(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
21 September 2006 (21.09.2006)

PCT

(10) International Publication Number
WO 2006/098635 A1

(51) International Patent Classification:
B60C 23/04 (2006.01)

(21) International Application Number:
PCT/NO2006/000095

(22) International Filing Date: 14 March 2006 (14.03.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
20051398 14 March 2005 (14.03.2005) NO

(71) Applicants and
(72) Inventors: **DØNVOLD, Terje** [NO/NO]; Konvallveien 13, N-0855 Oslo (NO). **AASEN, Torbjørn** [NO/NO]; Hatlestadlia 122, N-5227 Nesttun (NO).

(74) Agents: **ONSAGERS AS** et al.; P.O. Box 6963 St. Olavs plass, N-0130 Oslo (NO).

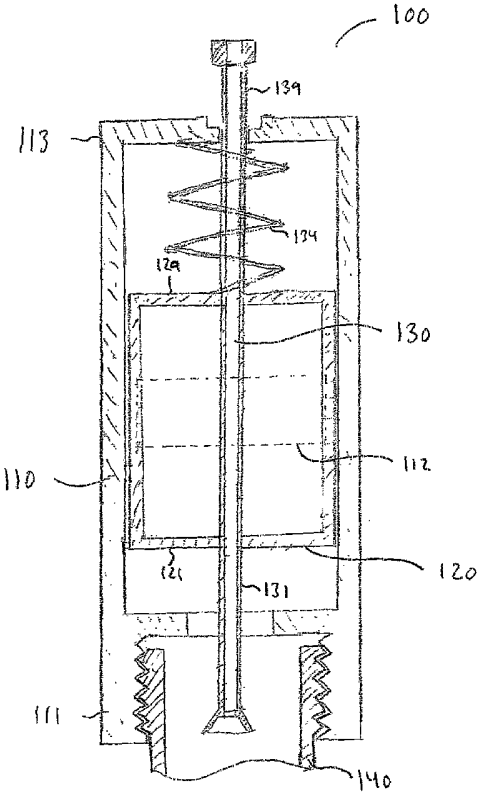
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: TIRE PRESSURE INDICATING DEVICE AND REMOTE PRESSURE MONITORING SYSTEM



(57) Abstract: The invention relates to an air pressure indicating device (100) for a vehicle tire. The device comprises an RF shielding member (110) which includes a cylindrical sleeve and which is arranged for connection to a valve member of the vehicle tire at a first end (111) of said sleeve. The device also comprises a transponder carrying member (120) which includes a cylindrical piston, slidingly arranged within said cylindrical sleeve. The piston is exposed to the tire air pressure at its lower end face (121) and influenced by a force exerting member (134) at its upper end face (129). The piston also comprises at least one interrogatable RF transponder (122, 124, 126). The relative position between the RF shielding member (110) and the transponder carrying member (120) is influenced by the air pressure in such a way that the shielding member (110) masks a number of the RF transponders (122, 124, 126) in dependency on said air pressure. Advantageously, the shielding member includes a non-shielding segment. The invention also relates to a system for remote monitoring of air pressure in a vehicle tire (150), wherein the device is included.

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TIRE PRESSURE INDICATING DEVICE AND REMOTE PRESSURE MONITORING SYSTEM

FIELD OF THE INVENTION

The present invention relates to an air pressure indicating device for a vehicle tire and a system for remote monitoring of air pressure in a vehicle tire.

BACKGROUND OF THE INVENTION

US-5 886 254 and US-1 807 752 both relate to tire pressure covers which are arranged to indicate tire pressure by means of different colored cylindrical sections that appear in a viewing window, in dependence of the pressure in the tire. These device have the disadvantage that they are applicable only for visual inspection by a human.

JP-2002333079 relates to a valve opening detecting device which indicates the opening of a valve by means of a number of RFID tags arranged at different angular positions of a disc which is rotatable in accordance with the valve opening. An aperture mask made of a ferromagnetic material is arranged between the rotatable disc and a

US-6 758 089 describes a complex wireless sensing and communication system. In an embodiment, a SAW (Surface Acoustic Wave) pressure sensor located in a valve cap is arranged for measuring the tire pressure and for transmitting an RF signal which carries information about the measurement.

SUMMARY OF THE INVENTION

An object of the present invention is to provide an air pressure indicating device and a system for remote monitoring of air pressure in a vehicle tire which overcome at least some of the disadvantages of the prior art.

The above objects and further advantages are achieved by a device and a system as set forth in the appended set of independent claims.

Advantageous embodiments of the inventions are set forth in the dependent claims.

Additional features and principles of the present invention will be recognized from the detailed description below.

The invention is based on the principle of providing an RF shielding member, such as a ferromagnetic cylindrical sleeve, connected to a valve member of the vehicle tire. A transponder carrying member, such as a cylindrical piston, is rectilinearly

moveably arranged with respect to the RF shielding member. The piston is exposed to the tire air pressure at its lower end face and influenced by a force exerting member such as a spring at its upper end face. Interrogatable RF transponders are provided in the piston in such a way that the shielding member masks a number of the RF transponders, dependent on both the air pressure and the counteracting force caused by the exerting member. By this principle, the advantage is achieved that the measurement function and the transmission function are simultaneously merged into one combined action. This involves advantages such as simplicity, robustness, low cost, and reduced energy requirement for the RF transponders.

In an advantageous embodiment, a tubular passage is provided through the cylindrical piston. The tubular passage is provided between the piston's lower end face and its upper end face, and is extended with a valve activating tubular member at the lower end face and an air inlet tubular member at the upper end face. This makes it possible to operate the vehicle tire valve while the device is installed on the valve.

By appropriate choice of transmission properties such as frequency, power and appropriate antenna design, the RF communication range of the transponders will be restricted to a limited area close to the vehicle. This provides for a simple means for preventing interference from similar devices arranged in nearby vehicles, and it makes it unnecessary to include a unique ID in the transmitted signal or in the data included in the RF transponders. If such a unique ID is still included in the RF transponder and the transmitted signal, this provides for an advantageous redundancy in the identification of the valve and thus the vehicle wheel in question.

