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(54) **SELF-MONITORING TIRE OF VEHICLE**

SELBSTÜBERWACHENDER REIFEN EINES FAHRZEUGS

AUTO-SURVEILLANCE DE PNEU DE VÉHICULE

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(73) Proprietor: **Alpha Networks Inc.**
30078 Hsinchu (TW)

(72) Inventors:
- **WANG, Chun-Yuan**
  30078 Hsinchu (TW)
- **KUO, Rong-Fa**
  30078 Hsinchu (TW)
- **LEE, Chung-Wang**
  30078 Hsinchu (TW)

(74) Representative: **Reichert & Lindner Partnerschaft Patentanwälte**
Stromerstr. 2A
93049 Regensburg (DE)

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a tire of a vehicle, and more particularly to a self-monitoring tire of a vehicle.

BACKGROUND OF THE INVENTION

[0002] An unexpected tire condition is one of the most bothering and worrying problems for drivers, and it is usually hard for a driver to take prompt reaction to an emergent situation when a tire of a vehicle on the road goes wrong. For preventing or minimizing occurrence of unexpected tire conditions, a tire pressure monitoring system (TPMS) has been developed to automatically monitor whether the tire pressure is in a normal tire pressure range, and to dynamically detect whether air leakage from the tire happens or not.

[0003] Conventional tire-pressure monitoring systems, such as DE 199 24 830 A1, US 6,087,930 A, EP 0 505 906 A1, include direct ones and indirect ones. An indirect tire-pressure monitoring system is implemented with a wheel speed sensor, and insufficient tire pressure is determined when a wheel speed difference exceeding a threshold happens among wheels of a vehicle. In contrast, a direct tire-pressure monitoring system is implemented with a pressure sensor installed onto each tire of a vehicle to detect individual tire pressure. The detected information is transmitted to a receiver around the driver seat to be monitored. Since the indirect tire-pressure monitoring system cannot show abnormal tire conditions for more than one tire at the same time, the direct tire-pressure monitoring system has been the mainstream of tire pressure monitoring techniques in the market so far.

[0004] Conventional direct tire-pressure monitoring systems include internal tire-pressure sensors, for example JP 2010 145277 A, and external tire-pressure sensors, for example EP 0 689 950 A2. An external tire-pressure sensor is installed onto a tire of a vehicle at a position where a gas nozzle cap is supposed to be onto a tire of a vehicle, while an internal tire-pressure sensor is installed into a tire of a vehicle. Thus, the internal tire-pressure sensor extends into a space between the tire and a corresponding rim, so the installation is uneasy. In contrast, the external tire-pressure sensor can be installed easily which being subject to damage or malfunction due to exposure to unpredictable environment.

SUMMARY OF THE INVENTION

[0005] Therefore, the present invention provides a tire-pressure monitoring system which is embedded in a tire without additional installation, and protected from environmental threats.

[0006] The present invention provides a self-monitoring tire, comprises a tire body and a tire pressure sensor. The tire body includes a tread rubber for contact with ground, a bead for coupling to a rim, and a sidewall structure including two portions disposed at opposite sides of the tread rubber, and extending from opposite sides of the tread rubber to the bead. The tire pressure sensor is disposed between respective outward surfaces of the two portions of the sidewall structure, and secured on or embedded in either one of the two portions of the sidewall structure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The invention will become more readily apparent to those ordinarily skilled in the art after reviewing the following detailed description and accompanying drawings, in which:

FIG. 1 is a schematic diagram illustrating an elevational cross-sectional view of a self-monitoring tire according to an embodiment of the present invention;

FIG. 2 is a circuit block diagram illustrating a tire pressure sensor used in a self-monitoring tire according to an embodiment of the present invention;

FIG. 3A is a schematic diagram illustrating disposition of a tire pressure sensor in a self-monitoring tire according to an embodiment of the present invention;

FIG. 3B is a schematic diagram illustrating disposition of a tire pressure sensor in a self-monitoring tire according to another embodiment of the present invention;

FIG. 3C is a schematic diagram illustrating disposition of a tire pressure sensor in a self-monitoring tire according to a further embodiment of the present invention;

FIG. 3D is a schematic diagram illustrating disposition of a tire pressure sensor in a self-monitoring tire according to a further embodiment of the present invention; and

FIG. 4 is a schematic diagram illustrating disposition of a tire pressure sensor in a self-monitoring tire according to still another embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0008] The invention will now be described more specifically with reference to the following embodiments. It is to be noted that the following descriptions of preferred embodiments of this invention are presented herein for purpose of illustration and description only. For example, the expressions relating to directions such as over, under, left and right, are presented with reference to the annexed drawings. It is not intended to be exhaustive or to be limited to the precise form disclosed.

