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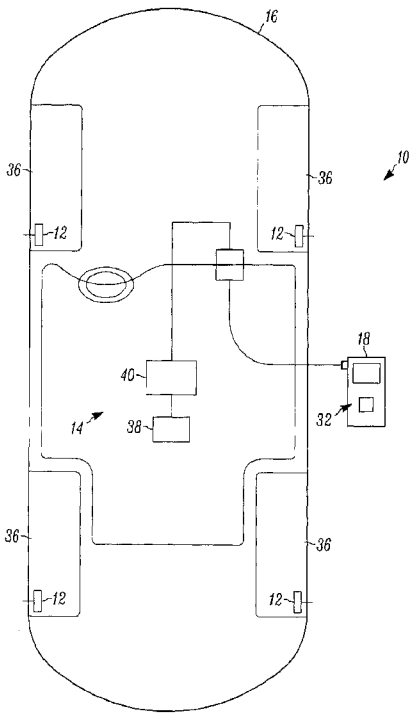

Fig. 1

(57) Abstract: The present invention relates to recording and storing identification information of tire pressure monitoring sensors (12) and transmission of the stored identification information to a tire pressure monitoring system (14). In a first aspect, the present invention provides a method of integrating one or more tire pressure monitoring sensors (12) with a tire pressure monitoring system (14) of a vehicle (16). The method includes programming and/or configuring a tire pressure monitoring sensor (12) with a suitable program software for a tire pressure monitoring system (14) of a vehicle (16). The method also includes utilizing a configuration tool (18) to cause the tire pressure monitoring sensor (12) to generate a signal including an identifier. The method further includes recording the identifier on a memory device of the configuration tool (18). The method further includes transmitting the recorded identifier from the configuration tool (18) to a memory device of a vehicle (16) when the vehicle (16) enters a learning mode.

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METHODS, SYSTEMS AND DEVICES FOR RECORDING AND TRANSMITTING IDENTIFICATION INFORMATION OF TIRE PRESSURE MONITORING SENSORS TO A VEHICLE

TECHNICAL FIELD

[0001] The present invention relates to methods, systems and devices for programming and/or configuring, recording and storing identification information of tire pressure monitoring sensors and transmission of the stored identification information to a tire pressure monitoring system of a vehicle.

BACKGROUND

[0002] Commercial and non-commercial vehicles now have tire pressure monitoring systems (TPMS) which include a central module, integrated or in communication with an electronic control unit of the vehicle, and tire pressure monitoring sensors (TPM sensors) for each vehicle wheel unit. In general, the TPM sensors monitor tire pressure within a respective tire and transmit a wireless signal to the central module which at a minimum includes tire pressure data. Should the sensed pressure be outside of an acceptable range or a substantial change in tire pressure occur, an alarm is generated and transmitted to the user of the vehicle.

[0003] Over time, TPM sensors require replacement by service technicians due to damage, depleted battery or otherwise. This requires installation and integration of new TPM

sensors with a TPMS of a vehicle. During this process, in one configuration, the technician places the TPMS receiver of the vehicle in a learning mode and triggers each TPM sensor for identification purposes. The technician then sequentially triggers each TPM sensor utilizing a TPMS configuration tool, causing each sensor, new or existing, to transmit a wireless signal including an identifier to a control module of the TPMS. These tools communicate with a sensor through low frequency signals which in turn communicate with the TPMS through a higher frequency radio signal. The control module records the identifier, which may comprise numbers, letters, a combination of numbers and letters or any other identifying identifier, of each signal so as to interpret the location of TPM sensor data during operation thereof.

[0004] In a learning process of a typical TPMS, a technician places the TPMS receiver of the vehicle in learning mode by performing one or more steps, such as cycling an ignition key, pressing remote buttons, depressing a brake pedal, utilizing door lock switches, utilizing headlight switches, combinations thereof, or otherwise. As should be appreciated, this can be a laborious task. Once the learning processes is initiated, the TPMS tool indicates which tire pressure monitoring sensor installed on the vehicle should be triggered. The service technician moves to the specified wheel unit and utilizes the TPMS configuration tool to cause a corresponding TPM sensor to transmit a signal including an identification identifier. Once the signal is received by the control module, the control module confirms the learning of the TPM senor by either an audible signal or visual signal. The TPMS tool also receives the sensor data and indicates which TPM sensor is to be triggered next. This continues until all of the TPM

sensors have been sequentially triggered, which requires the technician to walk to each wheel unit and place the tool next to a corresponding TPM sensor so as to trigger the sensor.

[0005] By design, the TPMS provides a limited amount of time for triggering each sensor. Unfortunately, should the signal not be received within the allotted time, the technician must start the learning process over. This occurs when the sensor fails to receive and process the triggering signal in the allotted time, the control module fails to receive and process the triggering signal in the allotted time, or the technician is interrupted or otherwise not able to move between the wheel units in the allocated time as indicated by the control module.

SUMMARY

[0006] The present approaches provide- methods, systems and devices for integrating one or more tire pressure monitoring (TPM) sensors with a tire pressure monitoring system (TPMS) of a vehicle. In one aspect, the features of the present invention are predicated upon, in part, programming and/or configuring, recording and storing identifiers of tire pressure monitoring sensors and transmission of the stored identifiers to a TPMS of a vehicle. In another aspect, the identifiers is stored on a TPM configuration tool that is configured to automatically or manually transmit the stored identifiers and associated data to a TPMS in response to requests made by the TPMS during a learning process. In one further particular configuration, the TPM configuration tool includes necessary protocol data for communication with the TPMS.

[0007] Using the present approaches, the probability of having to reinitiate a learning process of a vehicle is substantially reduced due to the elimination of relying on the timely

triggering of a TPM sensor and reception of a signal generated by the TPM sensor by the TPMS. This is because it is no longer necessary to travel to each TPM sensor, within a prescribed time period, for the purpose of triggering the same. Further, with identification of TPM sensor being stored on a TPMS configuration tool, it is possible to eliminate walking about a vehicle and additional triggering of TPM sensors. This elimination increasing efficiency in the replacement of TPM sensors thereby saving time and reducing costs to the service shop and customers.

[0008] In view of the foregoing, in a first aspect, a method of integrating one or more tire pressure monitoring sensors with a tire pressure monitoring system of a vehicle is provided. The method includes programming and/or configuring a tire pressure monitoring sensor with a suitable program software for a tire pressure monitoring system of a vehicle. The method also includes utilizing a configuration tool to cause the tire pressure monitoring sensor to generate a signal including an identifier. The method further includes recording the identifier on a memory device of the configuration tool. The method further includes transmitting the recorded identifier from the configuration tool to a memory device of a vehicle.

[0009] In another aspect, a tool for integrating one or more tire pressure monitoring sensors with a tire pressure monitoring system of a vehicle is provided. The tool includes a low frequency wireless transmitter and a high frequency wireless transmitter. The tool further includes a high frequency wireless receiver. The tool further includes a central processing unit and a memory device including software instructions for: i) programming and/or configuring a tire pressure monitoring sensor with suitable program software for a tire pressure monitoring system of a vehicle, ii) causing the low frequency wireless transmitter to transmit a signal

suitable for generating a response signal from a tire pressure monitoring sensor, iii) storing an identifier of the response signal onto a memory device, and iv) causing the high frequency wireless transmitter to transmit the recorded identifier and associated received data.

[0010] In another aspect, a computer-readable memory device storing computer program instructions is provided. Which, when executed by a computer comprising at least one processor, the result is: i) programming and/or configuring of a tire pressure monitoring sensor with suitable program software for a tire pressure monitoring system of a vehicle, ii) the transmission of a signal suitable for causing a tire pressure monitoring sensor to transmit a response signal; iii) storing of an identifier included with the response signal into a memory device; and iv) transmitting the stored identifier to a vehicle.

[0011] In another aspect a tire pressure monitoring sensor is provided. The sensor includes a pressure sensor configured for monitoring air pressure and generating signals indicative thereof. The sensor further includes a receiver configured for receiving wireless signals from a configuration tool. The sensor further includes a processing unit and memory device including suitable software for: i) storing configuration or program software received by the receiver onto the memory device, and ii) causing transmission of an identifier of the tire pressure monitoring sensor to a configuration tool in response to a request made by the configuration tool. The sensor further includes a wireless transmitter configured to transmit the identifier to a configuration tool.