In an embodiment, the device comprises a cap to be mounted on the device, more specifically on the upper end of the sleeve. Such a cap comprises a protruding member which is arranged for pushing down the inlet tubular member and thus the transponder carrying member when the cap is in its mounted position. This provides for a control function: If the cap is temporary removed, e.g. by the vehicle driver as a part of a manual control procedure, the piston will not be influenced by the tire pressure during the temporary cap removal. This will lead to an RF transponder event that may be recorded by an external system. The resulting data may subsequently prove that the control procedure has been accomplished properly.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only and not restrictive of the invention, as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings illustrate a preferred embodiment of the invention. In the drawings:

Fig. 1 is a cross sectional view illustrating the principles of a first embodiment of an indicating device in accordance with the invention,

Fig. 2 is a side elevation illustrating the principles of a transponder carrying member which is included in the first embodiment,

Fig. 3 is a side elevation view illustrating the principles of the first embodiment of the indicating device,

Fig. 4 is a schematic block diagram illustrating a first embodiment of a system in accordance with the invention,

Fig. 5 is a schematic block diagram illustrating a second embodiment of a system in accordance with the invention,

Fig. 6 is a cross sectional view illustrating the upper part of a second embodiment of an indicating device in accordance with the invention,

Fig. 7 is a cross sectional view illustrating the principles of a third embodiment of an indicating device in accordance with the invention,

Fig. 8 is a side elevation illustrating the principles of a transponder carrying member which is included in the second embodiment, and

Fig. 9 is a schematic diagram illustrating the principle of non-equidistant RF transponders.

DETAILED DESCRIPTION OF THE INVENTION

Reference will now be made in detail to the present invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

Fig. 1 is a cross sectional view illustrating the principles of a first embodiment of an indicating device in accordance with the invention.

The air pressure indicating device 100 for a vehicle tire comprises an RF shielding member 110, formed as a cylindrical sleeve. Advantageously, the sleeve or shielding member 110 is substantially composed of a ferromagnetic material, in order to attenuate or obstruct RF signals. The material is selected in order to prevent an RF interrogating transponder, such as a passive RFID (Radio Frequency Identification) tag, which is located within the sleeve, to be interrogated by an external RF signal.

The cylindrical sleeve is arranged for releasable connection to a valve member 140 of the vehicle tire at a first, lower end 111 of the sleeve. As illustrated, this is suitably achieved by means of internal threads in the sleeve, adapted for mounting on the external threads of the vehicle tire valve.

The air pressure indicating device 100 further comprises a transponder carrying member 120, which is rectilinearly moveably arranged with respect to the RF shielding member 110, i.e. the sleeve.

The transponder carrying member 120 comprises a cylindrical piston, which is slidingly arranged in an airtight way within the cylindrical sleeve. In order to provide a tight closure between the piston and the sleeve, the outer diameter of the piston is slightly less than the inner diameter of the sleeve.

Advantageously, although not specifically shown in the figure, a cylindrical sealing member made of e.g. plastic is additionally arranged between the sleeve 110 and the piston 120 in order to secure an airtight and easy sliding of the piston 120.

The piston 120 is preferably composed of a plastic material, or alternatively a rubber material of proper hardness and Mooney viscosity.

During operation, the piston is exposed to the tire air pressure at its lower end face 121. The piston is also influenced by a force exerting member 134, such as a steel spring, at its opposite, upper end face 129. This leads to the result that the vertical position of the piston is dependent on the tire pressure, as a balance will be achieved between the force caused by the air pressure and the force caused by the force exerting member 134.

Further with reference to fig. 2, which is a side elevation illustrating the principles of the transponder carrying member in the first embodiment, the RF shielding member further comprises at least one interrogatable RF transponder. Advantageously, the RF shielding member comprises at least two, preferably three, interrogatable RF transponders 122, 124, 126. Advantageously, the transponders are passive RFID tags.

The transponders 122, 124, 126 are arranged along the transponder carrying member 120, distributed along its length. In the illustrated embodiment, the transponders are substantially equally spaced along the length of the transponder carrying member 120. However, the spacing between the transponders does not necessarily have to be equidistant, and may be varied in accordance with the application and the relevant requirements. Such non-equidistant spacing has certain advantages which are further elaborated with reference to the embodiment illustrated in figure 9 below.

Relevant radio parameters including desired reading range and transmission frequency, transponder size, the corresponding reader/transceiver antennas, and the need for satisfactory distinguishing of the various transponders versus RF signal attenuation may be appropriately selected by the skilled person.

The relative position between the RF shielding member 110 and the transponder carrying member 120 is influenced by the tire air pressure in such a way that the shielding member 110 masks a number of said RF transponders 122, 124, 126, in dependency on the air pressure. For instance, in the case of three RF transponders, the shielding member may be arranged to mask two of the three transponders at any time, while one transponder is accessible to an external interrogating RF signal. The air pressure, and thus the relative position between the RF shielding member 110 and the transponder carrying member, will determine which one of the RF transponders that is accessible to the external interrogating RF signal.

In the simplest case, where only one RF transponder is arranged in the RF shielding member, the shielding member will be arranged to mask the one RF transponder or not, depending on the tire air pressure.

For instance, the RF transponder may be arranged in such a way that it is exposed (i.e., not masked) by the shielding member when the tire pressure is lower than an acceptable minimum pressure. Alternatively, the RF transponder may be arranged in such a way that it is exposed by the shielding member when the tire pressure is within an acceptable operating range. Both alternatives are easily achieved by balancing the spring constant of the counteracting force exerting member and the longitudinal position of the RF transponder.