[0009] Please refer to FIG. 1, which schematically illustrates a self-monitoring tire according to an embodiment of the present invention. The tire 10 is used in a vehicle and includes a tire body 100, a wire layer 110 and a tire pressure sensor 130. The tire body 100 includes a tread rubber 102, a bead 104 and a sidewall structure 106. The tread rubber 102 has a tread pattern 150 in direct contact with ground when the vehicle is on the road. The bead 104 is coupled to a rim (not shown) to facilitate installation of the tire 10 onto the rim. The sidewall structure 106 includes two portions disposed at opposite sides of the tread rubber 102, and extends from opposite sides of the tread rubber 102 to the bead 104. The wire layer 110 is wrapped with the tire body 100, and includes a steel belt 112 disposed inside the tread rubber 102 and under the tread pattern 150, and carcass wire layers 114 and 116 disposed inside the portions of the sidewalls structure 106, respectively. The tire pressure sensor 130 is installed at the sidewall structure 106.

[0010] It should be noted that the position of the tire pressure sensor 130 shown in FIG. 1 is for illustration only. FIG. 1 is used for embodying the disposition of the tire pressure sensor 130 inside the sidewall structure 106, i.e. between a left side face of the left portion of the sidewall structure 106 and a right side face of the right portion of the sidewall structure 106. The examples of disposition of the tire pressure sensor to render different embodiments of the self-monitoring tire according to the present invention will be described in more detail with reference to FIGS. 3A-3D and 4.

[0011] Please refer to FIG. 2, which schematically shows a circuit block diagram of the tire pressure sensor 130 as shown in FIG. 1. In this embodiment, the tire pressure sensor 20 is implemented with a circuit board 20 on which a pressure sensing chip 200 and a wireless transmitting device 210 are installed. For detecting a pressure imposed on the tire by the environment, a pressure sensing zone 202 is reserved on the pressure sensing chip 200, and in response to a pressure imposed on the pressure sensing zone 202, a pressure information is generated. The pressure information, after being processed by the pressure sensing chip 200, is converted into a set of electronic data. The wireless transmitting device 210 is electrically coupled to the pressure sensing chip 200, receives the electronic data from the pressure sensing chip 200, and transmits the electronic data outwards in a wireless manner. The circuit board 20 for carrying the pressure sensing chip 200 and the wireless transmitting device 210 may be a general printed circuit board (PCB) or a flexible PCB.

[0012] Hereinafter, Figures 3A, 3B and 3C schematically illustrate different disposition examples of a tire pressure sensor in a self-monitoring tire according to the present invention. The cross-sectional views of Figures 3A, 3B and 3C are taken from a portion between the AA' line and the BB' line. For focusing on the implementation of the tire pressure sensor according to the present invention, only relative positions of sidewall structure 300, wire layer 310, PCB 302 and tire pressure sensor including PCB 302 and pressure sensor chip 304 are shown in the figures.

[0013] As shown in the example of FIG. 3A, the sidewall structure 300 includes an outward surface 300a and an inward surface 300b. The wire layer 310 is embedded into the sidewall structure 300 between the outward surface 300a and the inward surface 300b. The PCB 302 and pressure sensor chip 304 of the tire pressure sensor are secured onto the inward surface 300b of the sidewall structure 300. The outward surface 300a as described above is the surface where the sidewall structure 300 contacts an environmental object, while the inward surface 300b is the surface where the sidewall structure 300 contacts an inner tube (not shown) or filling gas inside the tire body. In this embodiment, the tire pressure sensor can readily sense the pressure imposed thereon by the inner tube or filling gas inside the tire body, and transmit the pressure information to a corresponding receiver, e. g. a tire pressure display of the vehicle (not shown).

[0014] The embodiment as shown in FIG. 3B is similar to that as shown in FIG. 3A. For example, the sidewall structure 300 includes an outward surface 300a and an inward surface 300b, and the wire layer 310 is embedded into the sidewall structure 300 between the outward surface 300a and the inward surface 300b. This embodiment differs from the embodiment of FIG. 3A in that the PCB 302 and pressure sensor chip 304 of the tire pressure sensor are embedded in the sidewall structure 300 between the wire layer 310 and the inward surface 300b of the sidewall structure 300. In addition, a protective layer 306 overlying the entire pressure sensing chip 304 and partial or entire PCB 302, and a gas tunnel 308 for free gas flow are provided. The gas tunnel 308 penetrates through the protective later 306 so as to allow the gas inside the tire to reach the pressure sensing chip 304, e. g. the pressure sensing zone 202 as illustrated in FIG. 2. Since the pressure sensing chip 304 and the circuit board 302 are covered and protected with the protective layer 306, material for producing the sidewall structure 300 would not contact the protected parts of the pressure sensing chip 304 and the circuit board 302 during the manufacturing process of the tire. Since the gas tunnel 308 is uncovered from the inward surface 300b and the gas pressure inside the gas tunnel 308 always keeps balanced with the pressure inside the tire, the pressure sensing chip 304 covered by the protective layer 306 can still detect tire pressure via the gas tunnel 308.