[0012] These and other features can be best understood from the following specification and drawings, the following of which is a brief description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Fig. 1 illustrates a schematic view of an exemplary TPM sensor integration system for integration of a tire pressure monitoring sensor with a tire pressure monitoring system according to various embodiments of the present invention.

[0014] Fig. 2 illustrates a top view of an exemplary configuration tool for a tire pressure monitoring sensor according to various embodiments of the present invention.

[0015] Fig. 3 illustrates a schematic view of an exemplary configuration tool for a tire pressure monitoring sensor according to various embodiments of the present invention.

[0016] Figs. 4A and 4B illustrate a plurality of screenshots of a configuration tool during a recording process of a plurality of tire pressure monitoring sensors according to various embodiments of the present invention.

[0017] Fig. 5 illustrates a flow chart illustrating an exemplary method of integrating a tire pressure monitoring sensor with a tire pressure monitoring system according to various embodiments of the present invention.

[0018] Fig. 6 illustrates a top view of a tire pressure monitoring sensor including an integrated circuit according to various embodiments of the present invention.

DETAILED DESCRIPTION

[0019] Referring to Figs. 1 through 3, exemplary integration systems 10 for integration of a tire pressure monitoring (TPM) sensor 12 with a tire pressure monitoring system

(TPMS) 14 of a vehicle 16 are shown. The integration systems 10 include a configuration tool 18 for communication with a TPM sensor 12, via a first communication link 20, with a TPMS 14 of the vehicle 16, via a second communication link 22, and again with the TPMS sensor, via a third communication link 34. For example, in one example, the configuration tool 18 includes a first transmitter 24 configured to form the first wireless communication link 20 with a TPM sensor 12. The configuration tool 18 further includes a second transmitter 28 configured for forming a second wireless communication link 22 with the vehicle. The configuration tool 18 further includes a receiver 26 configured for forming a third wireless communication link 34 with the TPM sensor. The configuration tool 18 further includes a user interface 32 for interacting with program software of the configuration tool and for initiating communication links 20, 22.

[0020] In one general exemplary method of operation, an individual, such as a technician, generates a first communication link 20 between the configuration tool 18 and a TPM sensor 12 for the purpose of programming, configuring, integrating or reintegrating the TPM sensor with the TPMS 14 of the vehicle 16. In one particular configuration, the first communication link 20 comprises a wireless communication link. The user utilizes the configuration tool 18 to select a suitable software program for a TPM sensor 12 from a database of program software 48. The user then utilizes the configuration tool 18, via user interface 32, to program or configured the TPM sensor 12 and transmit a signal through the first communication link 20 to the TPM sensor 12 for the purpose of generating and receiving a response signal from the TPM sensor, including an identifier, such as numbers, letters, combinations of numbers and

letters or otherwise, through the third communication link 34. The identifier is stored on a memory device of the configuration tool 18 in relationship to a particular wheel unit of the vehicle 16, such as left front, right front, left rear, right rear, spare, or otherwise. This process is repeated until all of the identifiers of the TPM sensors 12 are recorded and associated with a particular wheel unit of the vehicle.

[0021] The individual next places the vehicle in a learning mode for the purpose of integrating and/or reintegrating the TPM sensor 12 with the TPMS 14 of the vehicle 16. In one example, the individual causes the TPMS 14 to enter a learning mode according to original equipment manufacturers (OEM) procedures. Placement of the TPMS 14 into a learning mode is achieved through the performance of one or more steps, such as cycling an ignition key, pressing remote buttons, depressing a brake pedal, utilizing door lock switches, utilizing headlight switches, combinations thereof, or otherwise. In other aspects, the configuration tool causes the TPMS 14 to enter a learning mode.

[0022] Once in a learning mode, the TPMS 14 is configured to receive and interpret wireless data having a particular data format, e.g. frequency, rate of data transmission, order of data transmission, or otherwise, as prescribed by original equipment manufacturers of the TPMS or vehicle 16. The TPMS 14 is configured to receive a particular number of responses based upon the number of TPM sensors being utilized by the vehicle 16, e.g. 4. The TPMS is further configured to receive the responses in a particular order. As an example, once in the learning mode the TPMS 14 anticipates the receipt of a first wireless signal from a front passenger wheel unit, a second wireless signal from a rear passenger wheel unit, a third wireless signal from a rear

driver wheel unit and the fourth wireless signal from a front driver wheel unit. Once received, the TPMS assigns a wheel position to an identifier transmitted with each wireless signal so as to identify the origination of each wireless signal received thereafter.

[0023] Once in the learning mode, the configuration tool 18 establishes a second communication link 22 with the TPMS 14 to transmit the identifier of a TPM sensor 12 to a control module 38 of the TPMS, electronic control unit 40 of the vehicle, or both. This process is repeated until all of the identifiers of the TPM sensors 12 are transmitted. Further, the identifiers are transmitted in a particular order according to the original equipment manufacturers of the TPMS 14 or vehicle 16. In one aspect, the configuration tool is manually actuated, via the user interface 32, to transmit the TPM sensor identification information. In another aspect, the configuration tool 18 automatically transmits the TPM sensor identification information.

[0024] Advantageously, features of the present invention improve upon prior systems by removing the requirement of traveling to each wheel unit of a vehicle for the purpose of triggering an associated TPM sensor during a TPMS sensor learning process. Instead, the a user is provided the ability to trigger TPM sensors at their own pace and location, which may be before or after the TPM sensors are mounted to a vehicle wheel unit. The removal of this step not only reduces learning time for a TPMS but also reduces or eliminates errors encountered during the learning process such as failure to timely trigger a TPM sensor according the original equipment manufacturers specification.

[0025] In greater detail, with reference to Figs. 2 and 3, examples of the configuration tools 18 are shown. The configuration tools 18 include first transmitter 24 and receiver 26 for

forming the first communication link 20 and the third communication link 34 with one or more TPM sensors 12, either sequentially or simultaneously. In one example, the first communication link 20 and third communication link 34 comprise wireless communication links formed between the configuration tool 18 and the TPM sensor 12. In this example, the first transmitter 24 comprises a wireless transmitter and the receiver 26 comprises a wireless receiver. The first transmitter 24 and receiver 26 are configured to send and receive signals suitable for communication with a TPM sensor 12. Accordingly, in one example, the first transmitter 24 transmits low frequency signals such as low frequency signals in the range of about 30 to 300 kHz. In one example, the receiver 26 receives high frequency signals such as signals commonly transmitted by TPM sensors 12. In one example, the high frequency signal comprises an ultra high frequency signal such as signals greater than about 300 MHz or in the range of about 300 MHz to 3 GHz. Non-limiting examples of signals receivable by the receiver includes between about 315 to 433 MHz and in certain particular configurations around 315 MHz, around 433 MHz or higher.

[0026] The configuration tools 18 further include second transmitter 28 for forming the second communication link 22 with the vehicle 16, such as with the control module 38 of the TPMS 14 or electronic control unit 40 of the vehicle 16. In one example, the second communication link 22 comprises a wireless communication link formed between the configuration tool 18 and the vehicle 16. In this example, the second transmitter 28 comprises a wireless transmitter. The second transmitter 28 is configured to send signals suitable for communication with the vehicle 16. Accordingly, in one example, the second transmitter 28

transmits high frequency signals. In one example, the high frequency signal comprises an ultra high frequency signal. It should be appreciated that ultra frequency signals are greater than about 300 MHz or in the range of about 300 MHz to 3 GHz. In one particular configuration, the second transmitter 28 transmits signals in the range of between about 315 to 433 MHz and in certain particular configurations around 315 MHz, around 433 MHz or higher. In another example, the second communication link 22 comprises or includes a physical connection formed between the configuration tool 18 and vehicle 16. In this configuration, the configuration tool 18 includes a wire, or connection for a wire, such as a on-board diagnostic connector 42, that is configured to connect and communicate with the components of the vehicle 16.

[0027] Referring to Fig. 3, the configuration tool 18 further includes a suitable central processing unit 44 and a computer-readable memory device 46 for controlling various components of the configuration tool. The central processing unit 44 is configured for programming and/or configuring one or more TPM sensors 12 either sequentially or simultaneously. The central processing unit is further configured for generating signals through the first transmitter 24 and second transmitter 28, and processing and/or storing signals received by the receiver 26 into a memory device, such as computer-readable memory device 46 or otherwise. The central processing unit 40 further executes operating instructions for the configuration tool 18 for communication with the various devices, generation and/or interaction with a user interface 32 of the configuration tool or otherwise.

