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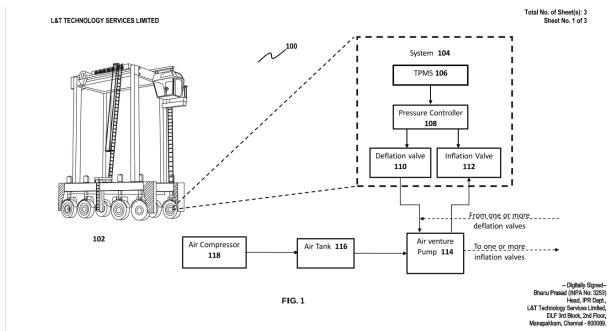
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(54) Title: METHOD AND SYSTEM FOR TIRE PRESSURE MONITORING AND CONTROL

(57) Abstract: Disclosed herein is a system and method for tire pressure monitoring and control. The method includes sensing an air pressure of one or more tires of a vehicle via one or more sensors, monitoring the air pressure of the one or more tires of the vehicle sensed by the one or more sensors. The method further includes determining whether the air pressure of the one or more tires is within a predefined range. The method further includes, wherein when the air pressure is above the predefined range for a first set of one or more tires from the plurality of tires, then, activating one or more deflation valves corresponding to the first set of one or more tires, to release a predetermined quantity of pressurized air and wherein when the air pressure is below the predefined range for a second set of the one or more tires from the plurality of tires, then, activating the one or more inflation valves corresponding to the second set of one or more tires, to receive the released predetermined quantity of the pressurized air.



FORM 2

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Complete Specification

(See Section 10 and Rule 13)

1. TITLE OF THE INVENTION

METHOD AND SYSTEM FOR TIRE PRESSURE MONITORING AND CONTROL

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3. PREAMBLE TO THE DESCRIPTION

COMPLETE

The following specification describes the invention and the manner in which it is to be performed

DESCRIPTION

TECHNICAL FIELD

[001] This disclosure relates generally to tire pressure monitoring, and more particularly to relates a tire pressure monitoring and control technique.

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BACKGROUND OF THE INVENTION

[002] The following description includes information that may be useful in understanding the present invention. It is not an admission that any of the information provided herein is prior art or relevant to the presently claimed invention, or that any publication specifically or implicitly referenced is prior art.

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[003] Tire pressure of vehicles fluctuates regularly due to various reasons. The most visible change in tire pressure is experienced in the fall season when the outside temperatures fluctuate rapidly. In case of huge off- highway vehicles like big straddle and girder transport vehicles, but not limited thereto, the most common cause of tire pressure fluctuation is the weight of load handled by said vehicles. Tire pressure directly affects a vehicle's behaviors such as its stability, tire's wear and tear, and fuel consumption. Low tire pressure often makes the tires damaged and can result in fatalities if the cases are severe. Thus, the tire pressure needs to be maintained at an ideal level for better balancing and operation of the vehicle and for safety purposes as well.

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[004] Currently, conventional systems such as a tire pressure monitoring system (TPMS) is used in the vehicles that monitors the tire pressure and report tire pressure information to driver of the vehicle. Wireless transmission can be used to transmit information on the pressure data to a centralized receiver component in the vehicle. Such a configuration can enable the system to report or signal pressure increase/decrease of the tires to the driver. However, the conventional systems do not provide any mechanism to control the air pressure of tires.

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[005] Thus, a technology is highly required that not only monitor the tire pressure but also controls the tire pressure of the vehicles because man and machine safety, tire's life, fuel consumption and comfort are directly related to the long-term condition of tires.

SUMMARY OF THE INVENTION

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[006] The following presents a simplified summary to provide a basic understanding of some aspects of the disclosed tire pressure monitoring and control technique. This summary is not an extensive overview and is intended to neither identify key or critical elements nor

delineate the scope of such elements. Its purpose is to present some concepts of the described features in a simplified form as a prelude to the more detailed description that is presented later.

[007] Various example embodiments described herein relate to a tire pressure monitoring and control system. The tire pressure monitoring and control system comprises one or more sensors configured to sense air pressure of a plurality of tires of a vehicle. The system comprises one or more inflation valves configured to receive pressurized air to inflate one or more tires from the plurality of tires, and one or more deflation valves configured to release the pressurized air from the one or more tires to deflate said one or more tires. Furthermore, the system comprises at least one controller coupled to the one or more sensors, the one or more inflation valves, and the one or more deflation valves. The at least one controller is configured to monitor the air pressure of the one or more tires of the vehicle sensed by the one or more sensors. Further, the at least one controller configured to determine whether the air pressure of the one or more tires is within a predefined range. When the air pressure is above the predefined range for a first set of one or more tires from the plurality of tires, then the at least one controller configured to activate the one or more deflation valves corresponding to the first set of one or more tires, to release a predetermined quantity of pressurized air and when the air pressure is below the predefined range for a second set of one or more tires from the plurality of tires, then the at least one controller configured to activate the one or more inflation valves corresponding to the second set of one or more tires, to receive the released predetermined quantity of the pressurized air.

[008] Various example embodiments described herein relate to a tire pressure monitoring and control system, wherein when the air pressure is above the predefined range for the first set of the one or more tires, and wherein when the air pressure is not less than the predefined range for the second set of the one or more tires, the at least one controller further configured to activate the one or more deflation valves corresponding to the first set of the one or more tires, to release the predetermined quantity of the pressurized air into atmosphere.

[009] Various example embodiments described herein relate to a tire pressure monitoring and control system, wherein when the air pressure is less than the predefined range for the first set of the one or more tires, and wherein when the air pressure is within the predefined range for the second set of the one or more tires, the at least one controller further configured to activate the one or more inflation valves corresponding to the first set of the one more tires, to receive a predetermined quantity of the pressurized air from an air tank.

[010] Various example embodiments described herein relate to a tire pressure monitoring and control system, wherein when the air pressure is greater than the predefined range for the

first set of the one or more tires, the at least one controller further configured to activate the one or more deflation valves corresponding to the first set of one or more tires from the plurality of tires, to release a predetermined quantity of the pressurized air. Further, wherein when the air pressure is less than the predefined range for the second set of the one or more tires, and
5 wherein when the released predetermined quantity of the pressurized air from the first set of the one or more tires is not sufficient to inflate the second set of the one or more tires, then to activate the one or more inflation valves corresponding to the second set of the one or more tires, to receive the released predetermined quantity of the pressurized air from the first set of the one or more tires and receive another predetermined quantity of the pressurized air from
10 the air tank.

[011] Various example embodiments described herein relate to a tire pressure monitoring and control system, wherein the system further comprising one or more pressure reducing valves coupled to the deflation valve, wherein when the air pressure is greater than the predefined range for the first set of the one or more tires, the at least one controller configured
15 to enable the one or more pressure reducing valves to control releasing of the of the pressurized air from the first set of the one or more tires in a regulated manner and prevent back flow of air through a non- return valve.