[0015] The embodiment as shown in FIG. 3C is similar to that as shown in FIG. 3B. For example, the sidewall structure 300 includes an outward surface 300a and an inward surface 300b, and the wire layer 310 is embedded into the sidewall structure 300 between the outward surface 300a and the inward surface 300b. The sidewall structure 300 in this embodiment also includes a protective layer 306, which not only protects the entire pressure sensing chip 304 but also protect partial or entire PCB 302. This embodiment differs from the embodiment of

FIG. 3B in a few aspects. First of all, in this embodiment, a deformation detector, which detects a deforming degree of the sidewall structure 300 of a tire is used as the pressure sensing chip 304. As known, the sidewall structure 300 is subject to deformation due to a tire pressure, and the deforming degree of the sidewall structure 300 varies with the level of the tire pressure. Therefore, the tire pressure can be monitored by detecting a deforming degree of the sidewall structure or a member integrated with the sidewall structure 300, e.g. the circuit board 302 or the protective layer 306. For example, an oscillation circuit of the PCB 302 may function for sensing the deforming degree. When deformation occur, the oscillating frequency of the oscillating circuit will change, and the oscillating frequency change corresponds to a change of the tire pressure. In another example, distributed impedance is adapted for sensing the deforming degree. When deformation occurs so as to change current cross area, equivalent impedance will change accordingly to result in a different electric level, and the equivalent impedance change corresponds to a change of the tire pressure. In addition, in this embodiment, no gas tunnel is provided for tire pressure sensing because the tire pressure sensing in this embodiment is not conducted by detecting the gas pressure inside the tire directly. Nevertheless, a gas tunnel may still be reserved for providing a space for a deforming structure so as to protect the circuit board 302. Furthermore, without considering a gas tunnel, the tire pressure sensor may be disposed at any place of the sidewall structure and may face any direction. For example, in the embodiment shown in FIG. 3C, the tire pressure sensor is disposed between the wire layer 310 and the outward surface 300a of the sidewall structure 300, and has the pressure sensing chip 304 and the protective layer 306 disposed between the circuit board 302 and the wire layer 310. Alternatively, the position is not limited and the orientation may be changed, e.g. to have the circuit board 302 closer to the wire layer 310 than the pressure sensing chip 304 and the protecting layer 306.

[0016] The embodiment as shown in FIG. 3D is also similar to that as shown in FIG. 3B. For example, the sidewall structure 300 includes an outward surface 300a and an inward surface 300b, and the wire layer 310 is embedded into the sidewall structure 300 between the outward surface 300a and the inward surface 300b. The sidewall structure 300 in this embodiment also includes a protective layer 306, which not only protects the entire pressure sensing chip 304 but also protect partial or entire PCB 302. The embodiment as shown in FIG. 3D is different from the embodiment as shown in FIG. 3B in that the gas tunnel 308 is sealed in the sidewall structure 300 without free gas flow to or from the inner room of the tire. Therefore, the tire pressure sensing is not conducted by detecting the gas pressure inside the tire directly. Instead, the tire pressure sensing is conducted by detecting the pressure of the gas existing in the sealed gas tunnel 308. Since the pressure in the gas tunnel 308 may change due to the compression of the sidewall structure 300, e.g. the shift of the inward surface 300b resulting from the tire pressure change inside the tire, the pressure of the gas existing in the sealed gas tunnel 308 can reflect the tire pressure inside the tire.

[0017] Please refer to FIG. 4, in which disposition of a tire pressure sensor in a self-monitoring tire according to still another embodiment of the present invention is illustrated. In this embodiment, the sidewall structure 400 of the tire includes a sidewall rubber 410 having a surface serving as an outward surface 400a of the sidewall structure 400, a polyester layer 420 and an inner liner 430 having a surface serving as an inward surface 400b of the sidewall structure 400. The tire pressure sensor can be disposed at any proper position of the sidewall structure 400 between the outward surface 400a and the inward surface 400b. For example, the tire pressure sensor as shown in FIG. 3C may be used in this embodiment and installed at a zone 402 or any other suitable position between the sidewall rubber 410 and the polyester layer 420. Alternatively, the tire pressure sensor as shown in FIG. 3B or FIG. 3C may be used in this embodiment and installed at a zone 404 or any other suitable position between the inner liner 430 and the polyester layer 420. Furthermore, the tire pressure sensor has a distance from the wire layer 440, which varies with practical designs.