For the latter alternative, the information transmitted by the transponder also proves that the wheel is still on the vehicle. This is of importance, especially for trucks where loss of a wheel can happen unobserved by the driver.

In the case of two RF transponders, the RF transponders may be arranged in such a way that one of them is exposed by the shielding member when the tire pressure is lower than an acceptable minimum pressure, while the other one is exposed when the pressure is within an acceptable operating range.

Advantageously, each RF transponder is coded with air pressure data. The air pressure data that is coded in said RF transponder advantageously corresponds to the pressure value that causes the RF transponder to be exposed to the external, interrogating RF signal. The data content of the RF transponders may be set by an external programming device.

In the case of three RF transponders, the RF transponders may be arranged in such a way that one of them is exposed by the shielding member when the tire pressure is

lower than an acceptable minimum pressure, the second is exposed when the pressure is within an acceptable operating range, and the third is exposed when the pressure is higher than an acceptable maximum pressure.

In the case of four or more RF transponders the device may provide an external system and thus the vehicle driver with more detailed and exact information about pressure and direction of change in the three different pressure ranges: too low, acceptable and too high tire pressure. With a satisfactory high number of arranged transponders, the resolution of the scale may approximate a continuous scale.

In the case of four transponders, acceptable pressure range can be quite exactly indicated by arranging the second and the third transponder in order to define boundaries for both acceptable pressure range. In such an arrangement, the transponders are located at the upper and the lowest endpoint of the acceptable range of the scale where they can be exposed.

The exact and correct pressure level will in this case correspond to the mid point between these two transponders. If then pressure changes, say a little, then one of these two transponders' signal will disappear. Advantageously, the signals from these transponders (and the disappearance of one such signal) represent more exact pressure information. This is the case either if the transponder contains only a predefined code or if the transponder is coded with actual pressure data.

The corresponding external system, e.g. on the vehicle, may respond by recognizing that only one of the two transponders of the pressure range is exposed, and the system may interpret this state as an acceptable change. The direction of the change can be determined by observing which of the transponders that is no longer exposed (the upper or the lower transponder).

If the pressure continues to change in the same direction and so much that a new transponder is exposed together with the last remaining transponder, the external system may interpret this as a moderate pressure loss, i.e. a pressure loss to be warned. If the pressure then continue to change so much in the same direction that the last transponder for acceptable pressure range is not exposed, the system may interpret this as a serious pressure loss, i.e. a pressure loss to be alarmed.

All the above alternatives are straightforwardly achieved by balancing a chosen spring constant of the force exerting member and the longitudinal position of the RF transponders in the transponder carrying member 120.

Further with reference to fig 3, the RF transponders 122, 124, 126 are equipped with respective antennas 123, 125, 127. In the illustrated embodiment the transponder chips 122, 124, 126 are shown to be arranged inside the outer wall of the transponder carrying member 120, while each corresponding antenna 123, 125, 127,

respectively, is shown as a substantial circular loop or as substantial circular loop along and inside the circumference of the transponder carrying member 120. By arranging the RF transponders and corresponding antenna inside the walls of the transponder carrying member 120, the advantage is achieved that the transponders and antennas are covered by a protective layer of the wall material of the transponder carrying member 120.

Alternatively, the transponders and antennas may be arranged flush with the wall of the transponder carrying member 120.

Another advantageous alternative is to arrange bar shaped transponders, each including an integrated antenna, inside the wall of the transponder carrying member 120.

The exact arrangement of the antennas will of course influence signal field direction and thus RF transmission properties.

Fig. 3 is a side elevation view illustrating further principles of the first embodiment of the indicating device.

From figure 3, it should be understood that the cylindrical sleeve 110 is substantially composed of a ferromagnetic material except from a non-shielding segment 112 which is either empty or which is composed of a non-ferromagnetic material such as a plastic material. In figure 3, this segment is shaped as a rectangular window or cut-out of the cylindrical ferromagnetic wall. Alternatively or in addition, the segment 112 may include a metal grid, which provides physical strength and reduced risk of physical damage to the sleeve 110.

The transponders 122, 124, 126 are advantageously arranged along and inside the transponder carrying member, close to its surface, in such a way that at least one transponder is exposed to an external, interrogating RF signal through the non-shielding segment, i.e. through the window or cut-out 112, when the air pressure is within an operative pressure range.

Further with reference back to figure 1, i.e. the first embodiment of the air pressure indicating device, the transponder carrying member 120 further comprises a tubular passage 130 between the lower end face 121 and the upper end face 129 of the piston. The tubular passage 130 is further extended with a valve activating tubular member 131 at the lower end face 121. The tubular passage 130 is also extended with an air inlet tubular member 139 at the upper end face 129, i.e. at its upper end. The purpose of the tubular passage 130 and its extensions, i.e. the inlet tubular member 139 and the valve activating tubular member 131, are to provide a possibility of operating the vehicle valve 140, i.e. filling or draining the tire, without dismounting the air pressure indicating device.

In a second embodiment, the air pressure indicating device comprises all the above features. In addition, the second embodiment comprises further features illustrated in figure 6, which is a cross sectional view illustrating the upper part of the second embodiment. Thus, the features illustrated in figure 6 should be regarded as additional features appended to the features illustrated in figures 1, 2, and 3.

Figure 6 thus illustrates a cap 136 which is arranged to be mounted on the upper end of the cylindrical sleeve 110. The cap comprises a protruding member 138 which is arranged for pushing down the inlet tubular member 139 and thus the transponder carrying member 120 when the cap 136 is arranged in its mounted position. The cap is provided with internal threads 137 for releasable interlocking with external threads 135 on an extension of the cylindrical sleeve 110. However, other fastening means are of course possible, such as a bayonet-type connection between the cylindrical sleeve 110 and the cap 136, which may be easier to operate and which may provide further protection against unintended release of the cap due to dirt, snow, ice or shaking movements.

Fig. 7 is a cross sectional view illustrating the principles of a third embodiment of an indicating device in accordance with the invention.

