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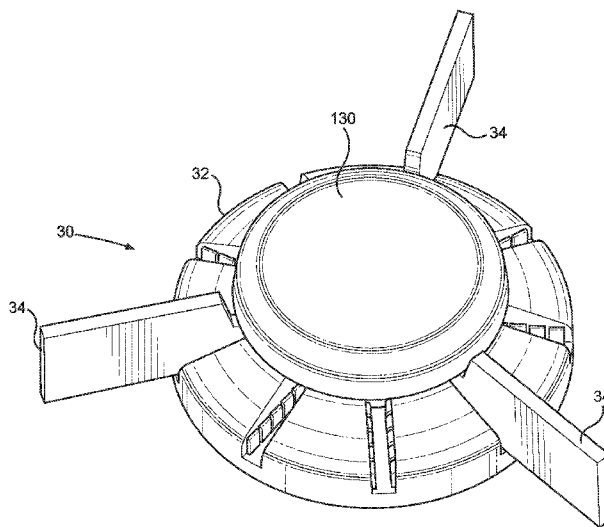


FIG. 3

(57) Abstract: A tire electronics assembly includes a base and a plurality of modules. The base is mechanically attached to the tire and includes an electronic device. A plurality of mechanical attachment elements are arranged on the base in a circular array. Each module includes an electronic device and a mechanical attachment element. Each mechanical attachment element on a module is configured to releasably mechanically attach to any one of the mechanical attachment elements on the base. In this configuration, the modules are interchangeably mechanically attachable to the base in the circular array. The base further includes a plurality of electrical terminals arranged in a circular array. Each module has an electrical terminal that is configured to releasably electrically connect with any one of the electrical terminals on the base, whereby the modules are interchangeably electrically connectable with the base in the circular array.



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## DAISY TIRE ELECTRONICS ASSEMBLY

### FIELD OF THE INVENTION

[0001] This technology includes electronic devices for sensing conditions of a tire on a vehicle.

### BACKGROUND

[0002] Electronic devices can be used to sense conditions of a tire on a vehicle. Such devices include air pressure and temperature sensors that are mounted inside the tire, and also include radio frequency transmitters for transmitting pressure and temperature signals from the tire to the vehicle.

### SUMMARY

[0003] An electronics assembly is provided for use with a tire. In a given example, the assembly includes a base and a plurality of modules. The base is mechanically attached to the tire and includes an electronic device. A plurality of mechanical attachment elements are arranged on the base in a circular array. Each module includes an electronic device and a mechanical attachment element. Each mechanical attachment element on a module is configured to releasably mechanically attach to any one of the mechanical attachment elements on the base. In this configuration, the modules are interchangeably mechanically attachable to the base in the circular array.

[0004] The base further includes a plurality of electrical terminals arranged in a circular array. Each module has an electrical terminal that is configured to releasably electrically connect with any one of the electrical terminals on the base, whereby the modules are interchangeably electrically connectable with the base in the circular array.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0005] **FIG. 1** is a schematic sectional view of a tire and an electronics assembly for use with the tire.

- [0006] **FIG. 2** is an exploded view of parts of the electronic assembly of **FIG. 1**.
- [0007] **FIG. 3** is a perspective view of the electronics assembly.
- [0008] **FIG. 4** is a schematic sectional view showing the electronics assembly mounted on the tire.

#### DETAILED DESCRIPTION

[0009] The structures illustrated in the drawings include examples of the elements recited in the claims. The illustrated structures thus include examples of how a person of ordinary skill in the art can make and use the claimed invention. They are described here to provide enablement and best mode without imposing limitations that are not recited in the claims. One or more elements of one embodiment may be used in combination with, or as a substitute for, one or more elements of another embodiment as needed for any particular implementation of the invention.

[0010] As shown in **FIG. 1**, a pneumatic tire **10** includes a tread **12**, bead portions **14**, and sidewalls **16** interconnecting the tread **12** with the bead portions **14**. An inner surface **18** of the tire **10** defines the periphery of a cavity **21** within the tire **10**. The inner surface **18** in this example is provided by an innerliner **22** that reaches fully throughout the interior of the tread **12**, the bead portions **14**, and the sidewalls **16**.