[0018] According to the present invention and referring to FIG. 1, the tire pressure sensor is disposed between respective exterior faces of the two portions of the sidewall structure 106 and securely embedded in either one of the portions of sidewall structure 106. The tire pressure sensor may include, in addition to the pressure sensing chip and the wireless transmitting device installed on a PCB, other sensing means for facilitating vehicular operations, e.g. a thermos sensor or a g-sensor. The additional sensing means may also be electrically coupled to the wireless transmitting device, thereby transmitting the sensing results, e.g. temperature or gravity variations, to the corresponding receivers outside the tire. The wireless transmitting device, for example, may be an electromagnetic transmitter or a sonic transmitter. The PCB described above may be a circuit board manufactured by three-dimensional printing. If the PCB is disposed closely enough to an outward surface of the tire, the tire pressure can be estimated by detecting the deforming degree of the tire.

[0019] For improving wireless transmitting capability, according to an embodiment of the present invention, the wire layer of the tire body, which includes a steel belt and other steel wires, may additionally function as a part of an antenna of the wireless transmitting device. Practical antenna designs should take many factors such as positions, configurations, clearances and orientations into considerations. Furthermore, the wire layer may be used as an induction coil or antenna of a wireless recharger for supplying power to the tire pressure sensor or supplying power to another device from which the tire pressure is powered.

[0020] To sum up, with the tire pressure sensor built in the tire according to the present invention, the tire pressure can be self-monitored without additional installation. If the tire pressure sensor is disposed inside the tire body and secured onto the sidewall structure, the impact of the environment on the tire pressure sensor can be minimized so as to avoid damage. Moreover, additional information, e.g. tire producing history, new tire information, or reproduced tire information, may be recorded in the tire pressure sensor and accessed for tire safety diagnosis.

Claims

1. A self-monitoring tire, comprising:

a tire body (100), comprising:

a tread rubber (102) for contact with ground;
a bead (104) for coupling to a rim; and
a sidewall structure (106, 300, 400) including two portions disposed at opposite sides of the tread rubber (102), and extending from opposite sides of the tread rubber (102) to the bead (104); and

a tire pressure sensor (130, 20), wherein the tire pressure sensor (130, 20) is disposed between respective outward surfaces (300a, 400a) of the two portions of the sidewall structure (106, 300, 400), and secured on or embedded in either one of the two portions of the sidewall structure (106, 300, 400),
characterized in that wherein the tire pressure sensor (130, 20) has a gas tunnel (308), which is sealed in a selected one of the two portions of the sidewall structure (106, 300, 400) at an inward surface (300b, 400b) of the selected portion of the sidewall structure (106, 300, 400) without free gas flow to or from an inner room of the tire, and tire pressure sensing is conducted by detecting gas pressure existing in the sealed gas tunnel (308).

2. The tire according to claim 1, further comprising a wire layer (110, 310, 440) embedded in the tire body (100), wherein the tire pressure sensor (130, 20) is disposed between an inward surface (300b, 400b) of either one of the two portions of the sidewall structure (106, 300, 400) and the wire layer (110, 310, 440), or the tire pressure sensor (130, 20) is disposed between an outward surface (300a, 400a) of the either one of the two portions of the sidewall structure (106, 300, 400) and the wire layer (110, 310, 440).

3. The tire according to claim 2, the tire pressure sensor (130, 20) including:

a circuit board (20, 302);
a pressure sensing chip (200, 304) disposed on the circuit board (20, 302) and having a pressure sensing zone (202) where a pressure is detected;
a protective layer (306) covering the pressure sensing chip (200, 304) and at least partially the circuit board (20, 302), and reserving the gas tunnel (308) in communication with the pressure sensing zone (202); and
a wireless transmitting device (210) electrically coupled to the circuit board (20, 302) and having an antenna for wirelessly transmitting out an information associated with the pressure detected in the pressure sensing zone (202).

4. The tire according to claim 2, wherein the antenna of the wireless transmitting device (210) is implemented with the wire layer (110, 310, 440).

5. The tire according to claim 1, wherein the tire pressure sensor (130, 20) is disposed on an inward surface (300b, 400b) of one of the two portions of the sidewall structure (106, 300, 400).