[012] Various example embodiments described herein relate to a tire pressure monitoring and control system, wherein the system further comprising one or more time operated solenoid valves and an air venture pump coupled to the one or more time operated solenoid valves,
20 wherein the at least one controller is configured to enable the one or more time operated solenoid valves to receive the predetermined quantity of the pressured air from the pressure reducing valve and release the predetermined quantity of the pressurized air for a predefined time period into the air venture pump.

[013] Various example embodiments described herein relate to a tire pressure monitoring and control system, wherein at least one controller is further configured to enable the one or more inflation valves to receive the released predetermined quantity of the pressured air from
25 the air venture pump to inflate the one or more tires.

[014] Various example embodiments described herein relate to a tire pressure monitoring and control system, wherein the system further comprises a transceiver coupled to the controller, wherein the transceiver configured to transmit data including a measured air
30 pressure for the one or more tires to an external computing device.

[015] Various example embodiments described herein relate to a method for tire pressure monitoring and control. The method includes sensing an air pressure of one or more tires of a

vehicle via one or more sensors, monitoring the air pressure of the one or more tires of the vehicle sensed by the one or more sensors. The method further includes determining whether the air pressure of the one or more tires is within a predefined range. The method further includes, wherein when the air pressure is above the predefined range for a first set of one or more tires from the plurality of tires, then, activating one or more deflation valves corresponding to the first set of one or more tires, to release a predetermined quantity of pressurized air and wherein when the air pressure is below the predefined range for a second set of the one or more tires from the plurality of tires, then, activating the one or more inflation valves corresponding to the second set of one or more tires, to receive the released predetermined quantity of the pressurized air.

[016] Various example embodiments described herein relate to a method for tire pressure monitoring and control, wherein when the air pressure is above the predefined range for the first set of the one or more tires, and wherein when the air pressure is not less than the predefined range for the second set of the one or more tires, then, the method includes activating the one or more deflation valves corresponding to the first set of one or more tires, to release the predetermined quantity of the pressurized air into atmosphere.

[017] Various example embodiments described herein relate to a method for tire pressure monitoring and control, wherein when the air pressure is less than the predefined range for the first set of the one or more tires, and wherein when the air pressure is within the predefined range for the second set of the one or more tires, then, the method includes activating the one or more inflation valves corresponding to the second set of the one more tires, to receive a predetermined quantity of the pressurized air from an air tank.

[018] Various example embodiments described herein relate to a method for tire pressure monitoring and control, wherein when the air pressure is greater than the predefined range for the first set of the one or more tires, then the method includes activating the one or more deflation valves corresponding to a first set of one or more tires from the plurality of tires, to release a predetermined quantity of the pressurized air. Further, wherein when the air pressure is less than the predefined range for the second set of the one or more tires, and wherein when the released predetermined quantity of the pressurized air from the first set of one or more tires is not sufficient to inflate the second set of the one or more tires, then, the method includes activating the one or more inflation valves corresponding to the second set of the one or more tires, for receiving the released predetermined quantity of the pressurized air from the first set of the one or more tires, and for receiving another predetermined quantity of the pressurized air from an air tank.

[019] Various example embodiments described herein relate to a method for tire pressure monitoring and control, wherein when the air pressure is greater than the predefined range for the first set of the one or more tires, the method includes enabling one or more pressure reducing valves to control releasing of the of the pressurized air from the first set of the one or more tires in a regulated manner and preventing back flow of air through a non-return valve.

[020] Various example embodiments described herein relate to a method for tire pressure monitoring and control. The method includes enabling one or more time operated solenoid valves for receiving the predetermined quantity of the pressured air from the pressure reducing valve, and for releasing the predetermined quantity of the pressurized air for a predefined time period into an air venture pump coupled to the one or more time operated solenoid valve.

[021] Various example embodiments described herein relate to a method for tire pressure monitoring and control. The method includes enabling the one or more inflation valves for receiving the released predetermined quantity of the pressured air from the air venture pump to inflate the one or more tires.

[022] Various example embodiments described herein relate to a method for tire pressure monitoring and control. The method includes transmitting data including measured air pressure for the one or more tires to an external computing device via a transceiver.

[023] The above summary is provided merely for purposes of summarizing some example embodiments to provide a basic understanding of some aspects of the disclosure. Accordingly, it will be appreciated that the above-described embodiments are merely examples and should not be construed to narrow the scope or spirit of the disclosure in any way. It will be appreciated that the scope of the disclosure encompasses many potential embodiments in addition to those here summarized, some of which will be further described below.

BRIEF DESCRIPTION OF THE DRAWINGS

[024] The accompanying drawings, which are incorporated in and constitute a part of this disclosure, illustrate exemplary embodiments and, together with the description, explain the disclosed principles.

[025] **FIG. 1** illustrates a high-level block diagram of a tire pressure monitoring and control system, in accordance with an embodiment of the present disclosure.

[026] **FIG. 2** illustrates a low-level architecture of a tire pressure monitoring and control system, in accordance with some embodiments of the present disclosure.

[027] FIG. 3 is a flowchart of a method for tire pressure monitoring and control, in accordance with an embodiment of the present disclosure.

DETAILED DESCRIPTION

[028] Exemplary embodiments are described with reference to the accompanying drawings.

5 Wherever convenient, the same reference numbers are used throughout the drawings to refer to the same or like parts. While examples and features of disclosed principles are described herein, modifications, adaptations, and other implementations are possible without departing from the spirit and scope of the disclosed embodiments. It is intended that the following detailed description be considered as exemplary only, with the true scope and spirit being
10 indicated by the following claims. Additional illustrative embodiments are listed below.

[029] Various embodiments of the present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all
15 embodiments of the invention are shown. Indeed, the invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein.

Rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. The term “or” is used herein in both the alternative and conjunctive sense, unless
20 otherwise indicated. The terms “illustrative,” “example,” and “exemplary” are used to be examples with no indication of quality level. Like numbers refer to like elements throughout.

[030] The phrases “in an embodiment,” “in one embodiment,” “according to one
25 embodiment,” and the like generally mean that the particular feature, structure, or characteristic following the phrase may be included in at least one embodiment of the present disclosure and may be included in more than one embodiment of the present disclosure (importantly, such phrases do not necessarily refer to the same embodiment).

[031] The word “exemplary” is used herein to mean “serving as an example, instance, or
30 illustration.” Any implementation described herein as “exemplary” is not necessarily to be construed as preferred or advantageous over other implementations.

[032] If the specification states a component or feature “can,” “may,” “could,” “should,”
“would,” “preferably,” “possibly,” “typically,” “optionally,” “for example,” “often,” or
35 “might” (or other such language) be included or have a characteristic, that particular component or feature is not required to be included or to have the characteristic. Such component or feature may be optionally included in some embodiments, or it may be excluded.

[033] Throughout this specification, the term ‘system’ or ‘tire pressure monitoring and control system’ may be used interchangeably, and these terms shall not be taken in a sense to limit the scope of the present disclosure. Further, the term ‘controller’ or ‘pressure controller’ or “digital pressure controller” may be used interchangeably, and these terms shall not be taken
5 in a sense to limit the scope of the present disclosure.