[0011] Also shown in **FIG. 1** is an electronics assembly **30** mounted on the tire **10**. The electronics assembly **30** in this example includes a base **32** and multiple modules **34**. Each module **34** includes one or more electronic devices **36**. The devices **36** in the modules **34** may include air pressure sensors, temperature sensors, power generation or storage devices, radio frequency transmitters, radio frequency receivers, and/or any other electronic devices suitable for obtaining and/or providing information relating to conditions of the tire **10**.

[0012] The base **32** also includes one or more electronic devices **40**. These may include an electronic device **40** configured to provide a unique identification signal for identifying the tire **10** in distinction from another tire on the same vehicle or a different vehicle. Other electronic devices **40** in the base **32** may be configured to receive and/or transmit signals between the devices **40** in the base, the devices **36** in the modules **34**, and the vehicle. In each

case, the electronic devices **36** and **40** shown schematically in the drawings can be configured in any suitable manner known in the art.

[0013] The base **32** of the electronics assembly **30** is attached to the tire at the interior of the tire **10**. As shown in **FIG. 2**, the base **32** includes a housing **50** containing the electronic devices **40**. Mechanical attachment elements **54** face upward from the housing **50**.

[0014] The housing **50** has a vertical axis **55**, as viewed in the drawings, with a circular periphery **56** and a circular central recess **58** centered on the axis **55**. An upper surface **60** of the housing **50** is inclined radially inward and axially upward from the periphery **56** to the recess **58**. A plurality of slots **64** are arranged in a circular array centered on the axis **55**. The slots **64** are elongated radially relative to the axis **55** and are equally spaced apart circumferentially about the axis **55**. Each slot **64** has an open inner end at the recess **58**, an open outer end at the periphery **56** and an open top at the upper surface **60**.

[0015] The mechanical attachment elements **54** on the base **32** are arranged in radial alignment with the slots **64**. Specifically, the housing has an annular wall **70** that is centered on the axis **55**. The annular wall **70** is located at the recess **58** and reaches circumferentially beneath the open inner ends of the slots **64**. Each mechanical attachment element **54** is defined by a respective portion of the annular wall **70** beneath the open inner end of a respective slot **64**.

[0016] The modules **34** of **FIG. 1** include housings **100** (**FIG. 2**) containing the electronic devices **36**. The housings also contain printed circuit boards **102** (shown schematically) upon which the electronic devices **36** are mounted. Each housing **100** is shaped as a board that generally corresponds to the shape of the printed circuit board **102** and is sized to fit closely within any one of the slots **64** in the base **32**. Each housing **100** further has a notch **106** that is sized and shaped to fit closely over any one of the mechanical attachment elements **54** at the inner ends of the slots **64**. In this configuration, the modules **34** are interchangeably mechanically attachable to the base **32** in circumferentially spaced-apart positions projecting radially outward in a circular array.

[0017] As further shown in **FIG. 2**, each slot **64** in the base **32** contains one or more electrical terminals **120**. The electrical terminals **120** on the base **32** are located within the slots **64** at opposite sides of the slots **64**. Each module **34** also has one or more electrical terminals **122**. These electrical terminals **122**, which are shown schematically, may comprise any

suitable devices known in the art. The terminals on the modules **34** are located at opposite sides of the housings **100** so that the terminals **122** on each one of the modules **34** can releasably electrically connect with the terminals **120** in any one of the slots **64**. Accordingly, the modules **34** are interchangeably electrically connectable with the base **32** in circumferentially spaced-apart positions projecting radially outward in a circular array. A cap **130** interlocks with the base **32** at the top of the assembly **30** to secure the modules **34** in place on the base **32**, as shown in **FIG. 3**.