6. The tire according to claim 5, further comprising a wire layer (110, 310, 410) embedded in the tire body (100).

7. The tire according to claim 6, wherein the antenna of the wireless transmitting device (210) is implemented with the wire layer (110, 310, 440).

Patentansprüche

1. Selbstüberwachender Reifen, umfassend:

einen Reifenkörper (100), umfassend:

einen Laufflächengummi (102) zum Kontakt mit dem Boden;
einen Wulst (104) zum Koppeln mit einer Felge; und
eine Seitenwandstruktur (106, 300, 400), die zwei Abschnitte aufweist, die auf gegenüberliegenden Seiten des Laufflächengummis (102) angeordnet sind und sich von gegenüberliegenden Seiten des Laufflächengummis (102) zu dem Wulst (104) erstrecken; und

einen Reifendrucksensor (130, 20), wobei der Reifendrucksensor (130, 20) zwischen jeweiligen Außenflächen (300a, 400a) der beiden Abschnitte der Seitenwandstruktur (106, 300, 400) angeordnet ist und an jedem der beiden Abschnitte der Seitenwandstruktur (106, 300, 400) gesichert oder in diese eingebettet ist,

dadurch gekennzeichnet, dass der Reifendrucksensor (130, 20) einen Gastunnel (308) aufweist, der in einem ausgewählten der beiden Abschnitte der Seitenwandstruktur (106, 300, 400) an einer Innenfläche (300b, 400b) des ausgewählten Abschnitts der Seitenwandstruktur (106, 300, 400) ohne einen Strom freien Gases zu oder von einem Innenraum des Reifens abgedichtet ist, und dass das Erfassen des Reifendrucks durch Detektieren eines in dem abgedichteten Gastunnel (308) vorhandenen Gasdrucks ausgeführt wird.

2. Reifen nach Anspruch 1, ferner umfassend eine Drahtschicht (110, 310, 440), die in den Reifenkörper (100) eingebettet ist, wobei der Reifendrucksensor (130, 20) zwischen einer Innenfläche (300b, 400b) von jedem der beiden Abschnitte der Seitenwandstruktur (106, 300, 400) und der Drahtschicht (110, 310, 440) angeordnet ist, oder der Reifendrucksensor (130, 20) ist zwischen einer Außenfläche (300a, 400a) von jedem der beiden Abschnitte der Seitenwandstruktur (106, 300, 400) und der Drahtschicht (110, 310, 440) angeordnet.

3. Reifen nach Anspruch 2, wobei der Reifendrucksensor (130, 20) Folgendes umfasst:

eine Leiterplatte (20, 302);
einen Druckerfassungschip (200, 304), der auf der Leiterplatte (20, 302) angeordnet ist und eine Druckerfassungszone (202) aufweist, in welcher ein Druck detektiert wird;
eine Schutzschicht (306), die den Druckerfassungschip (200, 304) und mindestens teilweise die Leiterplatte (20, 302) abdeckt und den Gastunnel (308) in Kommunikation mit der Druckerfassungszone (202) bewahrt; und
eine drahtlose Übertragungsvorrichtung (210), die elektrisch mit der Leiterplatte (20, 302) gekoppelt ist und eine Antenne zum drahtlosen Übertragen von Informationen nach außen aufweist, die mit dem in der Druckerfassungszone (202) erfassten Druck assoziiert sind.

4. Reifen nach Anspruch 2, wobei die Antenne der drahtlosen Übertragungsvorrichtung (210) mit der Drahtschicht (110, 310, 440) implementiert ist.

5. Reifen nach Anspruch 1, wobei der Reifendrucksensor (130, 20) auf einer Innenfläche (300b, 400b) von einem der beiden Abschnitte der Seitenwandstruktur (106, 300, 400) angeordnet ist.

6. Reifen nach Anspruch 5, ferner umfassend eine Drahtschicht (110, 310, 410), die in den Reifenkörper (100) eingebettet ist.

7. Reifen nach Anspruch 6, wobei die Antenne der drahtlosen Übertragungsvorrichtung (210) mit der Drahtschicht (110, 310, 440) implementiert ist.