[0028] In one example, the configuration tool 18 includes or is in communication with a database of vehicle and TPM sensor program software 48 for programming and/or

configuring of a TPM sensor 12. In this example, the central processing unit 44 is adapted to program and/or configure a TPM sensor with suitable program software for interacting with a particular TPMS of a particular vehicle.

[0029] In greater detail, the program software may include a single piece of code or multiple pieces of code. Such software or pieces of code can include communication protocols such as transmission frequency, data format or otherwise. Such software or pieces of code can alternatively include operation instructions for function of the TPM sensor. Still further, the software or pieces of code can include a combination of communication protocols and operation instruction, or otherwise.

[0030] In one example, the operating instructions includes a single software program (or routine) or multiple software programs (or routines or subroutines) for causing the sensor to operate, which may be according to original manufacturers specification for a TPM sensor or a tire pressure monitoring system. For example, it is contemplated that the one or more software programs causes: i) tire pressure to be measured, ii) temperature of air within a tire to be measured, iii) tire pressure data to be calibrated based upon temperature, iv) a signal to be generated and transmitted according to original manufacturers specification, v) analysis of signals received by a receiver of the TPM sensor, vi) generation of a response signal to a signal received by a receiver of the TPM sensor, vii) formation of communication protocols (such as data structure, computer instructions or otherwise., viii) combinations thereof, or ix) otherwise. In one example, once the TPM sensor is programmed with the program software the program

software becomes permanently, or semi-permanently, embedded within a memory device of the TPM sensor to prevent change or substantial change of the program software.

[0031] In one example, the protocol comprises data structure of signals being generated and analyzed by the TPM sensor. The protocol can be implemented by program software received by or existing within a memory device the TPM sensor. The protocol may be automatically implemented when received by the TPM sensor, the protocol may include instruction for implementation, or otherwise. By example, the protocol may include one or more of: i) data structure, ii) computer instructions, iii) transmission frequency, iv) data frames per transmission, v) time periods between transmission, or vi) otherwise. In one particular example, the transmission received by the TPM sensor includes an indication that the signal comprises a protocol signal and includes communication protocol for the TPM sensor to operate, includes the data structure of signals to be generated including placement of wakeup signals, pressure data, temperature data, and/or otherwise. The signal also indicates frequency of transmission and number of frames to be transmitted per transmission, wherein each frame includes wakeup signal, pressure data, temperature data and/or otherwise. The protocol signal also indicates time periods between transmission. It should be appreciated that other communication protocols and configurations can be included.

[0032] The program software can vary based upon the vehicle make, model and/or year of manufacture. Alternatively, the program software can be configured for multiple applications, e.g. multiple vehicle makes, models and/or years of manufacture. As such, programming of the TPM sensor can include transfer of multiple communication protocols

and/or operation instructions for multiple tire pressure monitoring systems. Also, programming or configuration of the TPM sensor can include selection of communication protocols and/or operation instruction from a database located with the TPM sensor.

[0033] Referring to Fig. 2, the configuration tool 18 includes user interface 32 for facilitating in operation of the configuration tool including initiating commands of configuration tool operation software stored on the computer-readable memory device 46. In one example, the user interface 32 comprises display screen 50 and buttons 52, 54, 56, 58, 60, 62, 64 and 66 for initiating operation commands. For example, in one example, the display screen 50 displays information received from the TPM sensor 12. In another example, the display screen 50 displays information pertaining to programming or configuration of a TPM sensor to be integrated with a vehicle 16. For example, in one configuration the display screen indicates identifier of the TPM sensor, vehicle make, model and/or year of manufacture, which the TPM sensor was or is to be mounted to, wheel unit position, which the TPM sensor was or is to be mounted to, tire data recorded by a TPM sensor, TPM sensor configuration information, TPM sensor programming information, TPM sensor make, model and/or year of manufacturer, or otherwise.

[0034] In another aspect and referring to Figs. 4A and 4B, the display screen 50 displays various information for viewing or selection during configuration or programming of a TPM sensor 12. The configuration tool 18 includes a touch screen and/or scroll buttons for selection and manipulation through the various screens. For example, in a first screenshot 68, the display screen 50 lists the vehicle make to which a TPM sensor 12 is to be programmed or

configured for. In a second screenshot 70, the display screen 50 lists the models of the selected vehicle make. In a third screenshot 72, the display screen 50 lists years of manufacture of the selected vehicle make and model. In a fourth screenshot 74, the display screen 50 lists the wheel unit the TPM sensor was or is to be utilized for. In a fifth screenshot 76, the display screen 50 provides the ability to program or trigger the TPM sensor 12. In a sixth screenshot 78, the display screen 50 indicates that the TPM sensor 12 has been programmed and the identifier of the TPM sensor from a response signal. In a seventh screenshot 80, the display screen 50 provides the ability to assign a wheel position for the programmed or configured TPM sensor 12 and displays the identifier obtained during the trigging step. In an eighth screenshot 82, the display screen 50 provides the ability to assign a wheel position for another programmed or configured TPM sensor 12 and displays the identifier obtained during the trigging step. In a ninth screenshot 84, the display screen 50 provides the ability to write the recorded identifier to an electronic control unit 40 of the vehicle 16, read identifiers of TPM sensors 12 from the electronic control unit of the vehicle, or clear the memory device of the electronic control unit of previously stored TPM sensor identifiers . In a tenth screenshot 86, the display screen 50 confirms that the TPM sensor identifier has been properly written to the memory device of the electronic control unit 40 of the vehicle 16. It should be appreciated that additional screenshots would be generated for triggering and programming or configuring of additional TPM sensors, and for transmitting identification and location information of previously triggered TPM sensors. Other screenshot can also be generated according to the teachings of the present invention.

[0035] Referring again to Fig. 2, alternatively or in conjunction with the screenshots, the user interface 32 includes buttons 52-66 for performing similar and/or additional functions to that of the screenshots. For example, in one aspect, the configuration tool 18 includes a Signal TPM Sensor button 52 which initiates the transmission of a trigger signal through the first transmitter 24. As previously indicated, the display screen displays the response transmission from the TPM sensor including the TPM sensor identifier. The user interface 32 further includes a Select Vehicle button 54 for selecting a configuration or program software for a TPM sensor. The user interface 32 further includes a Program TPM Sensor button 56 which initiates programming of one or more TPM sensors based upon the selected vehicle, make, model and year of manufacture. The user interface 32 further includes Select TPM Sensor Position button 58 for indicating which wheel unit 36 the TPM sensor 12 was or is to be mounted to. The user interface 32 further includes a Record TPM Sensor ID 60 for recording in a memory device of the configuration tool the TPM sensor identifier and wheel unit position. The user interface 32 further includes an Activate TPMS Learning Mode button 62 for placing the vehicle in learning mode thereby causing the TPMS to transmit signals requesting TPM identifier for particular wheel units. The user interface 32 further includes a Transmit TPM Sensor ID button 64 for transmitting one or more TPM sensor identifiers through the second transmitter 28. The user interface 32 further includes an On/Off button 66. It should be appreciated that more or less buttons may be used, in view of the teachings herein, and may be configured to act with the screenshots shown and described with reference to Figs. 4A and 4B.

[0036] Referring to Fig. 6, an exemplary TPM sensor 12 is shown. The sensor includes an integrated circuit board 88 including a processing unit 90, one or more computer-readable memory device 92, pressure sensor 94, receiver 96 and wireless transmitter 98. The TPM sensor 12 further includes a suitable power supply, such as battery 99, for providing power to various components of the integrated circuit board 88 including processing unit 90, wireless transmitter 98 or otherwise. The pressure sensor 94 of the TPM sensor 12 generates raw data indicative of air pressure within the associated tire. The raw data is transmitted to the processing unit 90 and stored on the computer-readable memory device 92 of the TPM sensor 12. In one aspect, the memory device 92 further stores the unique identifier for the TPM sensor 12.