The third embodiment is a simpler one, which does not allow for filling or draining of air to/from the tire while the device is in its mounted position. However, it enables remote monitoring by an external RF interrogating transceiver.

The device according to the third embodiment corresponds directly to the first embodiment illustrated in figure 1, 2 and 3, except from that the RF shielding member 110 is closed and sealed at is upper end 113. Also, the transponder carrying member 120 lacks a tubular passage. This will be discussed further below with reference to fig. 8.

Fig. 8 is a side elevation illustrating the principles of a transponder carrying member 120 which is included in the third embodiment. As can be seen, the transponder carrying member 120 according to the third, simpler embodiment is identical to the corresponding part in the first embodiment in figure 2, except from that it does not comprise a tubular passage 130. Instead, the transponder carrying member consists merely of a slidingly moveable piston, which is influenced by tire air pressure at its lower end face 121 and which is influenced by the force exerting member 134 at its upper end face 129. The location of RF interrogating transponders is similar to the first embodiment described with reference to fig. 2, and may be modified in accordance with the mentioned alternatives and variations.

The present invention also relates to a system for remote monitoring of air pressure in a vehicle tire (150). Two embodiments of the system are illustrated, in figures 4 and 5, respectively.

Fig. 4 is a schematic block diagram illustrating a first embodiment of a system in accordance with the invention.

The purpose of the system is to provide a remote monitoring of air pressure in a vehicle tire 150. To this end, the system comprises an air pressure indicating device 100 in accordance with the invention, e.g. as described above with reference to one or more of the figures 1, 2, 3, 6, 7, 8, and 9. The air pressure indicating device is mounted on the valve of the vehicle tire, or alternatively, the device is integrated in the valve of the vehicle tire. By this arrangement, an RF interrogating transponder will be available for interrogating by an external interrogating signal, the identification of the transponder being dependent on the pressure in the vehicle tire. In order to achieve this result, the system further comprises an interrogating RF transceiver 160 which is arranged for wireless communication with the interrogatable RF transponders that are included in the indicating device. In the first system embodiment of figure 4, the interrogating RF transceiver 160 is installed in the vehicle in the vicinity of the tire 150. Also, the system comprises a remote monitoring device 170, which is operatively connected to the interrogating RF transceiver by means of an electric wire or by means of a wireless communication connection. The remote monitoring device is typically located in the vehicle compartment, adapted for viewing by the vehicle driver.

The remote monitoring device 170 may comprise a control unit (not shown) for deriving certain secondary information from the primary information that is read from the RF transponders.

For instance, the control unit may be arranged for deriving secondary information that identifies which wheels that have correct tire pressures, and which wheels that possibly have incorrect tire pressures.

Further, the control unit may derive secondary information that identifies the sign of a possible pressure change in each wheel. This is achieved by comparing current primary information from the RF transponders with stored previous primary information from the RF transponders

Fig. 5 is a schematic block diagram illustrating a second embodiment of a system in accordance with the invention. This system is identical to the system of fig. 4, except for that the interrogating RF transceiver 160 is installed externally to the vehicle. More specifically, the interrogating RF transceiver may be installed in the road surface, advantageously close to the surface, in order to enable a RF communication between the transceiver and the relevant RF transponder when the vehicle passes the location of the RF transceiver 160. In this case, the remote monitoring device 170 may comprise a display board at the roadside or above the driving lane, arranged to be viewed by the vehicle driver. In this case the transceiver 160 and the monitoring device 170 may be operatively connected by a

wired or wireless connection. In case a wireless connection between the transceiver 160 and the monitoring device 170 is employed, the monitoring device may alternatively be located within the vehicle compartment, adapted for viewing by the vehicle driver.

The communication between the transceiver 160 and the monitoring device 170 may comprise the use of a wireless communication network, such as a WLAN, or a mobile communication network such as a GSM/GPRS enabled network. The network may be further connected to a satellite communication network or a fixed network such as the PSTN telephone network.

In a special embodiment the monitoring device 170 is a mobile communication terminal such as a mobile phone operated by the vehicle driver, such as the driver's personal handphone or a mobile phone installed in the vehicle, and the information is provided to the terminal by means of a message service such as an SMS.

In another special embodiment the monitoring device comprises both a mobile communication terminal such as a mobile phone operated by the vehicle driver, and a separate monitor terminal which is arranged for being mounted in the vehicle compartment, adapted for receiving information and for displaying it to the vehicle driver. In this case, the mobile communication terminal is arranged for communicating with the monitor terminal, in particular for transmitting the above information to the monitor terminal. To this end, the mobile communication terminal may be provided with a local communication means, such as an RFID communication means, and the monitor terminal is also arranged for receiving information by the local communication means such as RFID. Alternatively, Bluetooth, ZIGBEE, WLAN or another type of local wireless communication may be used.

The system may be further operatively connected to external monitoring systems operated by public offices, e.g. the customs services, the road/transport authorities, research establishments or the police, which may utilize tire pressure information for various purposes such as fine collection, monitoring, surveillance or statistics.

In any of the above embodiments, each RF transponders may be an RFID tag which is writeable, i.e. the data that is returned from the transponder as an interrogating response, may be predefined by means of the system. The data associated with one RFID tag may for instance identify its location on the vehicle, such as left front, right rear etc. The data may also include pressure calibration information, which may be varied in accordance with, e.g., the actual loading of the vehicle, the season (summer/winter) and temporary temperature changes.

The system may be arranged to provide a warning notifications by means of the remote monitoring device 170 in the case of too low or too high pressure with

respect to a nominal or correct pressure. In addition, the system may be arranged to distinguish between non-critical pressure deviation, in which case a warning is generated, or a critical pressure deviation, in which case an alarm is generated.

Figure 9 is a schematic diagram illustrating the principle of non-equidistant RF transponders.