Revendications

1. Pneu à autocontrôle, comprenant :
un corps de pneu (100), comprenant :

une gomme de bande de roulement (102) pour un contact avec le sol ;
un talon (104) pour un couplage à une jante ; et
une structure de paroi latérale (106, 300, 400) comportant deux portions disposées au niveau de côtés opposés de la gomme de bande de roulement (102), et s'étendant depuis des côtés opposés de la gomme de bande de roulement (102) jusqu'au talon (104) ; et
un capteur de pression de pneu (130, 20), dans lequel le capteur de pression de pneu (130, 20) est disposé entre des surfaces vers l'extérieur (300a, 400a) respectives des deux portions de la structure de paroi latérale (106, 300, 400), et arrimé sur ou incorporé à l'une ou l'autre des deux portions de la structure de paroi latérale (106, 300, 400),
caractérisé en ce que le capteur de pression de pneu (130, 20) a un tunnel de gaz (308), qui est étanche dans une portion sélectionnée des deux portions de la structure de paroi latérale (106, 300, 400) au niveau d'une surface vers l'intérieur (300b, 400b) de la portion sélectionnée de la structure de paroi latérale (106, 300, 400) sans écoulement de gaz libre vers ou depuis une chambre interne du pneu, et un captage de pression de pneu est effectué par détection d'une pression de gaz existant dans le tunnel de gaz (308) étanche.

2. Pneu selon la revendication 1, comprenant en outre une couche de fil (110, 310, 440) incorporée au corps de pneu (100), dans lequel le capteur de pression de pneu (130, 20) est disposé entre une surface vers l'intérieur (300b, 400b) de l'une ou l'autre des deux portions de la structure de paroi latérale (106, 300, 400) et la couche de fil (110, 310, 440), ou le capteur de pression de pneu (130, 20) est disposé entre une surface vers l'extérieur (300a, 400a) de l'une ou l'autre des deux portions de la structure de paroi latérale (106, 300, 400) et la couche de fil (110, 310, 440).

3. Pneu selon la revendication 2, le capteur de pression de pneu (130, 20) comportant :

une carte de circuit imprimé (20, 302) ;
une puce de captage de pression (200, 304) disposée sur la carte de circuit imprimé (20, 302) et ayant une zone de captage de pression (202) où une pression est détectée ;
une couche protectrice (306) couvrant la puce de captage de pression (200, 304) et au moins partiellement la carte de circuit imprimé (20, 302), et réservant le tunnel de gaz (308) en communication avec la zone de captage de pression (202) ; et
un dispositif de transmission sans fil (210) couplé électriquement à la carte de circuit imprimé (20, 302) et ayant une antenne pour transmettre sans fil une information associée à la pression détectée dans la zone de captage de pression (202).

4. Pneu selon la revendication 2, dans lequel l'antenne du dispositif de transmission sans fil (210) est mise en oeuvre avec la couche de fil (110, 310, 440).

5. Pneu selon la revendication 1, dans lequel le capteur de pression de pneu (130, 20) est disposé sur une surface vers l'intérieur (300b, 400b) de l'une des deux portions de la structure de paroi latérale (106, 300, 400).

6. Pneu selon la revendication 5, comprenant en outre une couche de fil (110, 310, 410) incorporée au corps de pneu (100).

7. Pneu selon la revendication 6, dans lequel l'antenne du dispositif de transmission sans fil (210) est mise en œuvre avec la couche de fil (110, 310, 440).