[0037] The receiver 96 is configured for receiving wireless signals from the configuration tool 18. The signals received by the receiver 96 are transmitted to the processor 90 where it is evaluated in part through suitable software stored on the computer-readable memory device 92. Should the signal be interpreted as a request for a transmission of the unique identifier then the processor 90 transmits the identifier through the transmitter 98. Examples of signals that can be interpreted as a request for a transmission of an identifier include signals having a particular frequency, code or both. Such signals may include signals commonly transmitted by a configuration tool for causing triggering of a TPM sensor or a signal including instructions for transmission of the unique identifier, or otherwise. Similarly, response signals initiated by the processor 90 and software stored on the computer-readable memory device 92 may include a signal including data commonly transmitted by the TPM sensor (e.g. tire pressure data, transmission formats, temperature, identifier or otherwise), alternatively the response signal

may solely, or substantially solely, include the unique identifier, or alternatively the response signal may include a combination of the unique identifier and data commonly transmitted by the TPM sensor. Other configurations are possible.

[0038] Referring to Fig. 5, methods 100 of integrating TPM sensors 12 with a TPMS 14 of a vehicle are provided. The method includes a step 102 of selecting identification information of a vehicle 16 with a TPMS configuration tool 18. In one exemplary configuration, the selection process comprises the selection process shown in Fig. 4A.

[0039] The method includes a step 104 of generating communication links between a TPMS configuration tool 18 and a plurality of TPM sensors 12 mounted or configured to be mounted to wheel units 36 of a vehicle 16. In one configuration, this comprises a technician or user walking about a vehicle to each wheel unit and placing the configuration tool 18 proximate with a corresponding TPM sensor 12 of each wheel unit 36. At each wheel unit, the technician or user utilizes the user interface 32 of the configuration tool 18 to form first communication links 20 with the TPM sensors 12, by transmitting a signal through the first transmitter 24. In one alternate configuration, one or more of the TPM sensors 12 may not yet be mounted to a wheel unit 36 but instead be configured for mounting to a wheel unit. Such condition may arise when one or more TPM sensors are being replaced by new TPM sensors.

[0040] The method includes a step 106 of programming or configuring at least one of the plurality of TPM sensors 12 with suitable software for operation with a TPMS 14 of the vehicle. In situations where a signal TPM sensor 12 is being replaced, this comprises a programming or configuring of a single programmable TPM sensor; however, it may comprise

programming or configuring multiple TPM sensors. To this end, this may include simultaneous programming or configuring of a plurality of TPM sensors 12 or sequential programming of TPM sensors.

[0041] The method includes a step 108 of utilizing the TPMS configuration tool 18 to cause the TPM sensors 12 to generate signals including identifiers of each TPM sensor. This step is performed at each wheel unit, proximate to each TPM sensor 12 or combination thereof. In one configuration, the TPM sensors generate signals, and in particular response signals, based upon the signals transmitted by the TPMS configuration 18 through the first transmitter 24. In one particular configuration, the signal transmitted by the TPMS configuration 18 comprises what is commonly called a TPM sensor trigger signal.

[0042] The method includes a step 110 of recording the identifiers of each TPM sensor 12 on a computer-readable memory device 46, or other memory device, of the TPMS configuration tool 18. In one configuration, the signals received by the TPMS configuration tools 18 are analyzed, through the use of the central processing unit 44 and software stored on a computer-readable memory device 46, to determine the identification code. In another configuration, the signal received by the TPMS configuration tool 18 is simply recorded on the computer readable memory device 46, or other memory device, including identification information of the TPM sensor 12, tire pressure data or otherwise. In either configuration, the identifier and/or signal is associated with a particular wheel unit 36 position of the vehicle 16 utilizing the TPMS configuration tool, as shown in Figs. 4A.

[0043] The method includes a step 112 of placing the TPMS 14 of the vehicle 16 in a learning mode. In one configuration this is achieved utilizing original equipment manufacturers procedures. In another configuration, this is achieved through the use of the TPMS configuration tool 18. In either configuration, the TPMS 14 of the vehicle is ready, and expected, to receive a signal, including identifier, from a particular TPM sensor 12 of a particular wheel unit 36 in a prescribed amount of time.

[0044] The method includes a step 114 of transmitting the recorded identifiers to a memory device of the vehicle 16, such as a memory device of the TPMS 14, electronic control unit 40 or otherwise. In one configuration, the technician or user utilizes the user interface 32 of the TPMS configuration tool 18 to selectively transmit the recorded TPM sensor 12 signals, identifiers , or both, to the TPMS 14 in a prescribed order according to original equipment manufacture's procedures, e.g. right front, right rear, left rear, left front or other combinations thereof. In another configuration, the TPMS configuration tool 18 automatically transmits the recorded signals, identifiers , or both, to the TPMS 14 in a prescribed order. This automatic transmission can be based upon an indication received by the vehicle, technician or otherwise. As previously mentioned, the recorded signals, identifiers , or both, can be transmitted by the second transmitter 28 of the TPMS configuration tool 18 or through an on-board diagnostic connector 42. It should be appreciated that more or less steps may be included, as shown and described herein.

[0045] While the invention has been described with reference to a preferred embodiment it will be understood by those skilled in the art that various changes may be made

and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.

CLAIMS

1. A method of integrating one or more tire pressure monitoring sensors with a tire pressure monitoring system of a vehicle, the method comprising:

programming or configuring a tire pressure monitoring sensor (12) with a suitable program software for a tire pressure monitoring system (14) of a vehicle (16);

utilizing a configuration tool (18) to cause the tire pressure monitoring sensor (12) to generate a signal including an identifier;

recording the identifier on a memory device of the configuration tool (18); and

transmitting the recorded identifier from the configuration tool (18) to a memory device of the vehicle (16) when the vehicle (16) enters a learning mode.

2. The method of claim 1, further comprising the step of selecting the suitable program software for the tire pressure monitoring sensors (12) based upon identification information of a vehicle.

3. The method of claim 2, wherein the suitable program software is selected from a database of program software (48) for the tire pressure monitoring sensors (12).

4. The method of claim 3, further comprising the step of forming a communication link with the database of program software (48) for the tire pressure monitoring sensors (12).

5. The method of claim 3, wherein the configuration tool (18) includes the database of program software (48) for the tire pressure monitoring sensors (12).

6. The method of claim 1, wherein the suitable program software is selected through a user interface (32) of the configuration tool (18).

7. The method of claim 1, wherein the communication link (20) between the tire pressure monitoring sensor (12) and configuration tool (18) is established prior to mounting of the tire pressure monitoring sensor (12) to a wheel unit (36) of the vehicle (16).

8. The method of claim 1, wherein the signal further includes tire pressure data.

9. The method of claim 1, wherein the identifier of the tire pressure monitoring sensor (12) is transmitted to the memory device of the vehicle (16) through a wireless communication link (22).

10. The method of claim 1, wherein the identifier of the tire pressure monitoring sensor (12) is transmitted to the memory device of the vehicle (16) through an on-board diagnostic connector (42).

11. The method of claim 1, further comprising the step of placing a tire pressure monitoring system (14) of the vehicle (16) in a learning mode prior to transmitting the recorded identifier to the memory device of the vehicle (16).

12. The method of claim 1, further comprising the step of assigning the identifier to a wheel unit (36) of the vehicle (16).

13. The method of claim 1, wherein the configuration tool (18) includes a wireless receiver (26) configured to receive the signal transmitted by the tire pressure monitoring sensor (12).

14. The method of claim 1, further comprising:

generating a plurality of communication links between a plurality of tire pressure monitoring sensors (12) and the configuration tool (18);

programming or configuring the plurality of tire pressure monitoring sensors (12) with suitable program software for the tire pressure monitoring system (14) of the vehicle (16);

utilizing the configuration tool (18) to cause each of the plurality of tire pressure monitoring sensors (12) to transmit a signal including an identifier;

recording each identifier on the memory device of the configuration tool (18); and

transmitting each of the recorded identifiers to the vehicle (16).

15. The method of claim 14, further comprising the step of selecting the suitable program software for the plurality of tire pressure monitoring sensors (12) based upon identification information of a vehicle.

16. The method of claim 15, wherein the suitable program software is selected from a database of program software (48) for the tire pressure monitoring sensors (12).

17. The method of claim 14, wherein at least one of the plurality of communication links formed between the plurality of tire pressure monitoring sensors (12) and the configuration tool (18) is established prior to mounting of an associated tire pressure monitoring sensor (12) to a wheel unit (36) of the vehicle (16).

18. The method of claim 14, wherein the plurality of communication links formed between the plurality of tire pressure monitoring sensors (12) and the configuration tool (18) are established prior to mounting of the plurality of tire pressure monitoring sensors (12) to wheel units (36) of the vehicle (16).

19. The method of claim 14, further comprising the step of associating the recorded identifiers to wheel units (36) of the vehicle (16).