[0018] As noted above, the base **32** is attached to the tire **10** at the interior of the tire **10**. As shown in **FIG. 4**, the base **32** in the given example is mounted on a platform **140**. The platform **140** is installed between the innerliner **22** and an attachment layer **142** adhered to innerliner **22**. A locking device **144** projects upward from the platform **140** and comprises a twist-lock or other suitable device configured to interlock with the base **32**.

[0019] This written description sets for the best mode of carrying out the invention and describes the invention so as to enable a person of ordinary skill in the art to make and use the invention, by presenting examples of the elements recited in the claims. The detailed descriptions of those elements do not impose limitations that are not recited in the claims.

## CLAIMS

What is claimed is:

1. An apparatus for use with a tire, comprising:

a base attached to the tire, the base including an electronic device, and further including a plurality of mechanical attachment elements arranged in a circular array; and

a plurality of modules, each of which contains an electronic device and a has mechanical attachment element, wherein each mechanical attachment element on a module is configured to releasably mechanically attach to any one of the mechanical attachment elements on the base, whereby the modules are interchangeably mechanically attachable to the base in the circular array.

2. An apparatus as defined in claim 1, wherein each mechanical attachment element on the base includes a slot aligned radially with a central axis of the circular array.

3. An apparatus as defined in claim 2, wherein each module is shaped as a board configured for insertion in any one of the slots.

4. An apparatus as defined in claim 1, wherein the base overlies an interior surface of the tire.

5. An apparatus as defined in claim 1, wherein the electronic device in the base is configured to provide a unique identification signal identifying the tire.

6. An apparatus as defined in claim 1, wherein the electronic devices in the modules include air pressure sensors.

7. An apparatus as defined in claim 1, wherein the electronic devices in the modules include temperature sensors.

8. An apparatus for use with a tire, comprising:

a base attached to the tire, the base including an electronic device, and further including a plurality of electrical terminals arranged in a circular array; and

a plurality of sensor modules, each of which contains an electronic device and has an electrical terminal, wherein each electrical terminal on a module is configured to releasably

electrically connect with any one of the electrical terminals on the base, whereby the modules are interchangeably electrically connectable with the base in the circular array.

9. An apparatus as defined in claim 8, wherein each mechanical attachment element on the base includes a slot aligned radially with a central axis of the circular array.

10. An apparatus as defined in claim 8, wherein each module is shaped as a board configured for insertion in any one of the slots.

11. An apparatus as defined in claim 8, wherein the base overlies an interior surface of the tire.

12. An apparatus as defined in claim 8, wherein the electronic devices in the modules include air pressure sensors.

13. An apparatus as defined in claim 8, wherein the electronic devices in the modules include temperature sensors.

14. An apparatus as defined in claim 8, wherein the electronic device in the base is configured to provide a unique identification signal identifying the tire.

15. An apparatus as defined in claim 8, wherein the base includes a plurality of mechanical attachment elements arranged in a circular array, and each module has a mechanical attachment element configured to releasably mechanically attach to any one of the mechanical attachment elements on the base, whereby the modules are interchangeably mechanically attachable to the base in the circular array.

16. An apparatus comprising:

a tire;

a base attached to the tire, the base including an electronic device, and further including a plurality of mechanical attachment elements arranged in a circular array; and

a plurality of modules, each of which contains an electronic device and a has mechanical attachment element, wherein each mechanical attachment element on a module is configured to releasably mechanically attach to any one of the mechanical attachment elements on the base, whereby the modules are interchangeably mechanically attachable to the base in the circular array.

17. An apparatus as defined in claim 16, wherein each mechanical attachment element on the base includes a slot aligned radially with a central axis of the circular array.
18. An apparatus as defined in claim 17, wherein each module is shaped as a board configured for insertion in any one of the slots.
19. An apparatus as defined in claim 16, wherein the electronic device in the base is configured to provide a unique identification signal identifying the tire.
20. An apparatus as defined in claims 16, wherein each module has an electrical terminal configured to releasably electrically connect with any one of the electrical terminals on the base, whereby the modules are interchangeably electrically connectable with the base in the circular array.