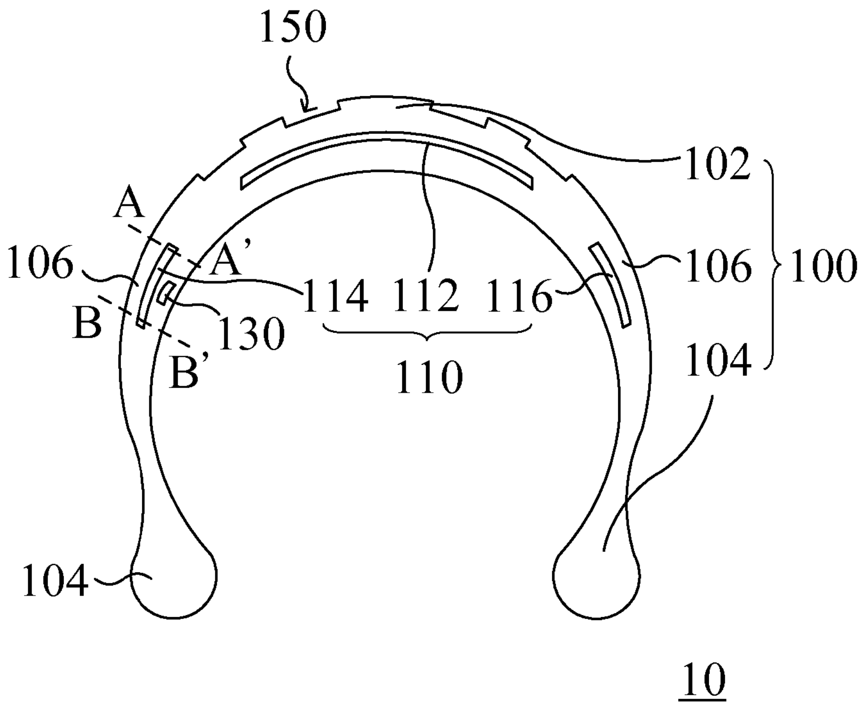

FIG. 1

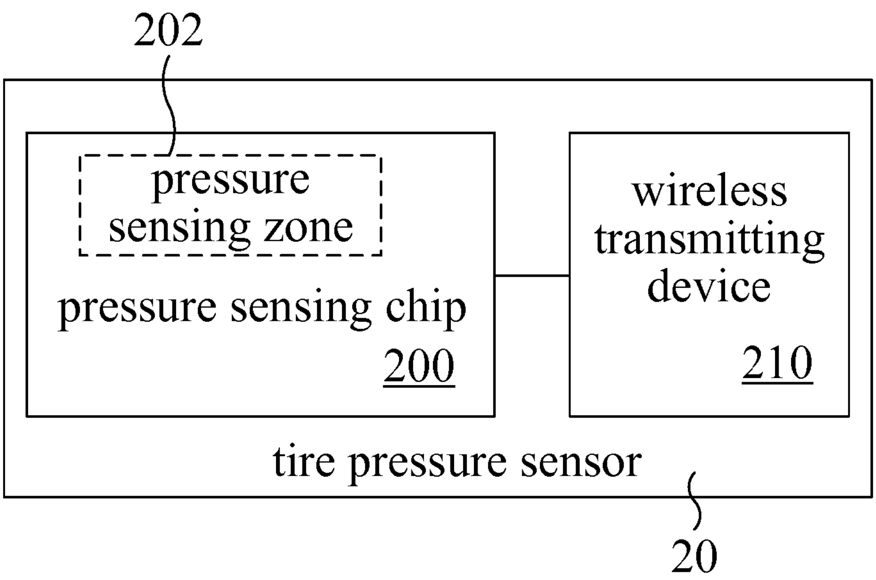
202
pressure sensing zone
pressure sensing chip
200
wireless transmitting device
210
tire pressure sensor
20

FIG. 2

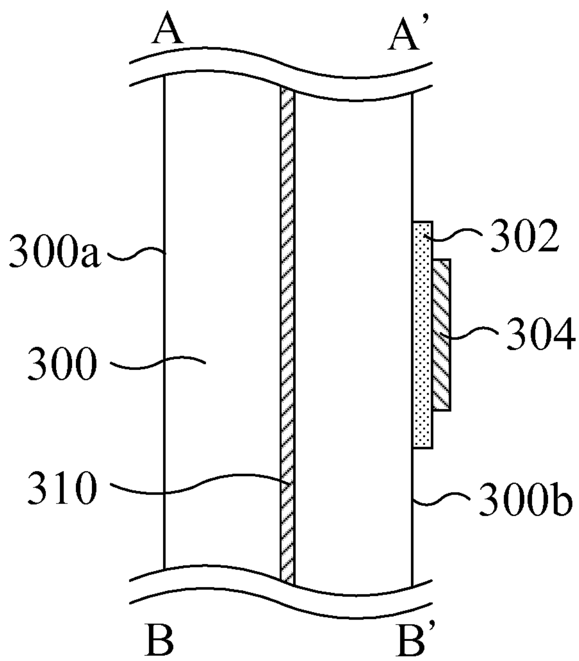
A
A'
300a
300
310
302
304
300b
B
B'

FIG. 3A

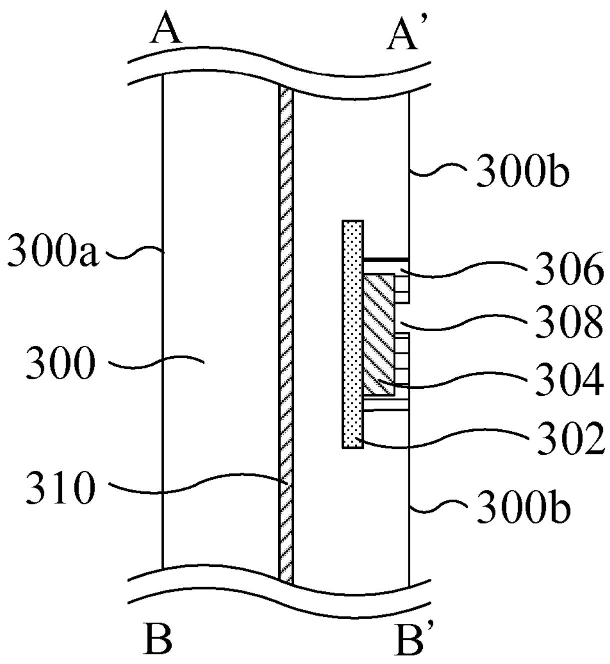
A
A'
300b
300a
306
308
300
304
302
310
300b
B
B'