20. A configuration tool (18) for integrating one or more tire pressure monitoring sensors with a tire pressure monitoring system (14) of a vehicle (16), comprising:

a low frequency wireless transmitter (24);

a high frequency wireless receiver (26);

a high frequency wireless transmitter (28); and

a central processing unit (44) and a memory device (46) including software instructions for:

programming or configuring a tire pressure monitoring sensor (12) with suitable program software for a tire pressure monitoring system (14) of a vehicle (16);

causing the low frequency wireless transmitter (24) to transmit a signal suitable for generating a response signal from a tire pressure monitoring sensor (12);

storing an identifier of the response signal onto a memory device (46); and

causing the high frequency wireless transmitter (28) to transmit the recorded identifier.

21. The configuration tool (18) of claim 20, further comprising a database of program software (48) for tire pressure monitoring sensors (12).

22. The configuration tool (18) of claim 20, further comprising a connector for forming a communication link with a database of program software (48) for the tire pressure monitoring sensors (12).

23. The configuration tool (18) of claim 20, further comprising a user interface (32) for interacting with the software instructions and causing the low frequency wireless transmitter (24) to program or configure the tire pressure monitoring sensor (12) with suitable software.

24. The configuration tool (18) of claim 23, wherein the user interface (32) is configured for interacting with the software instructions and causing the low frequency wireless transmitter (24) to transmit the signal suitable for generating a response signal from the tire pressure monitoring sensor (12).

25. The configuration tool (18) of claim 23, wherein the user interface (32) is configured for interacting with the software instructions and causing the high frequency wireless transmitter (28) to transmit the recorded identifier.

26. The configuration tool (18) of claim 23, wherein the user interface (32) is configured for assigning wheel unit positions (36) of a vehicle (16) for each of the identifiers received by the high frequency receiver (26).

27. The configuration tool (18) of claim 23, wherein the user interface (32) is configured for transmitting the recorded identifiers to an electronic control unit (40) of a vehicle (16) through an on-board diagnostic connector (42).

28. A computer-readable memory device storing computer program instructions which when executed by a computer comprising at least one processor results in:

programming or configuring of a tire pressure monitoring sensor (12) with suitable program software for a tire pressure monitoring system (14) of a vehicle (16);

transmission of a signal suitable for causing the tire pressure monitoring sensor (12) to transmit a response signal;

storing of an identifier included with the response signal into a memory device; and

transmitting the stored identifier to the vehicle (16).

29. The computer-readable memory device of claim 28, further resulting in display of the identifier on a user interface (32).

30. The computer-readable memory device of claim 28, further resulting in assigning the identifier to a wheel unit (36) of the vehicle (16).

31. The computer-readable memory device of claim 28, further resulting in:

programming or configuring a plurality of tire pressure monitoring sensors (12) with suitable software for the tire pressure monitoring system (14) of the vehicle (16);

transmission of a plurality of signals suitable for causing a plurality of tire pressure monitoring sensors (12) to transmit response signals;

storing of an identifier included with each of the plurality of response signals into the memory device; and

transmitting the stored identifiers to the vehicle (16).

32. A tire pressure monitoring sensor (12), comprising:

a pressure sensor (94) configured for monitoring air pressure and generating signals indicative thereof;

a receiver (96) configured for receiving wireless signals from a configuration tool (18);

a processing unit (90) and memory device (92) including software for:

storing configuration or program software received by the receiver (96) onto the memory device (92); and

causing transmission of an identifier of the tire pressure monitoring sensor (12) to a configuration tool (18) in response to a request by the configuration tool; and

a wireless transmitter (98) configured to transmit the identifier to a configuration tool (18) for storage onto the configuration tool (18) and eventual transmission to a memory storage unit of a vehicle (16).

33. The tire pressure monitoring sensor (12) of claim 32, wherein the receiver (96) comprises a low frequency receiver configured to receive wireless signals in the range of about 30 to 300 kHz.

34. The tire pressure monitoring sensor (12) of claim 32, wherein the wireless transmitter (98) comprises a low frequency transmitter configured to transmit wireless signals in the range of about 30 to 300 kHz.

35. The tire pressure monitoring sensor (12) of claim 32, wherein the wireless transmitter (98) comprises a high frequency transmitter configured to transmit wireless signals in the range of about 300 MHz to 3 GHz.

36. The tire pressure monitoring sensor (12) of claim 32, wherein processing unit (90) and memory device (92) including suitable software further transmits recorded data from the pressure sensor (94).

37. The tire pressure monitoring sensor (12) of claim 32, wherein processing unit (90) and memory device (92) including suitable software transmits only the identifier to the configuration tool (18).

