timer **20** is utilized to reset the microprocessor **16** in the event a long period of time elapses between microprocessor functions that indicate erroneous operation of the microprocessor. The function of the deadmean timer **20** is conventionally included to provide a reset to all the microprocessor functions and allow it to restart its operations.

The display driver **22** functions to receive the output data signals of the microprocessor and to energize the appropriate display segments in the odometer display **24**. The display driver **22** acts as a decoder and in the preferred embodiment is implemented as a 4-bit microprocessor designated as HMCS43 by Hitachi, Ltd.

The addressing sequence for the eight 32-bit storage locations in the non-volatile memory (NVM) **18** is shown in FIG. **2**. The layout indicates that the individually addressable locations #0–#7 are sequential and form a loop whereby location #0 follows location #7. The purpose of the loop arrangement is to mimimize the number of erase/write cycles to any particular location in the NVM and thus maximize the length of data retention. Therefore, a multiple number of odometer values will be stored in the NVM at various locations. The read method has to determine which value is the appropriate one to be used as the base odometer value for display and subsequent accumulation of distance measurements.

The main program for the microprocessor **16** is illustrated in FIG. **5** and commences after the vehicle ignition is turned on at **001**. Immediately, the sub-routine method is called at **002** to read the base odometer value from the NVM.

FIGS. **3A** and **3B** illustrate the sub-routine called at **002** for reading the odometer base value from the non-volatile memory. In that sub-routine, a start read location (SRL) is set to the **0** location of the NVM in instruction **221**. A current read location (CRL) is set to match the start read location in instruction **222**. The odometer value at the current read location is read at **223** and its three parity bits of the 32 bit word are compared at **224** with the correct parity to determine if the odometer value read at the current read location has correct parity. If the parity is not correct, the current read location is advanced at **225** to the next storage location of the NVM. If the advanced current read location is not equal to the start read location when compared at **226**, the odometer value is then read at that advanced current read location at **223** and the parity is again compared at **224**. If no parity correct values are read from the NVM over the entire loop, an error flag is set at **227** when the current read location again equals the start read location at **226**. The sub-routine then returns to the main program at **228**.

On the other hand, when a value at a particular current read location is read at **223** and its parity at **224** is correct, that odometer value and the location of the current value (CVL) are stored at **230** in the microprocessor's internal RAM (temporary storage). The current read location is advanced at **231** and then compared at **232**. If the current read location as compared at **232** is not yet equal again to the start read location, at **240** (FIG. **3B**), the odometer's value is read at the current read location. If the parity is not correct at **241**, the current read location in the NVM is again advanced at **231** (FIG. **3A**), the current read location is compared at **232**, the value is read at **240** and the parity is compared at **241** until the current read location is again equal to the start read location or a second odometer value is read that has correct parity.

If the current read location is advanced to the start read location and so determined at **232**, the flag is set for "no error" at **234** and the sub-routine then returns to the main program at **235**.

If a second odometer value is read at **240** that has correct parity at **241**, its relationship to the odometer value stored in the microprocessor RAM is checked at **242**. The predetermined relationship must be such that the most recent odometer value read at the current read location minus the odometer value stored in the microprocessor RAM must be less than 25 miles (38 km) but greater than 0. In the present invention, the NVM is updated or written with new odometer values at accumulated increments of approximately 10 miles or whenever the ignition is switched off. Therefore, if a particular location in the NVM contains faulty data, the relationship established in the read sub-routine method allows for the system to obtain an odometer value that is still within an acceptable degree of accuracy.

In FIG. 3B, after the relationship is checked at **242**, a determination is made as to whether the relationship is correct or not at **243**. If the relationship is correct, (i.e., the second odometer value read at the current read location is not more than 25 miles greater than the previous value stored in the microprocessor RAM) the second odometer value and its location value are substituted at **250** into the microprocessor RAM for the value that was earlier stored. Until the current read location has been advanced to the start read location and verified at **252**, the steps of advancing at **251**, reading the value at **255** and parity checking at **256**, as well as checking the relationships of validly read odometer values at **257**, are repeated. If subsequent odometer values are read at **255** which have correct parity at **256** and acceptable relationships at **257/258** to the values stored in the microprocessor RAM, then each of those values are substituted for the one previously stored at **250**. When the current read location is advanced to the start read location at **252**, the error flag is set to "no error" at **253** and the read routine returns to the main program. At that time, the value stored in the microprocessor RAM corresponds to the correct base odometer value used for subsequent calculations and display.