[034] Throughout this specification, the tire pressuring monitoring and control system is illustrated in the context of huge off- highway vehicles like big straddle and girder transport vehicles which have numerous tires (e. g. 90 tires or more). However, such examples are used for explaining the one or more embodiments for the purpose of understanding the present
10 disclosure and not for purposes of limitation. A person skilled in the art will understand that the embodiments described may be well suited for any other type of vehicles (preferably a four-wheeled or multi-wheeled vehicle) where it is required to monitor and maintain an ideal pressure in tires. Therefore, the examples mentioned throughout the specification shall not be taken in a sense to limit the scope of the present disclosure.

[035] Referring now to FIG. 1, a high-level block diagram 100 of a tire pressure monitoring and control system 104 is illustrated in accordance with an embodiment of the present disclosure. In the illustrated figure, as a non- limiting example, the vehicle 102 is a straddle carrier having a plurality of tires. The system 104 may include a tire pressure monitoring system (TPMS) 106, a pressure controller 108, a deflation valve 110 and an inflation valve 112. The
20 deflation valve 110 and the inflation valve 112 are further coupled to an air venture pump 114 such that the air venture pump 114 may receive/ release air pressure from/to one or more tires. The air venture pump 114 is further coupled to an air tank 116. The air tank 116 is further coupled to an air compressor 118 which supplies pressurized air to the air tank 116. The pressure controller 108 may be communicably coupled to the TPMS 106 and the deflation
25 valve 110 and the inflation valve 112.

[036] In some examples, the pressure controller 108 may be a digital pressure controller, an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or other programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A controller can
30 be a microprocessor, but in the alternative, it can be a microcontroller, or the like. Although the embodiments described herein are primarily with respect to digital pressure controller, the controller 108 may also include primarily analog components. For example, any of the signal processing algorithms described herein may be implemented in analog circuitry. The pressure controller 108 may include capabilities to monitor the tire pressure and to control different

essential components such as various valves such as the inflation valve 110 and/or deflation valve 112 etc., to maintain an ideal tire pressure.

[037] In some examples, the deflation valve 110 and inflation valves 112 are solenoid valves which, when electrically energized, either release pressurized air from one or more tires or receive the pressurized air from the one or more tires or from the air tank 116, respectively. However, a person of ordinary skill will appreciate that any other available valves in the art that serves the intended purpose of the present disclosure may be utilized to implement the embodiments of the present invention.

[038] In one non-limiting example, the system may comprise a memory (not shown in fig.) coupled to the controller 108. In some examples, the memory may represent any type of non-transitory computer readable medium such as random-access memory (RAM), read only memory (ROM), magnetic disk or tape, optical disk, flash memory, or holographic memory. In one embodiment, the memory may comprise a combination of random-access memory and read only memory and may include data/instructions related to processing of one or more components of the system. In some embodiments, the controller 108 and memory may be combined in a single chip.

[039] In the illustrated example of Fig. 1, the system 104 is a direct tire pressuring monitoring and control system which is directly attached to each tire's valve and may use individual TPMS, pressure controller and inflation and deflation valves attached to each tire of the vehicle 102. However, such example is used for explaining the one or more embodiments for the purpose of understanding the present disclosure and not for purposes of limitation. It may be worth noted that the system 104 may also be implemented as an indirect (programmed) tire pressuring monitoring and control system, that may be controlled by an electronic control unit (ECU) of the vehicle 102 and uses a plurality of parameters to monitor and compare tire characteristics to determine when one or more tires are significantly underinflated/ inflated. Non limiting examples of the plurality of parameters may include VSA/ABS wheel speed sensors, Yaw and G sensor, brake pressure, steering angle, and outside temperature (measured from the front bumper), etc. Thus, it should be well noted that in both non-limiting implementations of the system 104 as discussed above, the tire pressure is being monitored continuously in real time and controlling measures can be taken in real time as well in accordance with the embodiments of the present disclosure to maintain an ideal air pressure in the tires of the vehicle 102.

[040] As shown in the example embodiment of FIG. 1, the controller 104 may monitor the air pressure of the one or more tires of the vehicle 102 sensed by the one or more sensors present in the TPMS 106. Further, the controller 104 may determine whether the air pressure of the one or more tires is within a predefined range. It may be noted that the predefined range of the air pressure may be defined based on the type of vehicle. When the air pressure is above the predefined range for a first set of one or more tires from a plurality of tires of the vehicle 102, the controller 104 may activate the one or more deflation valves 110 corresponding to the first set of one or more tires, to release a predetermined quantity of pressurized air. The predetermined quantity of pressurized air may be defined as a quantity of the pressurized air that is when released/received from/to a tire or the air tank, will keep the tire pressure within the predefined range. Further, when the air pressure is below the predefined range for a second set of one or more tires from the plurality of tires, the controller 104 may activate the one or more inflation valves corresponding to the second set of one or more tires, to receive the released predetermined quantity of the pressurized air. A detailed explanation of the system 104 is provided in the forthcoming paragraphs in conjunction with Figure 2.

[041] FIG. 2 illustrates a low-level architecture 200 of a tire pressure monitoring and control system, in accordance with some embodiments of the present disclosure.

[042] According to an embodiment, apart from the components such as at least one controller 202, at least one TPMS 212, one or more inflation valves 206, one or more deflation valves 204, air venture pump 214 and air tank 216, the low-level architecture of system may include additional components such as one or more T- valves 228, one or more pressure reduction valves 208, one or more non- return valves 220, one or more timer operated solenoid valves 210, one or more air rotary joints 222, to perform intended function of the present disclosure. As also described earlier, each tire of a plurality of tires (Tire-1.....Tire N) of the vehicle have its own individual system each of which is linked with the air tank 216 and air venture pump 214. In few examples, the one or more air rotary joints 220 are attached to respective tires and used to transfer pressurized air to or from the respective tires when required. In few examples, the one or more T- valves 212 are designed to enable the TPMS 212 to be fitted permanently to each of the plurality of tires while allowing open access to be able to inflate or deflate the tires with ease through the one or more air rotary joints 220. The at least one controller 208 is coupled to the TPMS 212 and to the one or more inflation valves 206 and the one or more deflation valves 204 to inflate or deflate tires. The one or more deflation valves 204 is coupled to the air venture pump 214 through the one or more pressure reduction valves

208, the one or more non- return valves 220, and one or more timer operated solenoid valves 210 in a sequential order.

[043] In operation, one or more sensors (not shown) of the at least one TPMS 212 may sense air pressure of the plurality of tires (Tire-1.....Tire N) of the vehicle 102. The at least one controller 202 may monitor the sensed air pressure of the one or more tires of the vehicle 102. The at least one controller 202 may determine whether the air pressure of the one or more tires is within a predefined range. As previously indicated, the predefined range of the air pressure may be defined or set based on the type of the vehicle. When the air pressure is above the predefined range for a first set of one or more tires from a plurality of tires of the vehicle 102, the at least one controller 202 may activate the one or more deflation valves 204 corresponding to the first set of one or more tires, to release a predetermined quantity of pressurized air. In one non-limiting example, the predetermined quantity of pressurized air may be defined as a quantity of the pressurized air that is when released/received from/by a tire, will keep the tire pressure within the predefined range. In one non- limiting example, when the air pressure is greater than the predefined range for the first set of the one or more tires, the at least one controller 202 may enable the one or more pressure reducing valves 208 coupled to the one or more deflation valves 204, to control releasing of the of the pressurized air from the first set of the one or more tires in a regulated manner. In some examples, the one or more pressure reducing valves 208 is a self-acting automatic control valve that reduces a higher unregulated air pressure, e. g. the pressurized air from the first set of the one or more tires, to a constant, reduced outlet pressure. Further, in some examples, back flow of pressurized air is prevented through use of the one or more non- return valve 220.