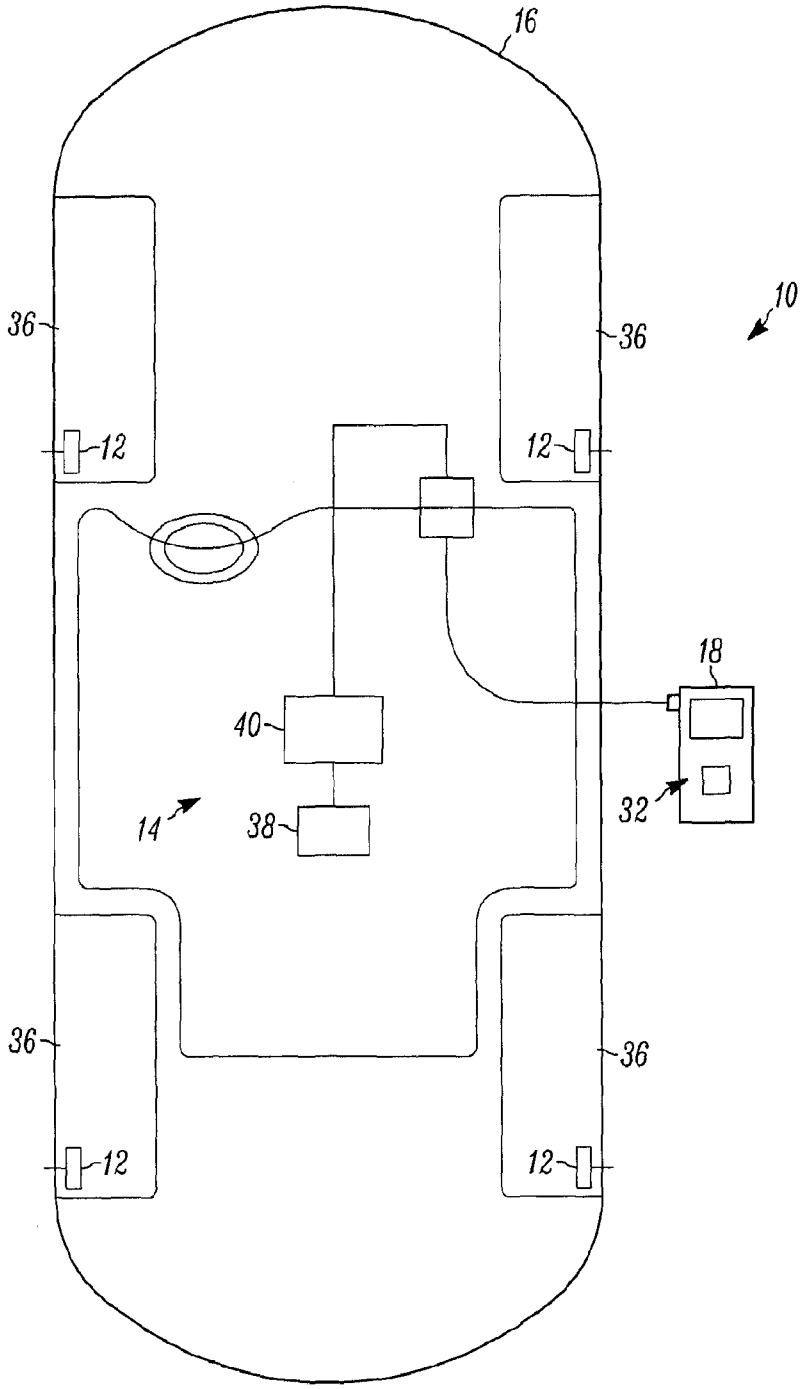

Fig. 1

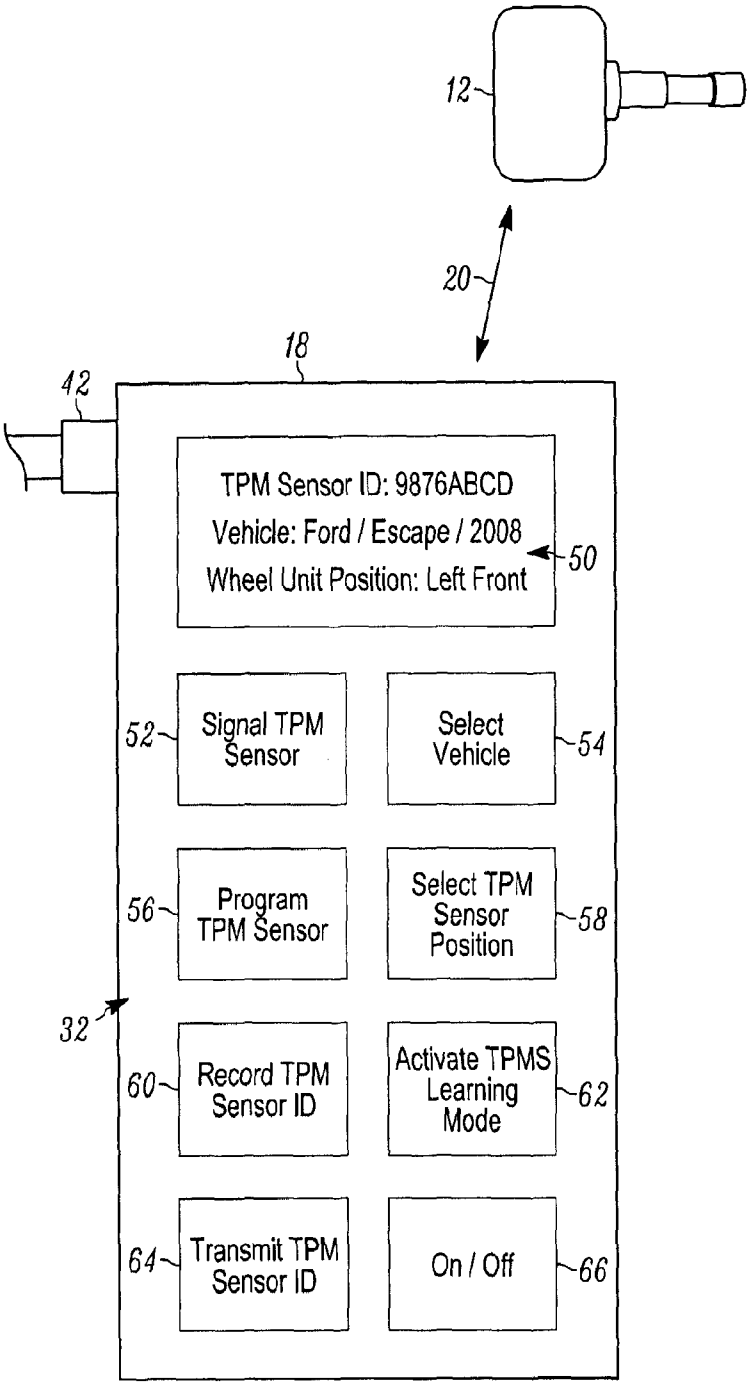
12
20
18
42
TPM Sensor ID: 9876ABCD
Vehicle: Ford / Escape / 2008
Wheel Unit Position: Left Front
50
52
Signal TPM Sensor
Select Vehicle
54
56
Program TPM Sensor
Select TPM Sensor Position
58
32
60
Record TPM Sensor ID
Activate TPMS Learning Mode
62
64
Transmit TPM Sensor ID
On / Off
66

Fig. 2

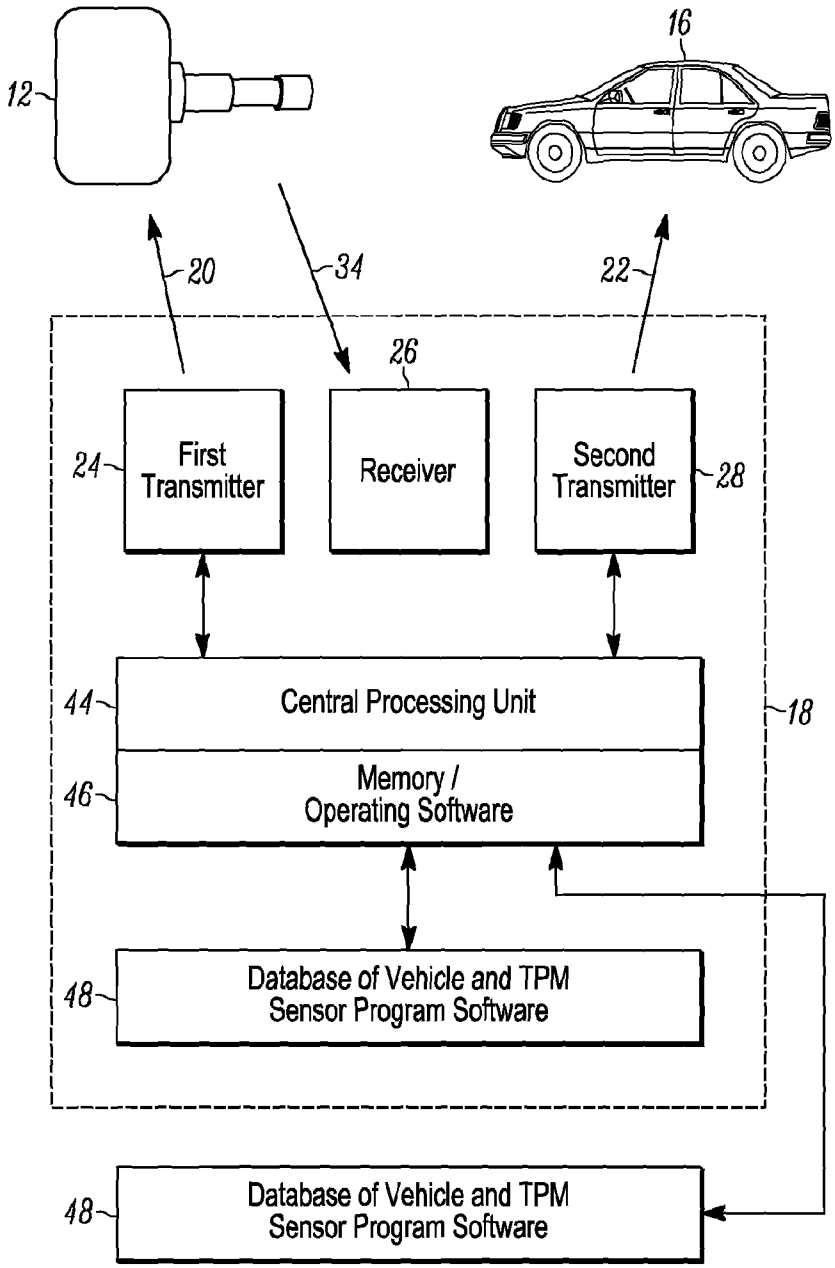
12
16
20
34
22
26
24
First Transmitter
Receiver
Second Transmitter
28
44
Central Processing Unit
18
46
Memory / Operating Software
48
Database of Vehicle and TPM Sensor Program Software
48
Database of Vehicle and TPM Sensor Program Software