It should be pointed out that if the second parity correct odometer value read at **240** is outside the relationship determination at **242/243** the read sub-routine, will cause the current read location to be advanced at **244** and the value read at each location until another parity correct value is read at **248/249**. The relationship of that parity correct value is then checked against the value stored in RAM at **242** to determine if the stored value should be replaced. However, in the event that only two parity correct odometer values are read from the NVM and the second value read is not within the predetermined relationship, the read sub-routine advances the start read location at **246** to the next location and again sequences through the steps described above from **222**. This is continued until the second read odometer value described above becomes the first value then stored in the microprocessor RAM and the first read odometer value described above becomes that which has its relationship compared with the value then stored in the microprocessor RAM. If at that time, the relationships are correct, the substituted value is accepted as the base odometer value and the read routine is returned to the main program at **235**. However, if even after the routine has been repeated until such time as the start read location is again read at **247** to be equal to its initial zero location and no correct relationship comparisons have been made, an error flag is set at **227** to indicate a malfunction. Otherwise an erroneous reading would be displayed by the odometer.

Referring again to FIG. **5**, after the base odometer value has been read from the NVM at **002**, a precount register is set to 25 counts (.005 km) at **003** and the odometer increment register is cleared to zero at **004**. If the error flag is not set at **005**, the base odometer value is displayed at **006** plus any increment value.

The precount register is initialized to .005 km to compensate for any loss of distance which may have occurred due to the dropping of the least significant data bits when values are written into the NVM subsequent to when the vehicle was previously turned off.

If the error flag is not set at **005**, the increment value is added to the base odometer value at **006** to obtain a summation value that is displayed as the odometer value.

Whenever a pulse is received from the crossover detector **14**, a single count is added to the odometer precount at **008**. When the precount register accumulates 50 counts (0.01 km) at **009** a single count is added to the increment register at **010**. The precount register is then cleared to zero at **011**. When the increment register accumulates 1536 counts (15.36) km (or approximately 10 miles) at **012** the routine is called at **013** which writes a new odometer value to the non-volatile memory.

The write routine shown in the flow diagram in FIG. **4** begins at **301** and **302** by calling up the read odometer base value from NVM sub-routine described above. If the read sub-routine did not return an error at **303** and the odometer increment register is not equal to 0 at **304**, the odometer increment is added to the base odometer value at **305** to get a new odometer value. The increment register is then cleared to zero at **306**. A write location is set at **307** to be equal to the current value location that is stored in the microprocessor RAM with the base odometer value. In order to make sure that the value stored in that location is not destroyed, the write location is advanced at **308** to the next storage location in the loop of the NVM. If the advanced write location does not equal the current value location at **309**, the new odometer value is then written at **310** into the NVM at that advanced write location by performing an erase/write cycle. The value written into the NVM is then read back at **311** and checked for accuracy. If the value is correct at **312** as written, the write routine returns back to the main program at **313**. In the event that the read back value is not correct at **312**, its parity is checked at **313** to determine if that portion corresponds. If the parity is correct but the value written is incorrect, an erase/write cycle at **314** is performed at that location in order to destroy the value present in that location and to write an erroneous parity. Following that sequence, the write location is advanced at **308** to the next storage location in the loop of the NVM and the series of steps **309-312** utilized to write the odometer value is again attempted. These attempts continue until the write location becomes equal to the current value location at **309**. At that point the write sub-routine returns to the main program at **315** and the read routine **014** is entered in order to update the microprocessor RAM with the odometer base value from the NVM. If the ignition switch is still on when checked at step **015**, the odometer base value read from the NVM at **014** is displayed at **006**.

When the vehicle ignition is turned off, power is maintained to the microprocessor **16** through the power control **10**. At such time, step **015** causes the write routine to be recalled at **016** and anything stored in the increment register is added to the base odometer value. The sum becomes the new odometer value that is written into the NVM. When the ignition is off and the write routine is completed, step **017** causes the power control **10** to extinguish power to the system. The bit size of the data stored in this NVM does not allow for storage of values that give a resolution greater than 0.1 km. Therefore, when the ignition is turned off, the precount accumulation is lost. Accordingly, the precount is set to 25 or an equivalent of 0.005 km when the vehicle ignition is turned back on to provide a compensation for what is deemed to be the average value that is lost over the life of the vehicle. It is expected that a random normal distribution for the loss of distance measurements at power down will cancel over the life of the vehicle.

It will be apparent that many modifications and variations may be implemented without departing from the scope of the novel concept of this invention. Therefore, it is intended by the appended claims to cover all such modifications and variations which fall within the true spirit and scope of the invention.