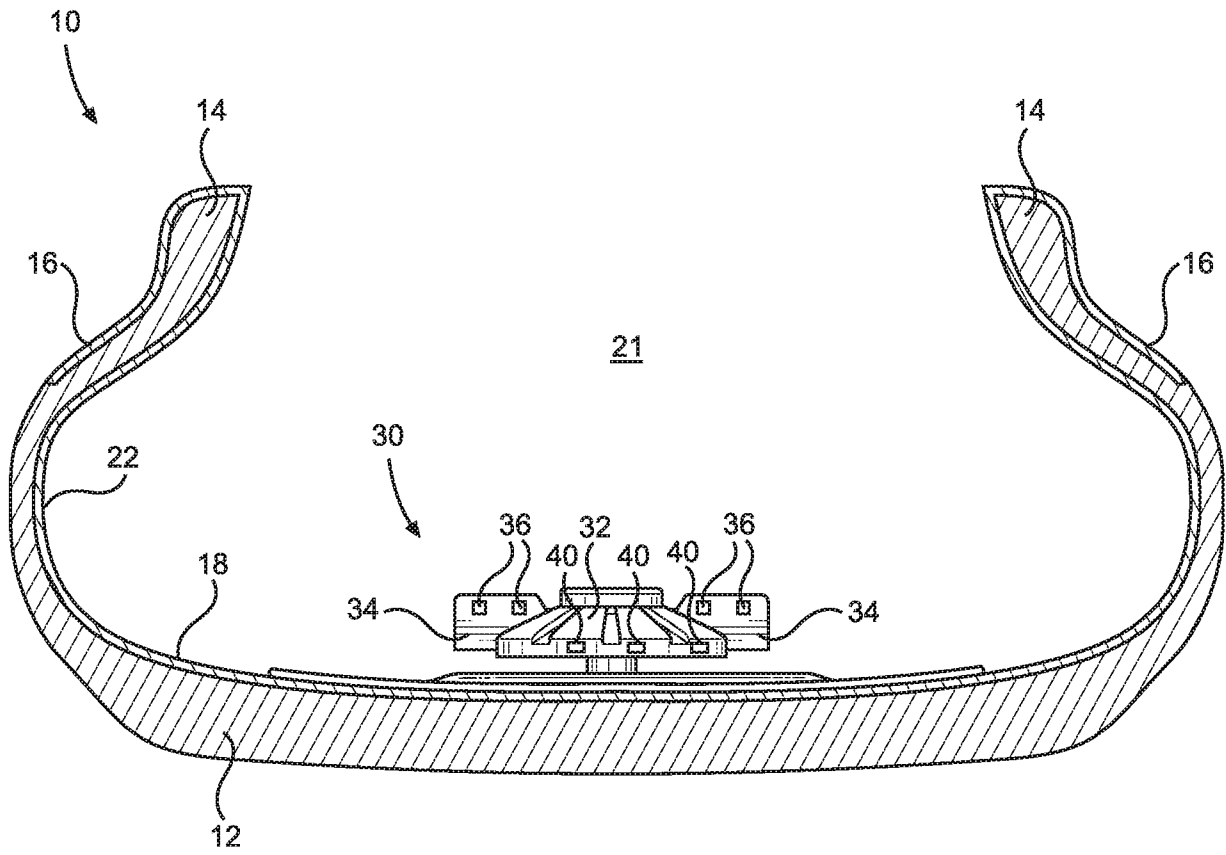


FIG. 1