Fig. 3

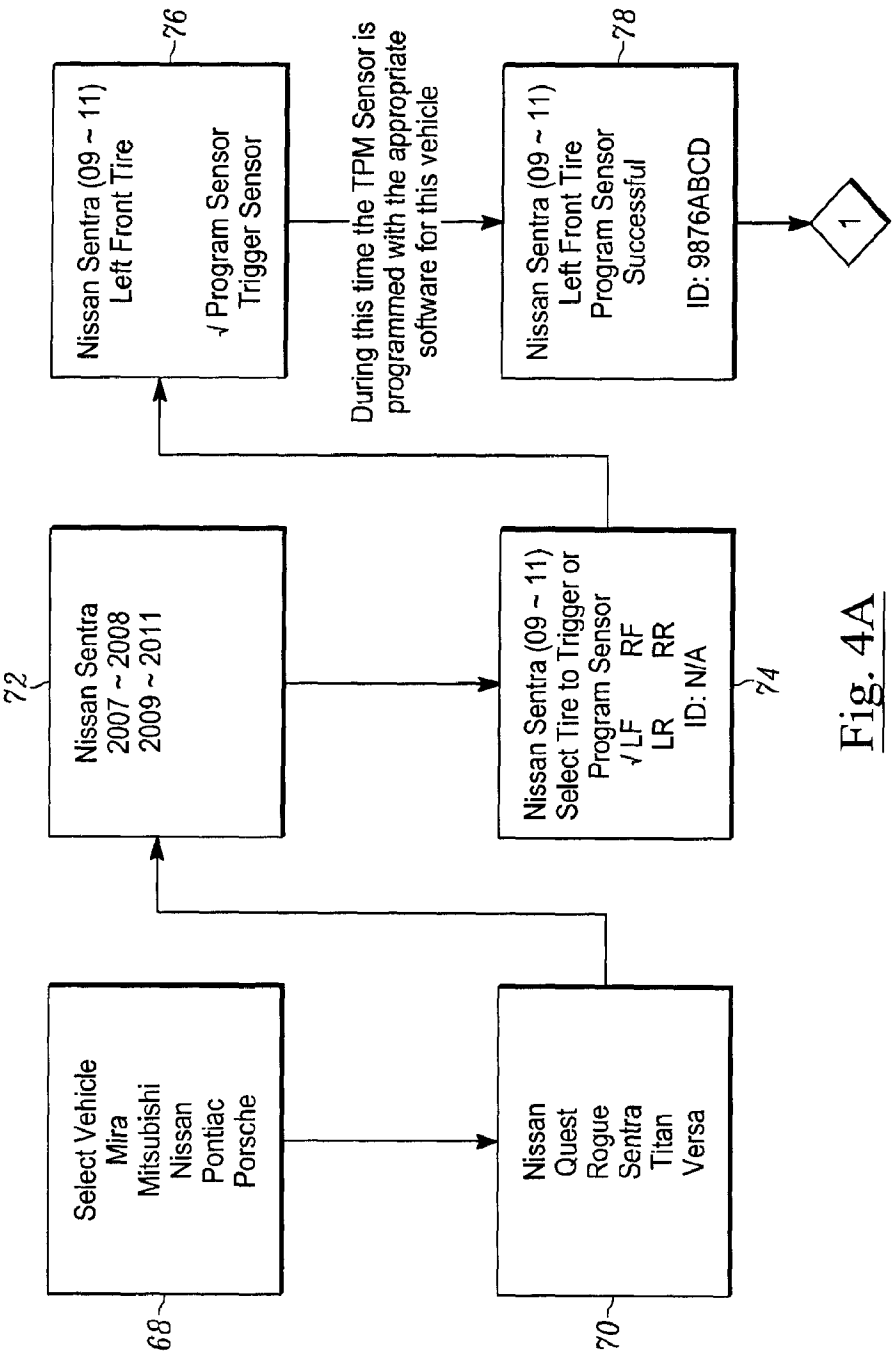
Select Vehicle
Mira
Mitsubishi
Nissan
Pontiac
Porsche
68
Nissan
Quest
Rogue
Sentra
Titan
Versa
70
Nissan Sentra
2007 ~ 2008
2009 ~ 2011
72
Nissan Sentra (09 ~ 11)
Select Tire to Trigger or
Program Sensor
√ LF RF
LR RR
ID: N/A
74
Nissan Sentra (09 ~ 11)
Left Front Tire
√ Program Sensor
Trigger Sensor
76
During this time the TPM Sensor is programmed with the appropriate software for this vehicle
Nissan Sentra (09 ~ 11)
Left Front Tire
Program Sensor
Successful
ID: 9876ABCD
78
1

Fig. 4A

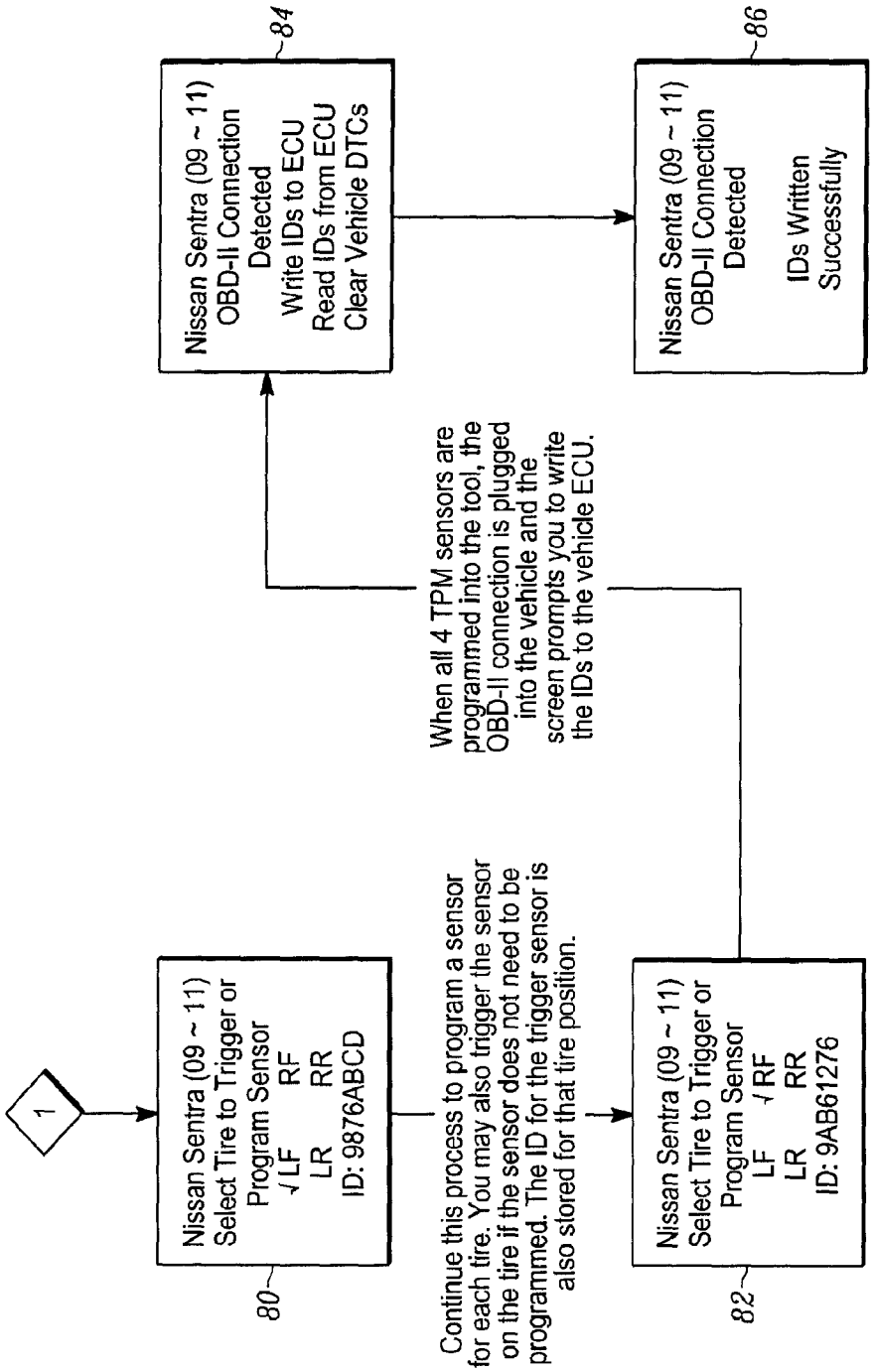
1
Nissan Sentra (09 ~ 11)
Select Tire to Trigger or
Program Sensor
√LF RF
LR RR
ID: 9876ABCD
80
Continue this process to program a sensor for each tire. You may also trigger the sensor on the tire if the sensor does not need to be programmed. The ID for the trigger sensor is also stored for that tire position.
Nissan Sentra (09 ~ 11)
Select Tire to Trigger or
Program Sensor
LF √RF
LR RR
ID: 9AB61276
82
When all 4 TPM sensors are programmed into the tool, the OBD-II connection is plugged into the vehicle and the screen prompts you to write the IDs to the vehicle ECU.
Nissan Sentra (09 ~ 11)
OBD-II Connection
Detected
Write IDs to ECU
Read IDs from ECU
Clear Vehicle DTCs
84
Nissan Sentra (09 ~ 11)
OBD-II Connection
Detected
IDs Written
Successfully
86