Figure 9 shows the transponder carrying member 120 which is slideably arranged within the sleeve 110 on a device according to the invention. This is illustrated in five different situations, labeled (A), (B), (C), (D), and (E), respectively.

Three RF transponders 123, 125, and 127 are arranged in the transponder carrying member 120 with non-equidistant spacing. The vertical distance between the lower transponder 123 and the intermediate transponder 125 is denoted y, the vertical distance between the intermediate transponder 125 and the upper transponder 127 is denoted z. The height of the non-shielding segment 112 is denoted x. The following relations apply in this particular example: $y<x<z$, $x=2y$, $z=1,25x$.

In the drawings (A), (B), and (C), the central, vertically shaded field denotes an area which, when it coincides with the area of the non-shielded segment, corresponds to a correct tire pressure. The right-shaded, upper field denotes an area which corresponds to a low tire pressure. The left-shaded, lower field denotes an area which corresponds to a high tire pressure.

(A) shows the situation at correct (normal) tire pressure. The intermediate transponder 125 is visible in the non-shielding segment 112, and is thus interrogatable by the external interrogating transceiver.

(B) shows the situation at an acceptable tire pressure, with a negative deviation with respect to the correct (normal) situation in (A). No transponder is visible in the non-shielding segment 112, i.e. interrogatable.

(C) shows the situation at a too low pressure. The upper transponder 127 is visible in the non-shielding segment 112, i.e. interrogatable.

(D) shows the situation at an acceptable tire pressure, with a positive deviation with respect to the correct (normal) situation in (A). The lower transponder 123 and the intermediate transponder 125 are both visible in the non-shielding segment 112, i.e. they are interrogatable.

(E) shows the situation at a too high pressure. The lower transponder 123 is visible in the non-shielding segment 112, i.e. interrogatable.

This shows that a non-equidistant spacing between the RF transponders may increase the obtainable information with a certain number of RF transponders. This is advantageous, since varying the distance and the height of the non-shielding

segment may be used for obtaining a higher resolution, rather than merely increasing the number of RF transponders, which is space-consuming and boosts costs.

Also, more than one non-shielding segment may be used.

It should be appreciated that colour coding may be used in addition to the arrangement of RF transponders. This makes it possible to provide a visual indication of tire pressure in addition to the RF interrogatable indication.

The device according to the invention indicates both under- and overinflation of tires.

In order to prevent unintended alarms caused by sudden temperature changes which may occur due to normal driving activity, i.e. after start-out from a heated garage wintertime; the driver can recalibrate the transponders by means of the following procedure: By using a RFID-enabled mobile phone or other terminal close up to each device, the desired, adjusted values are written into the write-in transponders.

Such prevention of unintended alarms may especially be desired if the resolution of the scale (number of transponders constituting the scale) is high. In the same manner, the driver can adjust the pressure indicator for different tire pressure desired in winter/summertime or with loaded/unloaded vehicle.

According to the invention, it is possible to use the transponders' capacity only in certain situations, such as when pressure level is to be alarmed. Hence, the invention reduces the use of the transponders material which is exposed by RF signals to generate piezoelectricity. This prolongs the transponder life-time.

Several modifications and adaptations of the present invention will be apparent to those skilled in the art from consideration of the above description and practicing of the invention.

For instance, although the air pressure indicating device has been illustrated as a add-on device for releasable mounting to a tire valve, the skilled person will readily realize that the indicating device may be provided as an integrated part of a tire valve. In this case, the first or second embodiments will be most appropriate, in order to provide filling/draining of the vehicle valve.

Although a ferromagnetic material has been mentioned for the RF shielding member 110, it should be understood that a sufficiently tight and short fibered carbon material or an appropriate nano-material may alternatively be used.

The above detailed description of the invention has been presented for purpose of illustration. It is not exhaustive and does not limit the invention to the precise form

disclosed. Modifications and variations are possible in light of the above teachings or may be acquired from the practicing of the invention.

CLAIMS

1. Air pressure indicating device (100) for a vehicle tire, comprising
- an RF shielding member (110), comprising a cylindrical sleeve, and arranged for connection to a valve member of the vehicle tire at a first end (111) of said sleeve,
- a transponder carrying member (120), rectilinearly moveably arranged with respect to the RF shielding member (110), the transponder carrying member (120) comprising
- a cylindrical piston, slidingly arranged within said cylindrical sleeve, said piston being exposed to the tire air pressure at its lower end face (121) and influenced by a force exerting member (134) at its upper end face (129) , and
- at least one interrogatable RF transponder (122, 124, 126) provided in said transponder carrying member (120),
the relative position between the RF shielding member (110) and the transponder carrying member (120) being influenced by the air pressure in such a way that the shielding member (110) masks a number of said RF transponders (122, 124, 126) in dependency on said air pressure.

2. Air pressure indicating device in accordance with claim 1, wherein said transponder carrying member (120) comprises at least two interrogatable RF transponders arranged along said transponder carrying member (124).

3. Air pressure indicating device in accordance with one of the claims 1-2, wherein said cylindrical sleeve is substantially composed of an RF shielding material, except from a non-shielding segment (112) which is composed of a non-RF-shielding material or which is empty, and
wherein said transponders (122, 124, 126 or more) are arranged at said transponder carrying member (129) in such a way that at least one transponder is exposed to an external, interrogating RF signal through said non-shielding segment (112) when the air pressure is within an acceptable pressure range.

4. Air pressure indicating device in accordance with one of the claims 1-3, wherein each RF transponder is rewritable coded with air pressure data.

5. Air pressure indicating device in accordance with claim 4, wherein said air pressure data coded in said RF transponder corresponds to an air pressure value that causes said RF transponder to be exposed to said external, interrogating RF signal.

6. Air pressure indicating device in accordance with one of the claims 1-5, wherein said interrogatable RF transponders are passive RFID tags.