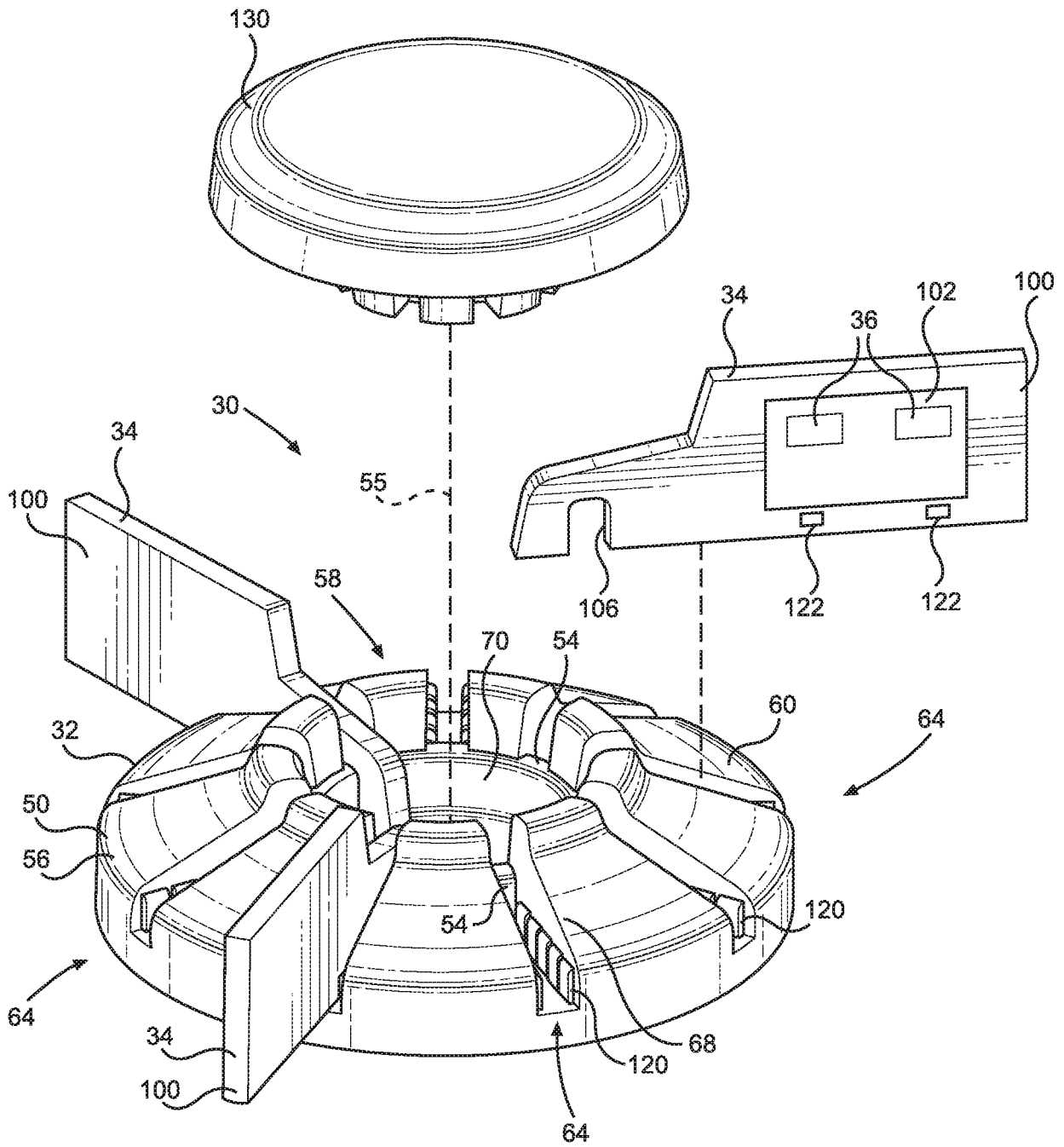
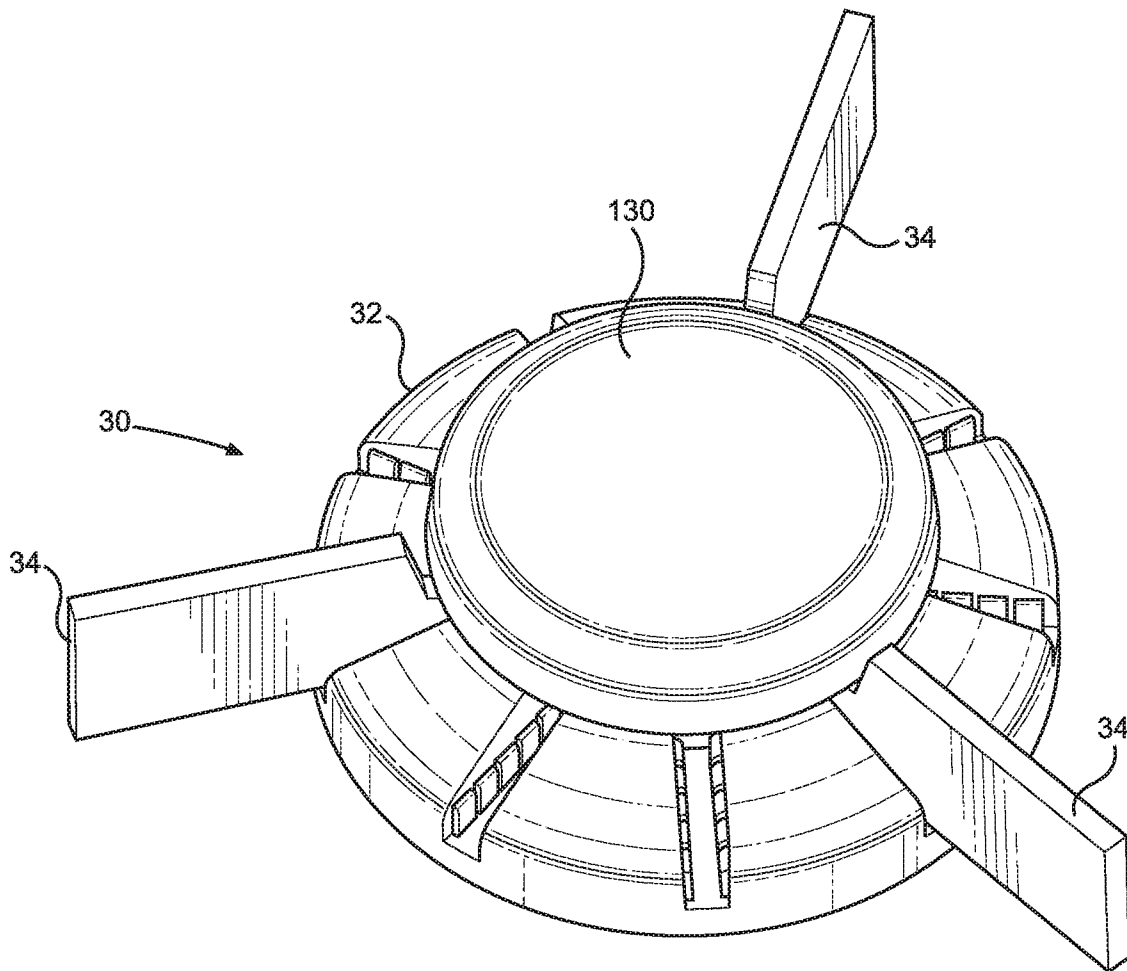