Fig. 4B

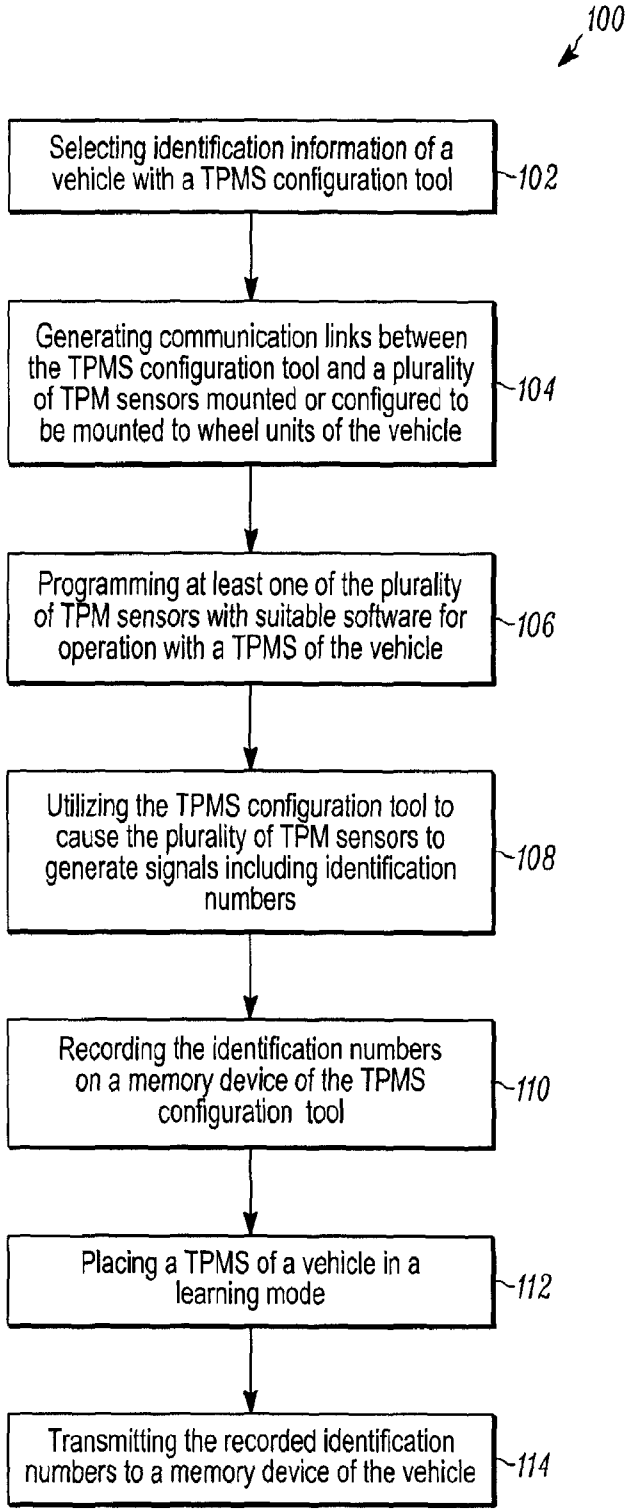
100
Selecting identification information of a vehicle with a TPMS configuration tool
102
Generating communication links between the TPMS configuration tool and a plurality of TPM sensors mounted or configured to be mounted to wheel units of the vehicle
104
Programming at least one of the plurality of TPM sensors with suitable software for operation with a TPMS of the vehicle
106
Utilizing the TPMS configuration tool to cause the plurality of TPM sensors to generate signals including identification numbers
108
Recording the identification numbers on a memory device of the TPMS configuration tool
110
Placing a TPMS of a vehicle in a learning mode
112
Transmitting the recorded identification numbers to a memory device of the vehicle
114

Fig. 5

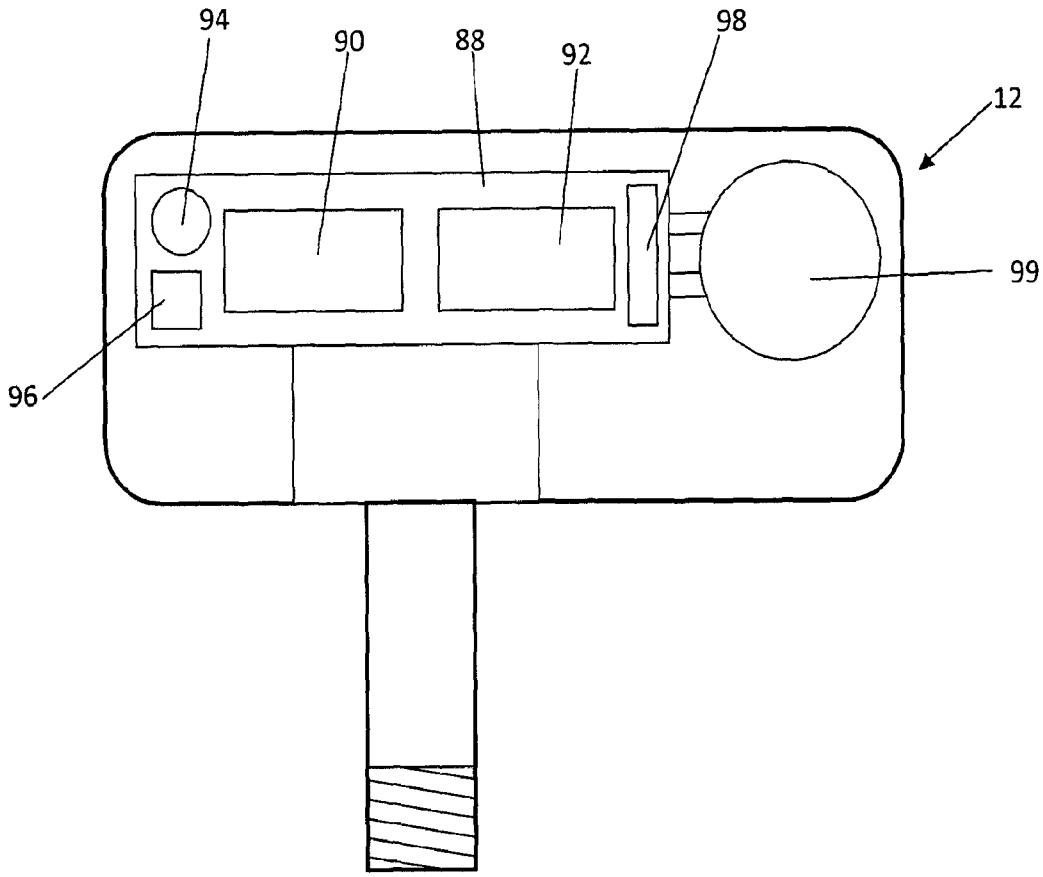

Fig. - 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2014/046468

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60C23/04
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B60C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	WO 2013/063061 A1 (ATEQ CORP [US]; MOUCHET JACQUES [CN]) 2 May 2013 (2013-05-02) the whole document paragraph [0055]; figure 9	1,20,28, 32 2-19, 21-27, 29-31, 33-37

X Y	US 2012/218096 A1 (YU SAN-CHUAN [TW] ET AL) 30 August 2012 (2012-08-30) the whole document paragraph [0041]	1,20,28, 32 2-19, 21-27, 29-31, 33-37

A	US 2005/132792 A1 (LEMENSE THOMAS J [US] ET AL) 23 June 2005 (2005-06-23) the whole document	1-37

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 September 2014	06/10/2014

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Gaillard, Alain

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2014/046468

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2012/050029 A1 (YU SAN-CHUAN [TW] ET AL) 1 March 2012 (2012-03-01) paragraph [0014] the whole document	1-37
A	US 2006/081697 A1 (BRINTON BRETT A [US] ET AL) 20 April 2006 (2006-04-20) the whole document	1-37
A	US 2010/066524 A1 (YU HUNG-CHIH [TW]) 18 March 2010 (2010-03-18) the whole document	1-37

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2014/046468

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2013063061 A1	02-05-2013	DE 112012004481 T5	10-07-2014
		US 2013106596 A1	02-05-2013
		WO 2013063061 A1	02-05-2013
US 2012218096 A1	30-08-2012	NONE	
US 2005132792 A1	23-06-2005	DE 102004047987 A1	04-08-2005
		US 2005132792 A1	23-06-2005
US 2012050029 A1	01-03-2012	NONE	
US 2006081697 A1	20-04-2006	NONE	
US 2010066524 A1	18-03-2010	NONE	