7. Air pressure indicating device in accordance with one of the claims 1 to 6, wherein said cylindrical piston comprises a tubular passage (130) between said lower end face (121) and said upper end face (129), said tubular passage (130) being extended with a valve activating tubular member (131) at the lower end face (121) and with an air inlet tubular member (139) at the upper end face (129) , and wherein said cylindrical sleeve is arranged to be releasably connected to a valve (140) of said vehicle tire (150).

8. Air pressure indicating device in accordance with claim 7, further comprising a cap (136) arranged to be mounted on a upper end of said sleeve, said cap comprising a protruding member (138) which is arranged for pushing down the inlet tubular member (139) and thus the transponder carrying member (120) by the force exerting member (134) when the cap (136) is brought into its mounted position.

9. Air pressure indicating device in accordance with one of the claim 1-8, wherein said transponder carrying device comprises at least three RF transponders, said transponders being non-equidistantly spaced in the transponder carrying device.

10. System for remote monitoring of air pressure in a vehicle tire (150), comprising
- an air pressure indicating device (100) as indicated in one of the claims 1-9,
- an interrogating RF transceiver (160) , arranged for wireless communication with the interrogatable RF transponders included in said indicating device, and
- a remote monitoring device (170) operatively connected to said interrogating RF transceiver (160) .

11. System in accordance with claim 10, wherein said interrogating RF transceiver (160) is installed in the vehicle in the vicinity of said tire (150).

12. System in accordance with claim 10, wherein said interrogating RF transceiver (160) is installed externally to the vehicle.

13. System in accordance with one of the claims 10-12, wherein said interrogating RF transceiver (160) is arranged to communicate with said remote monitoring device (170) in the vehicle by means of a wireless communication network.