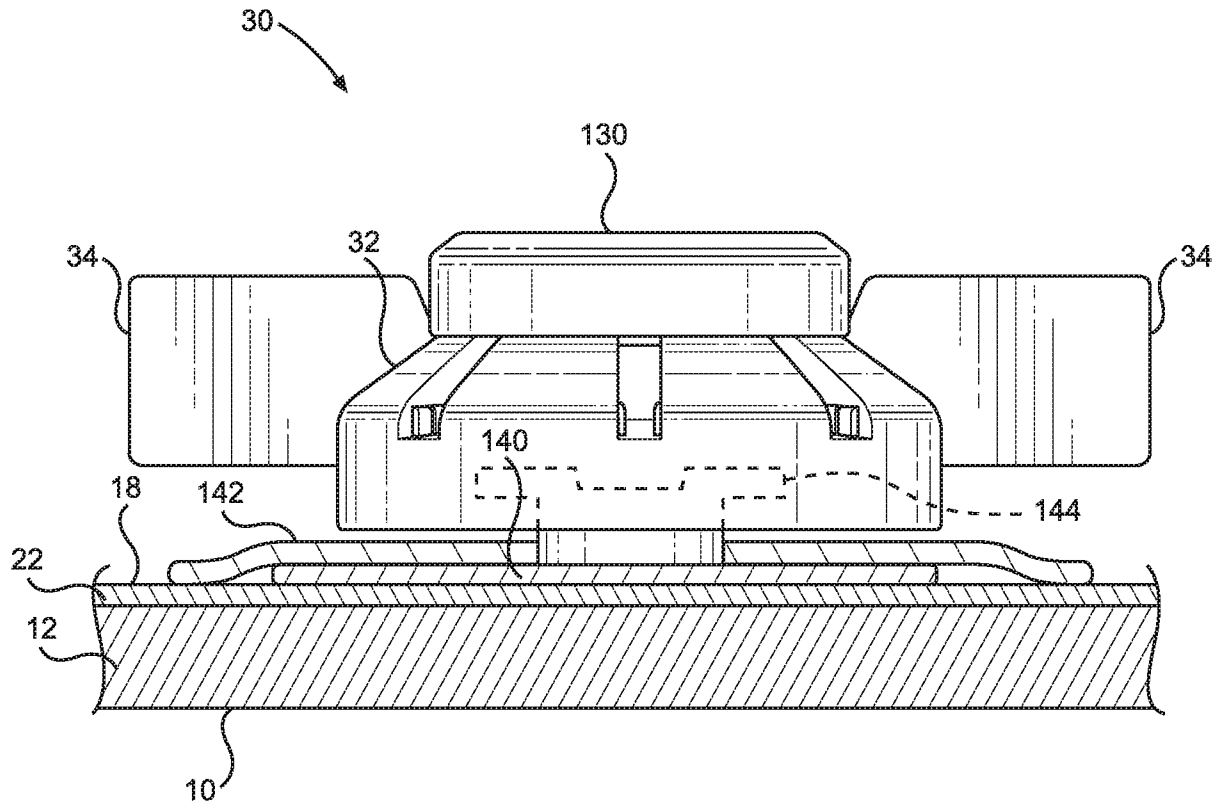