We claim:

1. A method of measuring, displaying and permanently recording the accumulated distance traveled by an automotive vehicle comprising:

providing a means for sensing the movement of said vehicle and providing an output signal indicative of predetermined portions of distance traveled;

monitoring said output signal from sensor means and accumulating data values corresponding to said portions of distance traveled until a predetermined increment of distance is sensed;

providing a memory means having a plurality of non-volatile and individually addressable locations each one of which is capable of storing data corresponding to a summation of all predetermined increments of distance traveled by said vehicle;

reading the most recently stored summation data stored in said NVM memory means as a base value;

accumulating each occurrence of said accumulated data values equaling said predetermined increment of distance until a predetermined number of increments is accumulated;

summing the data value corresponding to each occurrence of said accumulated data values equaling said increment and the base value read from said non-volatile memory means to derive a new value of accumulated distance traveled;

writing summation data to a location of said non-volatile memory means having an address that is different from that of the location containing the most recently stored summation data, when said summation data value exceeds the most recently written summation data value or said base value by a predetermined amount that is greater than said predetermined increment; and

providing a means for visually displaying the accumulated distance value; and

displaying the larger of said base value and said summation data value as the accumulated distance said vehicle has traveled.

2. A method as in claim 1, wherein said steps of accumulating, summing, reading and writing are performed by a microprocessor programmed to perform the recited functions with respect to said sensor means, said non-volatile memory means and said display means.

3. A method as in claim 2, wherein said addressable storage locations in said non-volatile memory means are arranged in a repeatable ordered sequence so that when the last location in a sequence is addressed, the next selectable location is the first location in that sequence.

4. A method as in claim 3, wherein said summing step is also performed whenever the vehicle is turned off.

5. A method as in claim 4, wherein said reading step provides an error signal to said display means, in the event it cannot determine the correct most recently stored summation data stored in said non-volatile memory means, to indicate a malfunction.

6. A method as in claim 5, wherein said step of reading addresses each storage location in said non-volatile memory means and compares each read data value having correct parity with previously read data values to determine the highest value, within a predetermined maximum difference, as the most recently stored summation data for said base value.

7. In an electronic odometer, a method of reading data from a non-volatile memory (NVM) device having data stored in one or more of a predetermined number of sequentially ordered storage locations including the following ordered steps of:

(a) selecting a storage location in said NVM as a starting read location;

(b) reading the data value present in the selected read location;

(c) comparing parity coded portions of the read data value with predetermined correct parity values to determine if said read data value is parity correct or not;

(d) advancing the reading location to the next sequential location in said NVM and repeating steps (b) and (c) only until the selected reading location is again equal to said starting reading location when said compared parity in step (c) is incorrect;

(e) providing a data error indication and ending said method when said compared parity in step (c) is incorrect and said reading location is again equal to said starting read location;

(f) temporarily storing the read data value in another memory device when the compared parity of step (c) is correct;

(g) advancing the selection of the reading location to the next sequential location in said NVM;

(h) providing said temporarily stored data value as a correct base odometer value and ending said method only when said selected read location is again equal to said starting read location;

(i) reading the data value present in the advanced read location;

(j) comparing the parity coded portions of the read data value with predetermined correct parity values to determine if said read data value is parity correct or not;

(k) repeating sequential steps of (g) through (j) when said compared parity in step (j) is incorrect;

(l) comparing the data value read in step (i) with the value temporarily stored in said other memory device when said compared parity in step (j) is correct to determine if said value read is within a predetermined relationship established with respect to the temporarily stored value;

(m) replacing the previously temporarily stored data in step (f) with the read data value compared in step (l) when that read data value is within the predetermined relationship established with respect to the previously temporarily stored value;

(n) repeating steps (g) through (m);

(o) repeating step (g) when the read data value compared in step (l) is without the predetermined relationship established with respect to the previously temporarily stored value;

(p) repeating steps (i) through (m) only until the selected read location is again equal to said starting read location;

(q) advancing the selection of the starting read location to the next sequential location in said NVM;

(r) repeat steps (b) through (q) only until the starting read location is again equal to the starting read location selected in step (a); and

(s) providing a data error indication and ending said method when said starting read location is again equal to the starting read location selected in step (a).

8. A method as in claim 7, wherein each step of temporarily storing a read data value includes the step of contemporaneously storing the corresponding selected read location for that value.

9. A method as in claim 8, incorporated in a method of writing new odometer data values to said NVM device including the following steps:

(a') reading the base odometer value and corresponding selected read location from the NVM device according to the steps recited in claim 8;

(b') ending said method if an error indication is present;

(c') selecting a storage location in said NVM as a write location equal to the selected read location read in step (a');

(d') advancing the selection of the storage location to the next sequential location in said NVM;

(e') adding a value of measured distance value data to said base odometer data value read from said NVM, wherein the sum of values is within the established predetermined relationship to derive a new base odometer value; and

(f') writing the new base odometer value data derived in step (e') to the advanced selected storage location in the NVM.