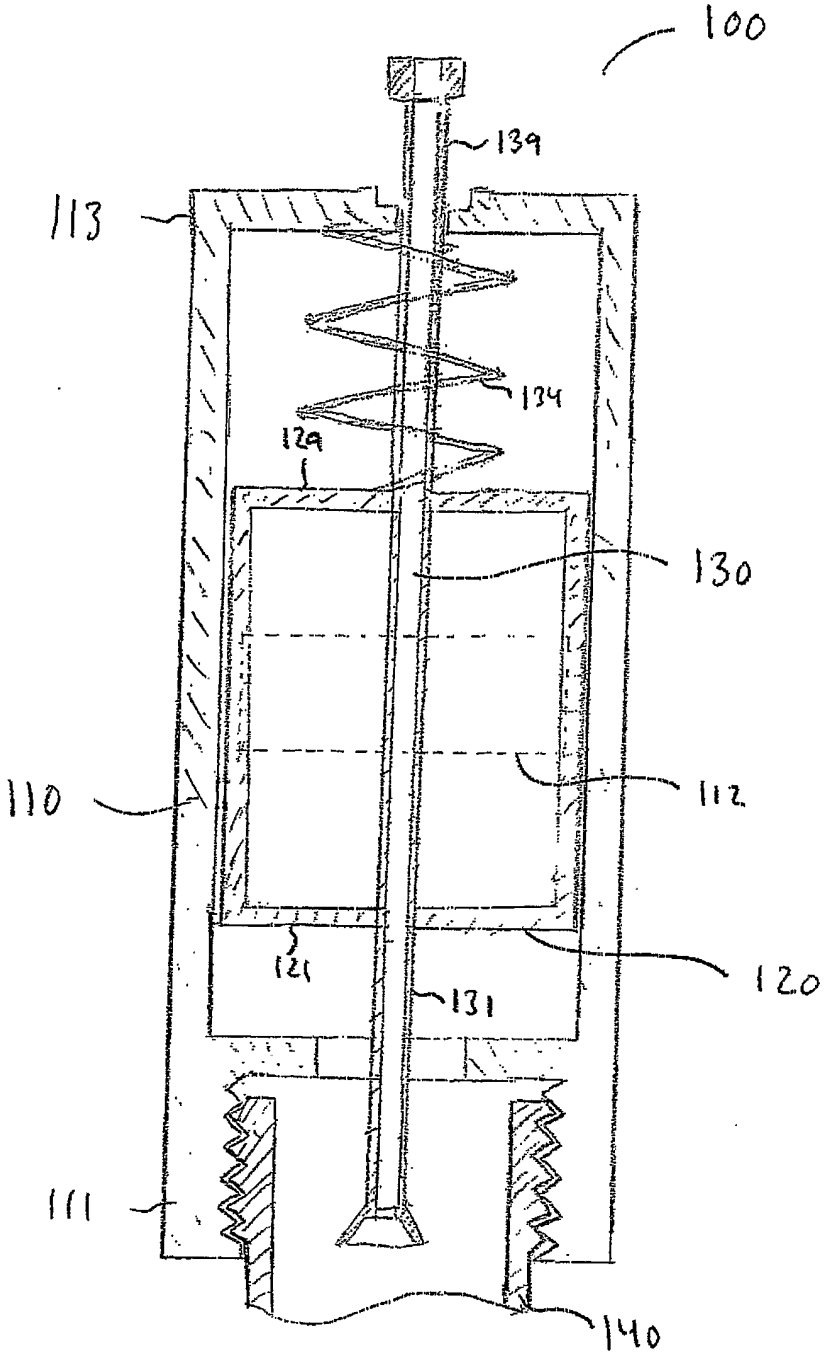

Fig. 1

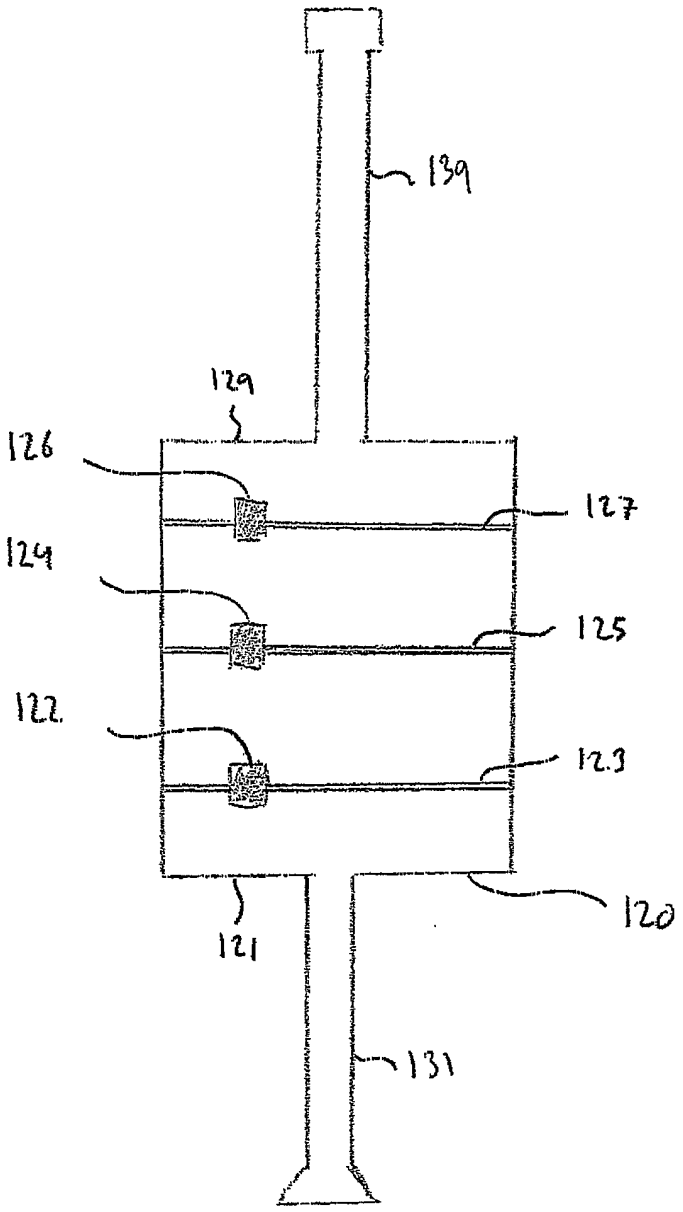

Fig 2

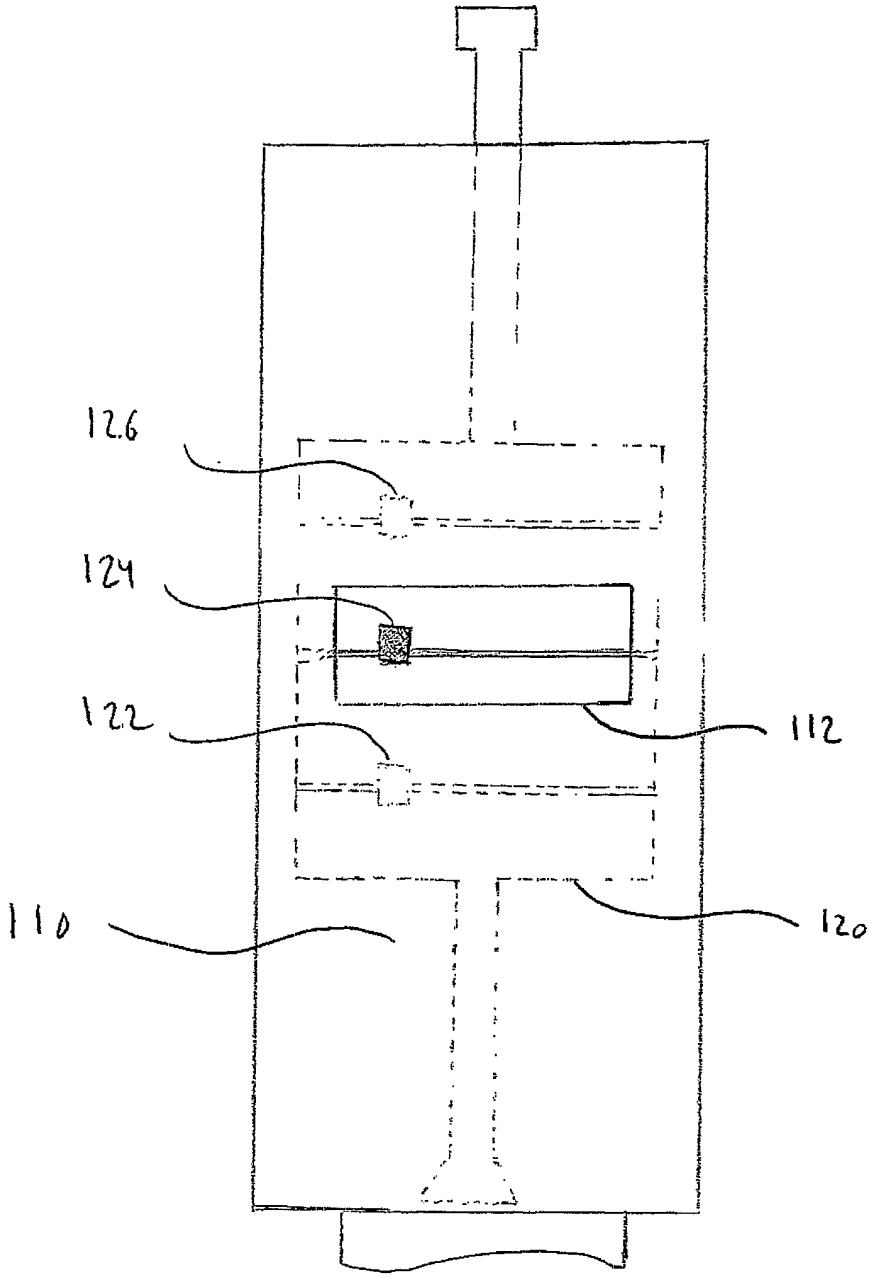

Fig 3