FIG. 3B

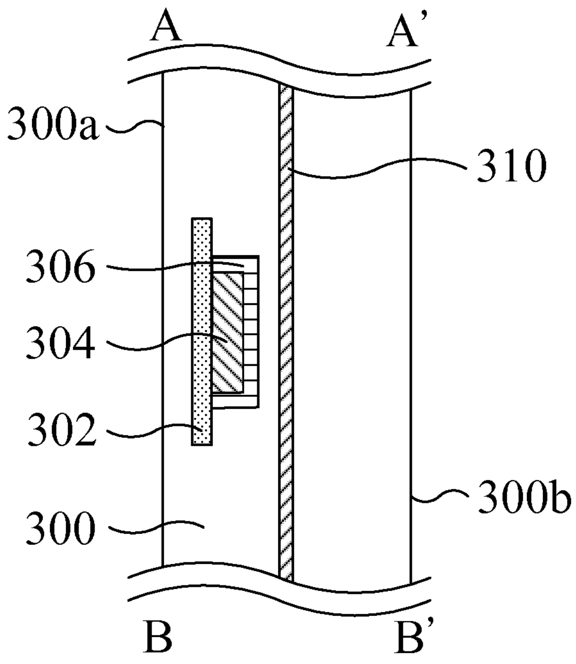
A
A'
300a
310
306
304
302
300b
300
B
B'

FIG. 3C

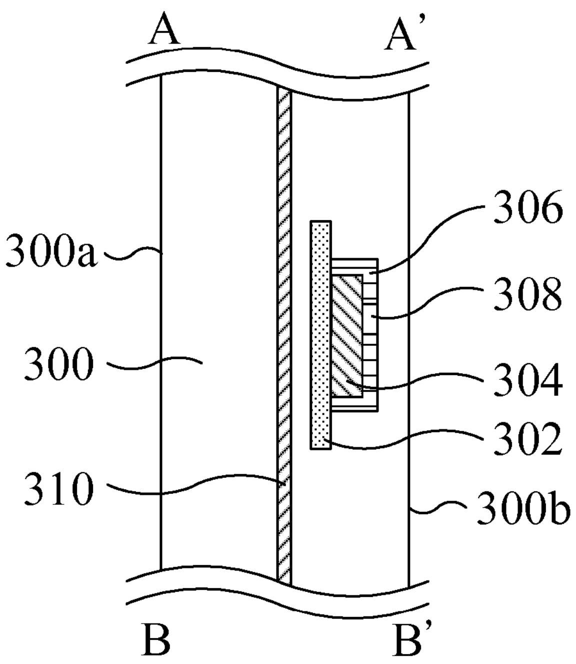
A
A'
300a
300
310
306
308
304
302
300b
B
B'

FIG. 3D

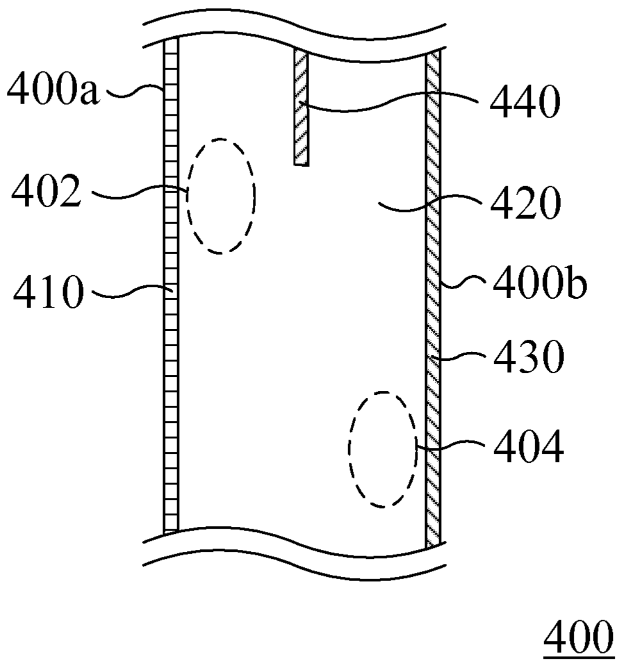
400a
402
410
440
420
400b
430
404
400

FIG. 4

REFERENCES CITED IN THE DESCRIPTION

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