FIG. 2



**FIG. 3**



**FIG. 4**

**A. CLASSIFICATION OF SUBJECT MATTER****B60C 23/04(2006.01)i, B60C 23/20(2006.01)i, B29D 30/00(2006.01)i, B60C 19/00(2006.01)i**

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

**B. FIELDS SEARCHED**Minimum documentation searched (classification system followed by classification symbols)  
B60C 23/04; B60C 19/00; B60C 23/20; B29D 30/00Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
Korean utility models and applications for utility models  
Japanese utility models and applications for utility modelsElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
eKOMPASS(KIPO internal) & Keywords: tire, base, electronic device, module, mechanical attachment, circular array, slot, unique identification, air pressure sensors, temperature sensors, electrical terminal**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2018-0297424 A1 (DENSO CORPORATION) 18 October 2018 paragraphs [0028]-[0040] and figures 3, 8	1-20
Y	JP 2019-104301 A (BRIDGESTONE CORP.) 27 June 2019 paragraphs [0032]-[0033] and figures 5A-5B	1-20
A	US 7999663 B2 (MANCOSU et al.) 16 August 2011 column 7, line 65 - column 9, line 23 and figures 1-3	1-20
A	US 2009-0183562 A1 (BRUSAROSCO et al.) 23 July 2009 paragraphs [0042]-[0075] and figures 1-4c	1-20
A	WO 2014-041060 A1 (BAYERISCHE MOTOREN WERKE AKTIENGESELLSCHAFT) 20 March 2014 pages 8-13 and figures 3-7	1-20

 Further documents are listed in the continuation of Box C. See patent family annex.

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

"&amp;" document member of the same patent family

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**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2020/043810**

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