10. A method as in claim 9, wherein said writing step (f') is accompanied by the steps of:

adding predetermined parity data to said new base odometer value data and writing both to the advanced storage location selected in step (d').

11. A method as in claim 10, wherein said writing step (f') is followed by the steps of:

(g') reading the data stored in the storage location selected in step (d');

(h') comparing said value data read in step (g') with the new base odometer value data written in step (f') to determine equality or inequality and ending said method if they are equal;

(i') selecting the next storage location by advancing to the next sequential location of the NVM;

(j') repeating steps (f') through (j') only until the storage location is again equal to the storage location selected in step (c'); and

(k') ending said method when said storage location in step (i') is equal to the storage location selected in step (c').

12. A method as in claim 11, wherein said comparing step (h') additionally includes the subsequent step of comparing the read parity data, when the preceding comparison results in an inequality, to determine parity equality or inequality and is followed by the step of writing an incorrect data value with incorrect parity data to the selected storage location of the NVM prior to step (i').

13. A method of reading data from a non-volatile memory (NVM) device having data stored in one or more of a predetermined number of sequentially ordered storage locations including the following ordered steps of:

(a) selecting a storage location in said NVM as a starting read location;

(b) reading the data value present in the selected read location;

(c) comparing parity coded portions of the read data value with predetermined correct parity values and determining if said read data value is parity correct or not;

(d) advancing the reading location to the next sequential location in said NVM and repeating steps (b) and (c) only until the selected reading location is again equal to said starting reading location when said compared parity in step (c) is incorrect;

(e) providing a data error indication and ending said method when said compared parity in step (c) is incorrect and said reading location is again equal to said starting read location;

(f) temporarily storing the read data value in another memory device when the compared parity of step (c) is correct;

(g) advancing the selection of the reading location to the next sequential location in said NVM;

(h) providing said temporarily stored data value as the correct read data and ending said method only when said selected read location is again equal to said starting read location;

(i) reading the data value present in the advanced read location;

(j) comparing the parity coded portions of the read data value with predetermined correct parity values and determining if said read data value is parity correct or not;

(k) repeating sequential steps of (g) through (j) when said compared parity in step (j) is incorrect;

(l) comparing the data value read in step (i) with the value temporarily stored in said other memory device when said compared parity in step (j) is correct to determine if said value read is within a predetermined relationship established with respect to the temporarily stored value;

(m) replacing the previously temporarily stored data in step (f) with the read data value compared in step (l) when that read data value is within the predetermined relationship established with respect to the previously temporarily stored value;

(n) repeating steps (g) through (m);

(o) repeating step (g) when the read data value compared in step (l) is without the predetermined relationship established with respect to the previously temporarily stored value;

(p) repeating steps (i) through (m) only until the selected read location is again equal to said starting read location;

(q) advancing the selected starting read location to the next sequential location in said NVM;

(r) repeat steps (b) through (q) only until the starting read location is again equal to the starting read location selected in step (a); and

(s) providing a data error indication and ending said method when said starting read location is again equal to the starting read location selected in step (a).

14. A method as in claim 13, wherein each step of temporarily storing a read data value includes the step of contemporaneously storing the corresponding selected read location for that value.

15. A method as in claim 14, incorporated in a method of writing new data values to said NVM device including the following steps:

(a') reading the data value and corresponding selected read location from the NVM device according to the steps recited in claim 7;

(b') ending said method if an error indication is present;

(c') selecting a storage location in said NVM as a write location equal to the selected read location read in step (a');

(d') advancing the selection of the write location to the next sequential storage location in said NVM;

(e') adding a value of data to said data value read from said NVM, wherein the sum of values is within the established predetermined relationship; and

(f') writing the summed value data derived in step (e') to the advanced write location selected in step (d').

16. A method as in claim 15, wherein said writing step (f') is accompanied by the steps of:

combining predetermined parity data with said summed value data and writing both the summed value data and parity data to the advanced write location selected in step (d').

17. A method as in claim 16, wherein said writing step (f') is followed by the steps of:

(g') reading the data stored in the storage location of the NVM selected in step (d');

(h') comparing said value data read in step (g') with the summed value data written in step (f') to determine equality or inequality and ending said method if they are equal;

(i') selecting the next write location by advancing to the next sequential storage location of the NVM;

(j') repeating steps (f') through (j') only until the selected write location is again equal to the storage location selected in step (c'); and

(k') ending said method when said storage location selected in step (i') is equal to the storage location selected in step (c').

18. A method as in claim 17, wherein said comparing step (h') additionally includes subsequent comparing the read parity data, when the preceding comparison results in an inequality, to determine parity equality or inequality and writing an incorrect data value with incorrect parity data to the selected storage location of the NVM prior to step (i').

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