[044] In some examples, the at least one controller 202 may enable the one or more timer operated solenoid valves 210 to receive the predetermined quantity of the pressured air from the one or more pressure reducing valve. The at least one controller 202 may then enable the one or more timer operated solenoid valves 210 to release the predetermined quantity of the pressurized air for a predefined time period into the air venture pump 214. In one example, the predefined time period may be defined or set (for example, 5s, 10s etc.) as per implementation requirements depending on the type of vehicle. The pressure difference between air pressure inside the air tank and the pressure inside nozzle of the venture pump 214 creates a vacuum, which sucks in predetermined quantity of the pressurized air through the nozzle and into the venture pump 214.

[045] Further, when the air pressure is below the predefined range for a second set of one or more tires from the plurality of tires, the at least one controller 202 may activate the one or

more inflation valves 206 corresponding to the second set of one or more tires, to receive the released predetermined quantity of the pressurized air supplied by the venture pump 214.

[046] As an example, to the above embodiment, let us suppose that the predefined range of ideal air pressure in the tires is between 80-90PSI. Due to some load unbalancing on the vehicle, if the air pressure for the first set of tires is increased to 95 PSI which is above the predefined range, the controller will enable the corresponding deflation valves to release 5PSI of the pressurized air which will be momentarily stored in the air venture pump. At the same, if second set of tires are under inflation, i.e., the air pressure is below 80 PSI due to load unbalancing or weather conditions, the controller will activate the corresponding inflation valves to receive a certain quantity or whole of pressurized air from the released 5PSI of the pressurized air to inflate the second set of tires. Thus, the at least one controller 202 may maintain the air pressure of the first of set of one or more tires and the second set of one or more tires within the predefined range.

[047] In this manner, excess pressurized air of the one set one or more tires is consumed by another set of the one or more tires which requires inflation, thereby providing pressured air recovery. In other words, as no pressurized air is lost, the energy that would have otherwise required to pressurize the air to inflate the tires, is conserved.

[048] According to an embodiment, wherein when the air pressure is above the predefined range for the first set of the one or more tires, and wherein when the air pressure is not less than the predefined range for the second set of the one or more tires, the at least one controller 202 may activate the one or more deflation valves corresponding to the first set of the one or more tires, to release the predetermined quantity of the pressurized air into atmosphere. This is the case, when the air pressure of the first set of the one or more tires is more (let's suppose 95 PSI) than predefined range of ideal air pressure (such as 80-90PSI illustrated in previous example) and require deflation. However, the second set of the one or more tires do not require any inflation. That is to say, the air pressure of the second set of the one or more tires (let's suppose 85 PSI) is within and thus not less then the predefined range. Thus, the extra air pressure (i.e., 5PSI) of the first set of one or more tires will be released through the corresponding deflation valves in the atmosphere to maintain the air pressure in predefined range.

[049] According to an embodiment, wherein when the air pressure is less than the predefined range for the first set of the one or more tires, and wherein when the air pressure is within the predefined range for the second set of the one or more tires, the at least one controller 202 further configured to activate the one or more inflation valves 206 corresponding to the first

set of the one more tires, to receive a predetermined quantity of the pressurized air from the air tank 216. This is the case, when the air pressure of the first set of the one or more tires (let's suppose 75 PSI) is less than predefined range (such as 80-90PSI illustrated in previous examples) and requires inflation. However, the second set of the one or more tires do not have
5 extra air pressure. That is to say, the air pressure of the second set of the one or more tires (let's suppose 85 PSI) is within than the predefined range and thus need not to be deflated. Thus, the pressurized air (i.e., at least having 5PSI) required to inflate the first set of one or more tires will be received from the air tank only, to maintain the first of set of one or more tires in predefined range.

10 **[050]** According to an embodiment, wherein when the air pressure is greater than the predefined range for the first set of the one or more tires, the at least one controller 202 may activate the one or more deflation valves 204 corresponding to the first set of one or more tires from the plurality of tires, to release a predetermined quantity of the pressurized air. Further, wherein when the air pressure is less than the predefined range for the second set of the one or
15 more tires, and wherein when the released predetermined quantity of the pressurized air from the first set of the one or more tires is not sufficient to inflate the second set of the one or more tires, the at least one controller 202 may activate the one or more inflation valves 206 corresponding to the second set of the one or more tires, to receive the released predetermined quantity of the pressurized air from the first set of the one or more tires and receive another
20 predetermined quantity of the pressurized air from an air tank 216. This is the case, when the air pressure of the first set of the one or more tires is more (let's suppose 95 PSI) than predefined range of ideal air pressure (such as 80-90PSI illustrated in previous example) and require deflation. However, the amount of the pressurized air released by the corresponding deflation valves of the first set of the one or more tires is not sufficient to inflate the second set of the
25 one or more tires which requires, for example, 10 PSI of pressurized air. Thus, in this case, the controller 202 will activate the one or more inflation valves 206 corresponding to the second set of the one or more tires, to receive the 5PSI of the pressurized air from the first set of the one or more tires as well as 5 PSI of the pressurized air from the air tank 216.

30 **[051]** In one embodiment, the TPMS 212 may perform remote monitoring of tire pressure and tire temperature, which is achieved by the TPMS sensors mounted on stem valve of the tires that wirelessly communicate with the TPMS Gateway 224 installed in the vehicle. In one non-limiting example, the TPMS Gateway 224 is responsible to upload the recorded telematics along with real-time TPMS information to cloud which may be displayed at a computing device 226 of a vehicle operator or driver. Examples of the computing device 226 may include, but

not limited thereto, to a portable computer, a personal digital assistant, a handheld device (including a smartphone), a desktop, and a digital display on the vehicle.

[052] In each of the above discussed embodiments, the real time TPMS information is presented as a detailed TPMS report to the vehicle operator or driver to show alerts on potential threats caused by improper pressure and temperature of the tires. In one non-limiting example, the detailed TPMS report may include one or more graphs and details about type of vehicle, tire status (such as: inflated, high pressure, leakage, low pressure, issues with tires, etc.), type of alert depending on the tire status, location of vehicle, etc. Thus, detailed insights on the tire pressure and temperature may be presented on the computing device 226 of the vehicle operator or driver in a graphical and intuitive format.

[053] In one non-limiting example, a user can also set a threshold value for the tire pressure and temperature to get customized alerts on potential threats caused by improper pressure and temperature of the tire. In another non-limiting example, dedicated reports on tire pressure can be generated by the user to analyze the performance and health of the tires to carry out preventive maintenance and reduce sudden breakdowns or road accidents.

[054] Thus, as previously discussed, the present disclosure offers an integrated unit for monitoring and controlling the tire pressure that provides air recovery. Hence, vehicle and driver safety is increased and tire wear tear and fuel consumption is reduced. Therefore, there is an increase in overall increase the tire life cycle which reduces the carbon footprint (i.e., sustainable environment).

[055] FIG. 3 is a flowchart of a method for tire pressure monitoring and control, in accordance with an embodiment of the present disclosure. The order in which the method 300 is described is not intended to be construed as a limitation, and any number of the described method blocks can be combined in any order to implement the method 300 or alternate methods. Additionally, individual blocks may be deleted from the method 300 without departing from the spirit and scope of the subject matter described herein. Furthermore, the method can be implemented in any suitable hardware, software, firmware, or combination thereof. However, for ease of explanation, in the embodiments described below, the method 300 may be considered to be implemented by the at least one controller 202 and/or one more component described with reference to FIG. 2.

[056] At step 302, the method may include sensing an air pressure of one or more tires of a vehicle via one or more sensors. In one implementation, the TPMS 212 may sense the air pressure of one or more tires.

[057] At step 304, the method may include monitoring the air pressure of the one or more tires of the vehicle sensed by the one or more sensors. In one implementation, the at least one controller 202 may monitor the air pressure of the one or more tires of the vehicle sensed by the one or more sensors.

5 **[058]** At step 306, the method may include determining whether the air pressure of the one or more tires is within a predefined range. In one implementation, the at least one controller 202 may determine whether the air pressure of the one or more tires is within a predefined range by comparing the sensed pressured with the predefined range.

[059] At step 308, the method may include activating one or more deflation valves
10 corresponding to the first set of one or more tires, to release a predetermined quantity of pressurized air, when the air pressure is above the predefined range for a first set of one or more tires from the plurality of tires. In one implementation, the at least one controller 202 may activate one or more deflation valves corresponding to the first set of one or more tires. In accordance with an embodiment, wherein when the air pressure is greater than the predefined
15 range for the first set of the one or more tires, the method may include enabling a pressure reducing valve to control releasing of the of the pressurized air from the first set of the one or more tires in a regulated manner and preventing back flow of air through a non-return valve. In accordance with an embodiment, the method may further include enabling a time operated solenoid valve for receiving the predetermined quantity of the pressured air from the pressure
20 reducing valve, and for releasing the predetermined quantity of the pressurized air for a predefined time period into an air venture pump coupled to the time operated solenoid valve.

[060] At step 310, the method may include activating the one or more inflation valves corresponding to the second set of one or more tires, to receive the released predetermined quantity of the pressurized air, when the air pressure is below the predefined range for a second
25 set of the one or more tires from the plurality of tires. In one implementation, the at least one controller 202 may activate the one or more inflation valves corresponding to the second set of one or more tires. In accordance with an embodiment, the method may include enabling the one or more inflation valves for receiving the released predetermined quantity of the pressured air from the air venture pump to inflate the one or more tires.

30 **[061]** In one non-limiting example, when the air pressure is above the predefined range for the first set of the one or more tires, and wherein when the air pressure is not less than the predefined range for the second set of the one or more tires, then, the method may include activating the one or more deflation valves corresponding to the first set of one or more tires, to release the predetermined quantity of the pressurized air into atmosphere.

[062] In one non-limiting example, when the air pressure is less than the predefined range for the first set of the one or more tires, and wherein when the air pressure is within the predefined range for the second set of the one or more tires, the method may include activating the one or more inflation valves corresponding to the second set of the one more tires, to receive
5 a predetermined quantity of the pressurized air from an air tank.

[063] In one non-limiting example, wherein when the air pressure is greater than the predefined range for the first set of the one or more tires, the method may include activating the one or more deflation valves corresponding to a first set of one or more tires from the plurality of tires, to release a predetermined quantity of the pressurized air. Further, when the
10 air pressure is less than the predefined range for the second set of the one or more tires, and wherein when the released predetermined quantity of the pressurized air from the first set of one or more tires is not sufficient to inflate the second set of the one or more tires, the method may include activating the one or more inflation valves corresponding to the second set of the one or more tires, for receiving the released predetermined quantity of the pressurized air from
15 the first set of the one or more tires, and for receiving another predetermined quantity of the pressurized air from an air tank.

[064] In accordance with an embodiment, the method may include transmitting data including measured air pressure for the one or more tires to an external computing device via a transceiver. In one non-limiting example, the TPMS Gateway 224 installed in the vehicle 102
20 is responsible to upload the recorded telematic along with TPMS information (e. g. measured air pressure) to cloud which may be displayed at a computing device 226 of a vehicle operator.

[065] The illustrated steps are set out to explain the exemplary embodiments shown, and it should be anticipated that ongoing technological development will change the manner in which particular functions are performed. These examples are presented herein for purposes of
25 illustration, and not limitation. Further, the boundaries of the functional building blocks have been arbitrarily defined herein for the convenience of the description. Alternative boundaries can be defined so long as the specified functions and relationships thereof are appropriately performed.

[066] The foregoing method descriptions and the process flow diagrams are provided merely
30 as illustrative examples and are not intended to require or imply that the steps of the various embodiments must be performed in the order presented. As will be appreciated by one of skill in the art the order of steps in the foregoing embodiments may be performed in any order. Words such as “thereafter,” “then,” “next,” etc. are not intended to limit the order of the steps; these words are simply used to guide the reader through the description of the methods. Further,

any reference to claim elements in the singular, for example, using the articles “a,” “an” or “the” is not to be construed as limiting the element to the singular.

[067] In some example embodiments, certain ones of the operations herein may be modified or further amplified as described below. Moreover, in some embodiments additional optional operations may also be included. It should be appreciated that each of the modifications, optional additions or amplifications described herein may be included with the operations herein either alone or in combination with any others among the features described herein.

[068] The hardware used to implement the various illustrative logics, logical blocks, modules, and circuits described in connection with the aspects disclosed herein may include a general purpose processor, a digital signal processor (DSP), a special-purpose processor such as an application specific integrated circuit (ASIC) or a field programmable gate array (FPGA), a programmable logic device, discrete gate or transistor logic, discrete hardware components, or any combination thereof designed to perform the functions described herein. A general-purpose processor may be a microprocessor, but, in the alternative, the processor may be any conventional processor, controller, microcontroller, or state machine. A processor may also be implemented as a combination of computing devices, e.g., a combination of a DSP and a microprocessor, a plurality of microprocessors, one or more microprocessors in conjunction with a DSP core, or any other such configuration. Alternatively or additionally, some steps or methods may be performed by circuitry that is specific to a given function.

[069] In one or more example embodiments, the functions described herein may be implemented by special-purpose hardware or a combination of hardware programmed by firmware or other software. In implementations relying on firmware or other software, the functions may be performed as a result of execution of one or more instructions stored on one or more non-transitory computer-readable media and/or one or more non-transitory processor-readable media. These instructions may be embodied by one or more processor-executable software modules that reside on the one or more non-transitory computer-readable or processor-readable storage media. Non-transitory computer-readable or processor-readable storage media may in this regard comprise any storage media that may be accessed by a computer or a processor. By way of example but not limitation, such non-transitory computer-readable or processor-readable media may include random access memory (RAM), read-only memory (ROM), electrically erasable programmable read-only memory (EEPROM), FLASH memory, disk storage, magnetic storage devices, or the like. Disk storage, as used herein, includes compact disc (CD), laser disc, optical disc, digital versatile disc (DVD), floppy disk, and Blu-ray disc™, or other storage devices that store data magnetically or optically with

lasers. Combinations of the above types of media are also included within the scope of the terms non-transitory computer-readable and processor-readable media. Additionally, any combination of instructions stored on the one or more non-transitory processor-readable or computer-readable media may be referred to herein as a computer program product.

5 [070] Many modifications and other embodiments of the inventions set forth herein will come to mind to one skilled in the art to which these inventions pertain having the benefit of teachings presented in the foregoing descriptions and the associated drawings. Although the figures only show certain components of the apparatus and systems described herein, it is understood that various other components may be used in conjunction with the supply
10 management system. Therefore, it is to be understood that the inventions are not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Moreover, the steps in the method described above may not necessarily occur in the order depicted in the accompanying diagrams, and in some cases one or more of the steps depicted may occur substantially
15 simultaneously, or additional steps may be involved. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

[071] The various illustrative logical blocks, modules, circuits, and algorithm steps described in connection with the embodiments disclosed herein may be implemented as electronic hardware, computer software, or combinations of both. To clearly illustrate this
20 interchangeability of hardware and software, various illustrative components, blocks, modules, circuits, and steps have been described above generally in terms of their functionality. Whether such functionality is implemented as hardware or software depends upon the particular application and design constraints imposed on the overall system. Skilled artisans may implement the described functionality in varying ways for each particular application, but such
25 implementation decisions should not be interpreted as causing a departure from the scope of the present invention.

WE CLAIM:

1. A tire pressure monitoring and control system, comprising:
one or more sensors configured to sense air pressure of a plurality of tires of a vehicle;
one or more inflation valves (206) configured to receive pressurized air to inflate a one or more tires from the plurality of tires;
one or more deflation valves (204) configured to release the pressurized air from the one or more tires to deflate said one or more tires; and
at least one controller (202) coupled to the one or more sensors, the one or more inflation valves (206) and the one or more deflation valves (204), wherein the at least controller (202) is configured to:
monitor the air pressure of the one or more tires of the vehicle sensed by the one or more sensors;
determine whether the air pressure of the one or more tires is within a predefined range; and
wherein when the air pressure is above the predefined range for a first set of one or more tires from the plurality of tires, then to:
activate the one or more deflation valves (204) corresponding to the first set of one or more tires, to release a predetermined quantity of pressurized air; and
wherein when the air pressure is below the predefined range for a second set of one or more tires from the plurality of tires, then to:
activate the one or more inflation valves (206) corresponding to the second set of one or more tires, to receive the released predetermined quantity of the pressurized air.
2. The tire pressure monitoring and control system as claimed in claim 1, wherein when the air pressure is above the predefined range for the first set of the one or more tires, and
wherein when the air pressure is not less than the predefined range for the second set of the one or more tires, the at least one controller (202) further configured to:
activate the one or more deflation valves (204) corresponding to the first set of the one or more tires, to release the predetermined quantity of the pressurized air into atmosphere.
3. The tire pressure monitoring and control system as claimed in claim 1, wherein when the air pressure is less than the predefined range for the first set of the one or more tires, and
wherein when the air pressure is within the predefined range for the second set of the one or more tires, the at least one controller (202) further configured to:

activate the one or more inflation valves (206) corresponding to the first set of the one or more tires, to receive a predetermined quantity of the pressurized air from an air tank (216).

4. The tire pressure monitoring and control system as claimed in claim 1, wherein when the air pressure is greater than the predefined range for the first set of the one or more tires, the at least one controller (202) further configured to:

activate the one or more deflation valves (204) corresponding to the first set of one or more tires from the plurality of tires, to release a predetermined quantity of the pressurized air; and

wherein when the air pressure is less than the predefined range for the second set of the one or more tires, and wherein when the released predetermined quantity of the pressurized air from the first set of the one or more tires is not sufficient to inflate the second set of the one or more tires, then to:

activate the one or more inflation valves (206) corresponding to the second set of the one or more tires, to:

receive the released predetermined quantity of the pressurized air from the first set of the one or more tires; and

receive another predetermined quantity of the pressurized air from an air tank.

5. The tire pressure monitoring and control system as claimed in claim 1, further comprising one or more pressure reducing valves (208) coupled to the one or more deflation valves, wherein when the air pressure is greater than the predefined range for the first set of the one or more tires, the at least one controller (202) configured to:

enable the one or more pressure reducing valves to control releasing of the of the pressurized air from the first set of the one or more tires in a regulated manner and prevent back flow of air through a non- return valve (220).

6. The tire pressure monitoring and control system as claimed in claims 1 and 5, further comprising a time operated solenoid valve (210) and an air venturi pump coupled to the time operated solenoid valve, wherein the at least one controller (202) is configured to enable the time operated solenoid valve to:

receive the predetermined quantity of the pressurized air from the pressure reducing valve; and release the predetermined quantity of the pressurized air for a predefined time period into the air venturi pump (216).

7. The tire pressure monitoring and control system as claimed in claim 6, the at least one controller is further configured to:
enable the one or more inflation valves (206) to receive the released predetermined quantity of the pressured air from the air venture pump (216) to inflate the one or more tires.
8. The tire pressure monitoring and control system as claimed in claim 1, further comprising a transceiver coupled to the at least one controller, wherein the transceiver configured to transmit data including a measured air pressure for the one or more tires to an external computing device (226).
9. A method for tire pressure monitoring and control comprising:
sensing (302) an air pressure of one or more tires of a vehicle via one or more sensors;
monitoring (204) the air pressure of the one or more tires of the vehicle sensed by the one or more sensors;
determining (306) whether the air pressure of the one or more tires is within a predefined range; and
wherein when the air pressure is above the predefined range for a first set of one or more tires from the plurality of tires, then:
activating (308) one or more deflation valves (204) corresponding to the first set of one or more tires, to release a predetermined quantity of pressurized air; and
wherein when the air pressure is below the predefined range for a second set of the one or more tires from the plurality of tires, then:
activating (310) the one or more inflation valves (206) corresponding to the second set of one or more tires, to receive the released predetermined quantity of the pressurized air.
10. The method as claimed in claim 9, wherein when the air pressure is above the predefined range for the first set of the one or more tires, and wherein when the air pressure is not less than the predefined range for the second set of the one or more tires, then:
activating the one or more deflation valves (204) corresponding to the first set of one or more tires, to release the predetermined quantity of the pressurized air into atmosphere.

11. The method as claimed in claim 9, wherein when the air pressure is less than the predefined range for the first set of the one or more tires, and wherein when the air pressure is within the predefined range for the second set of the one or more tires, then:

activating the one or more inflation valves (206) corresponding to the second set of the one or more tires, to receive a predetermined quantity of the pressurized air from an air tank (216).

12. The method as claimed in claim 9, wherein when the air pressure is greater than the predefined range for the first set of the one or more tires, then:

activating the one or more deflation valves (204) corresponding to a first set of one or more tires from the plurality of tires, to release a predetermined quantity of the pressurized air; and

wherein when the air pressure is less than the predefined range for the second set of the one or more tires, and wherein when the released predetermined quantity of the pressurized air from the first set of one or more tires is not sufficient to inflate the second set of the one or more tires, then:

activating the one or more inflation valves (206) corresponding to the second set of the one or more tires, for:

receiving the released predetermined quantity of the pressurized air from the first set of the one or more tires; and

receiving another predetermined quantity of the pressurized air from an air tank (216).

13. The method as claimed in claim 9, further comprising:

wherein when the air pressure is greater than the predefined range for the first set of the one or more tires, enabling one or more pressure reducing valves (208) to control releasing of the of the pressurized air from the first set of the one or more tires in a regulated manner and preventing back flow of air through a non- return valve (220).

14. The method as claimed in claim 9 and 13, further comprising:

enabling one or more time operated solenoid valves (210) for:

receiving the predetermined quantity of the pressured air from the one or more pressure reducing valves (208); and

releasing the predetermined quantity of the pressurized air for a predefined time period into an air venture pump coupled to the one or more time operated solenoid valves (210).

15. The method as claimed in claim 14, further comprising:
enabling the one or more inflation valves (206) for receiving the released predetermined quantity of the pressured air from the air venture pump to inflate the one or more tires.

16. The method as claimed in claim 9, further comprising:
transmitting data including measured air pressure for the one or more tires to an external computing device via a transceiver.

Dated this 21st day of March 2023

-- Digitally Signed--
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ABSTRACT

“METHOD AND SYSTEM FOR TIRE PRESSURE MONITORING AND CONTROL WITH AIR RECOVERY”

Disclosed herein is a system and method for tire pressure monitoring and control. The method includes sensing an air pressure of one or more tires of a vehicle via one or more sensors, monitoring the air pressure of the one or more tires of the vehicle sensed by the one or more sensors. The method further includes determining whether the air pressure of the one or more tires is within a predefined range. The method further includes, wherein when the air pressure is above the predefined range for a first set of one or more tires from the plurality of tires, then, activating one or more deflation valves corresponding to the first set of one or more tires, to release a predetermined quantity of pressurized air and wherein when the air pressure is below the predefined range for a second set of the one or more tires from the plurality of tires, then, activating the one or more inflation valves corresponding to the second set of one or more tires, to receive the released predetermined quantity of the pressurized air.

[Fig. 3]

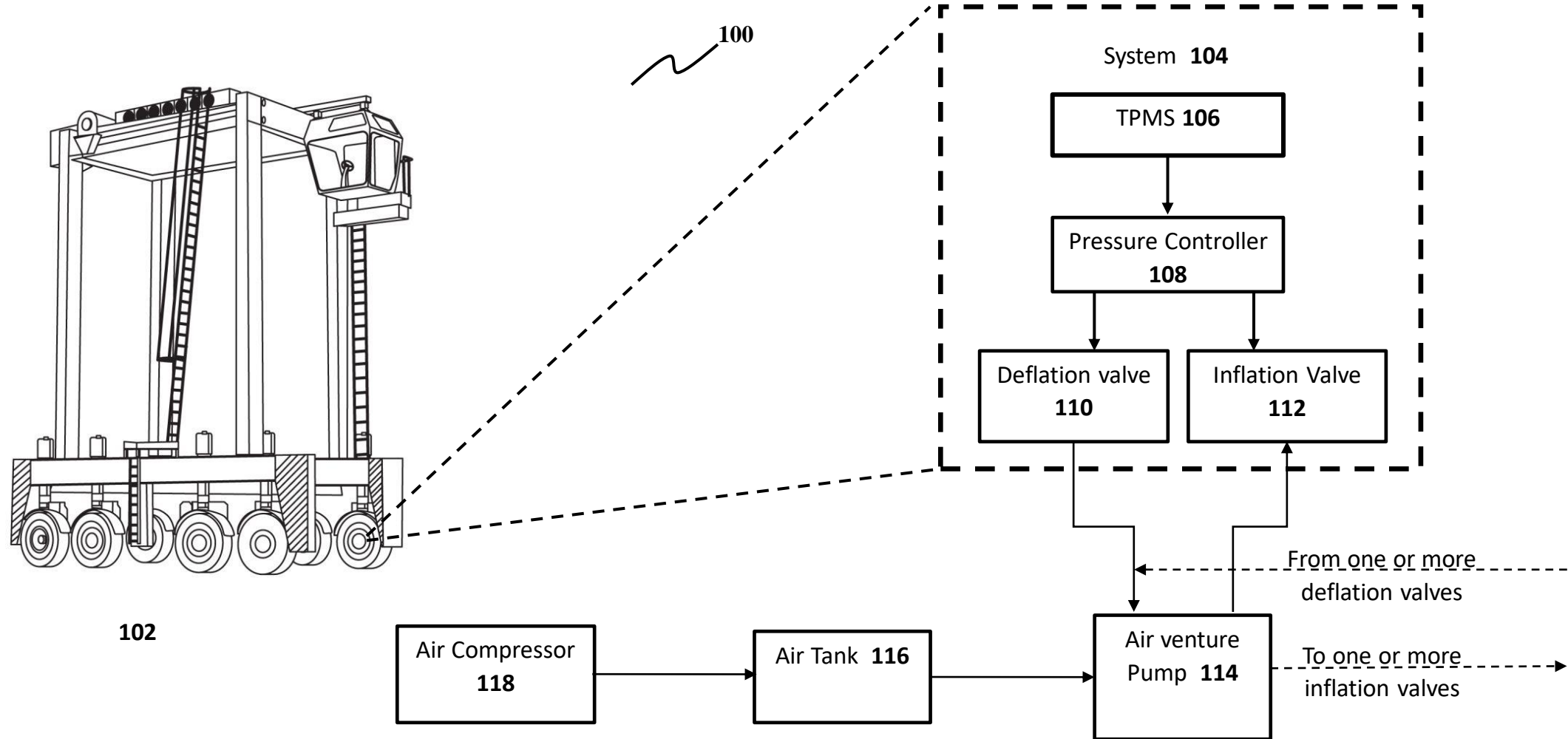


FIG. 1

200

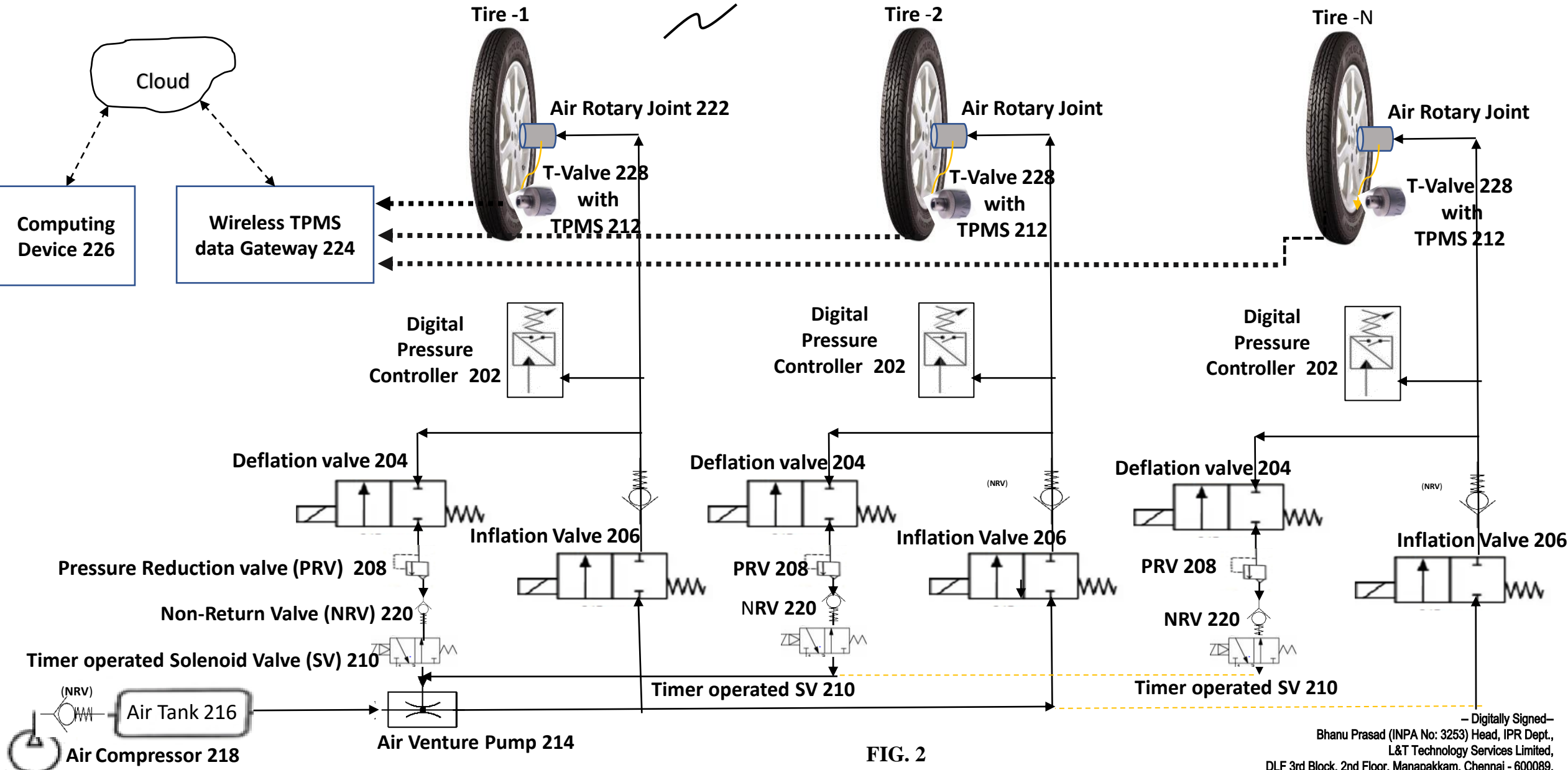


FIG. 2

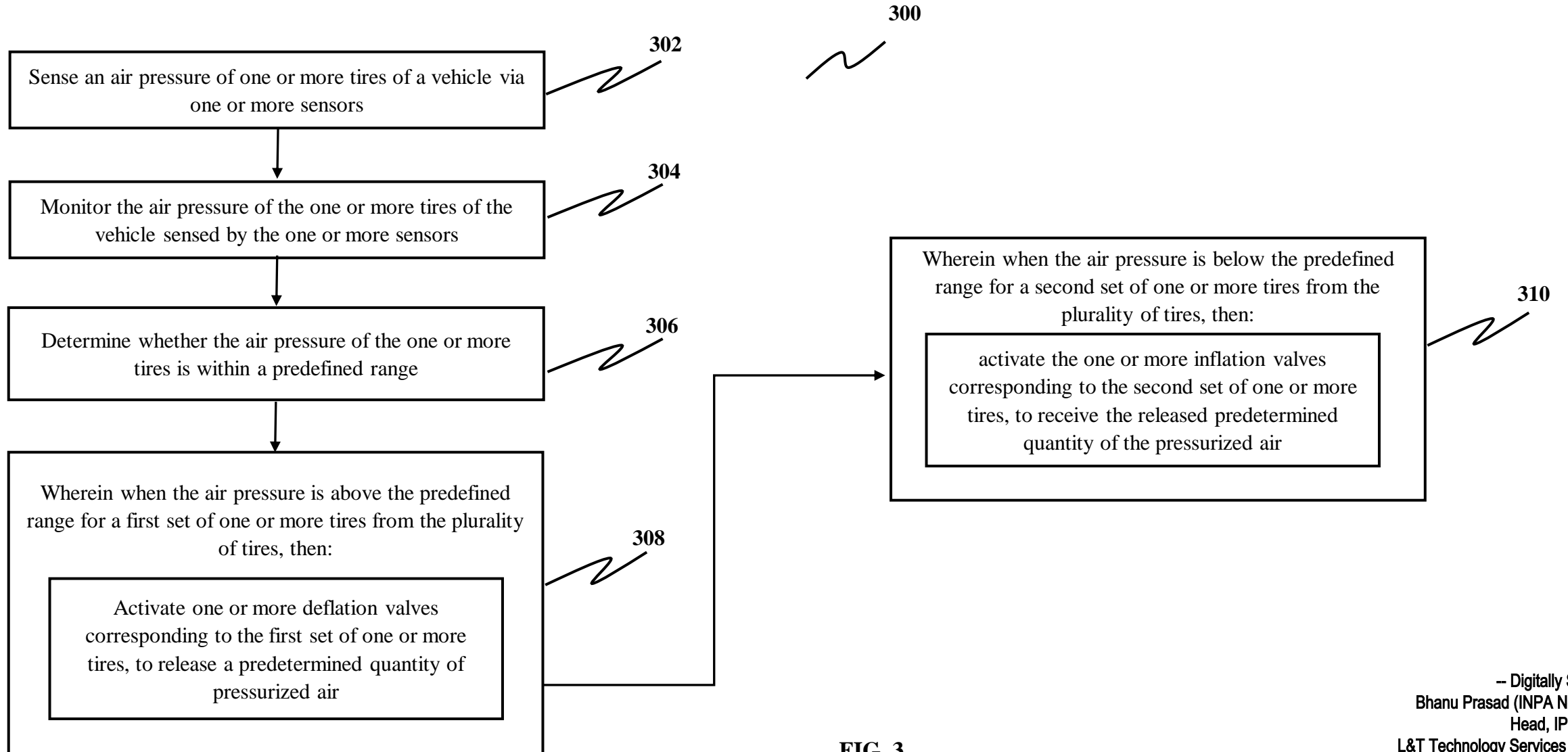


FIG. 3