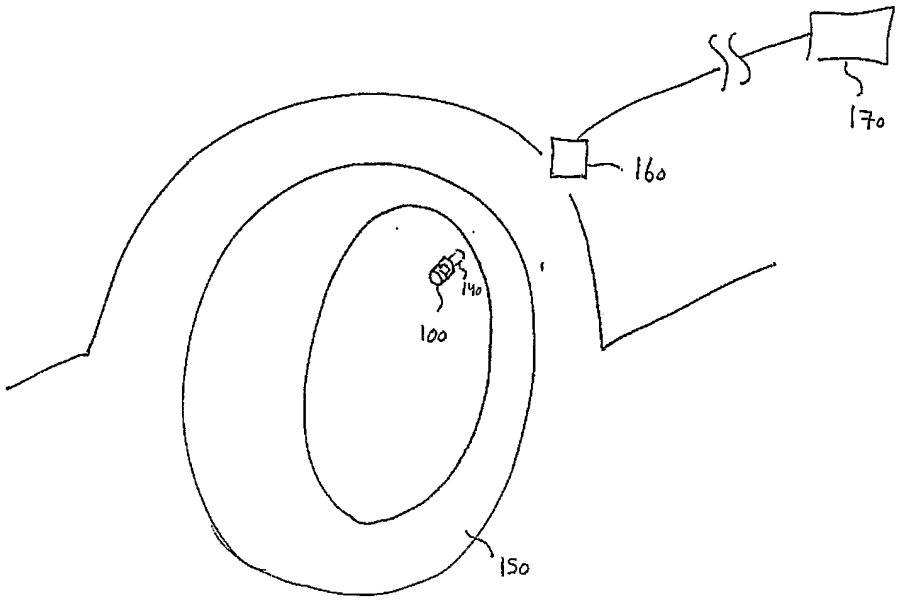

Fig 4

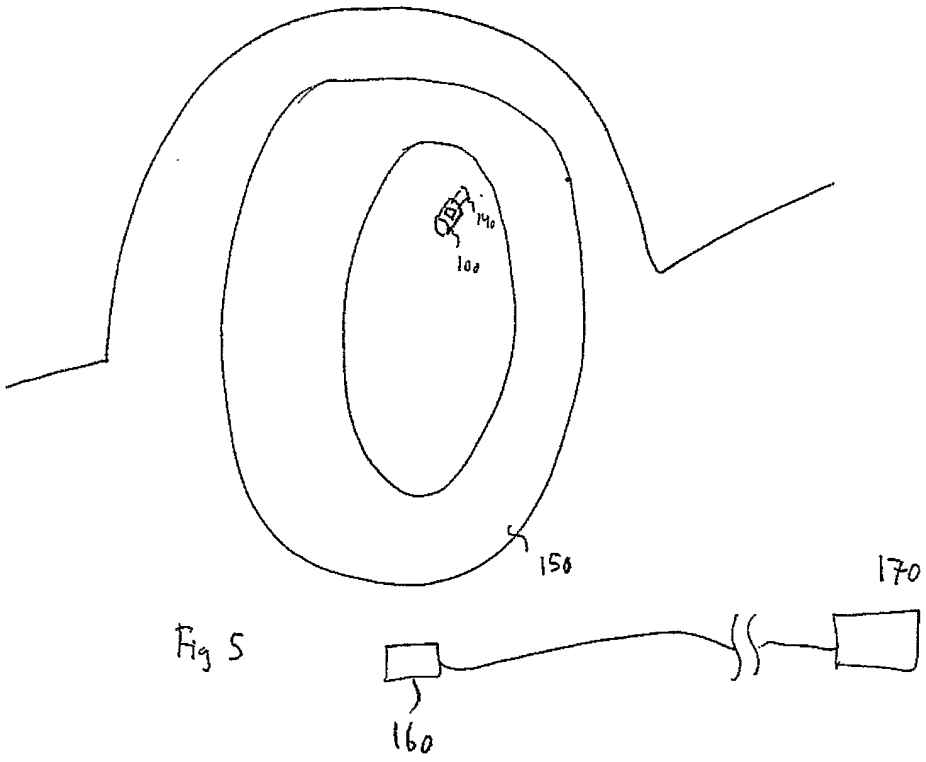

Fig 5

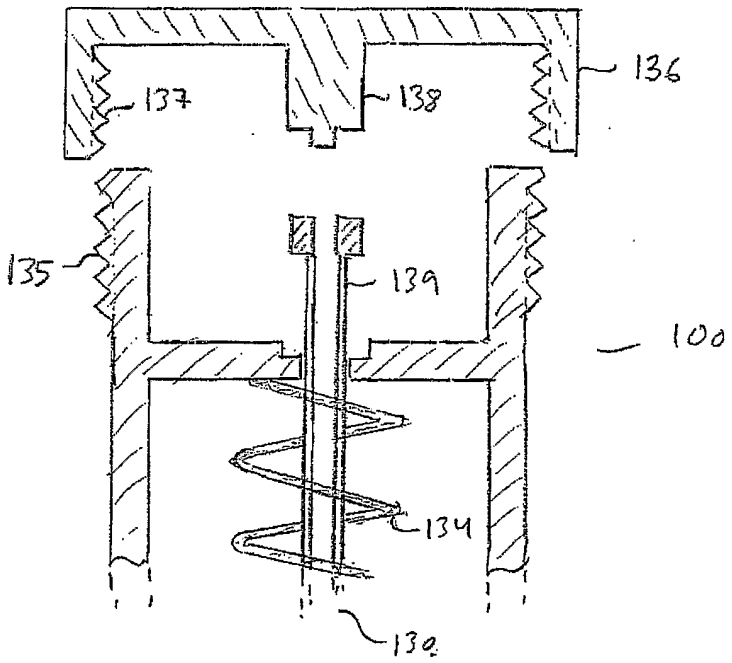

Fig. 6

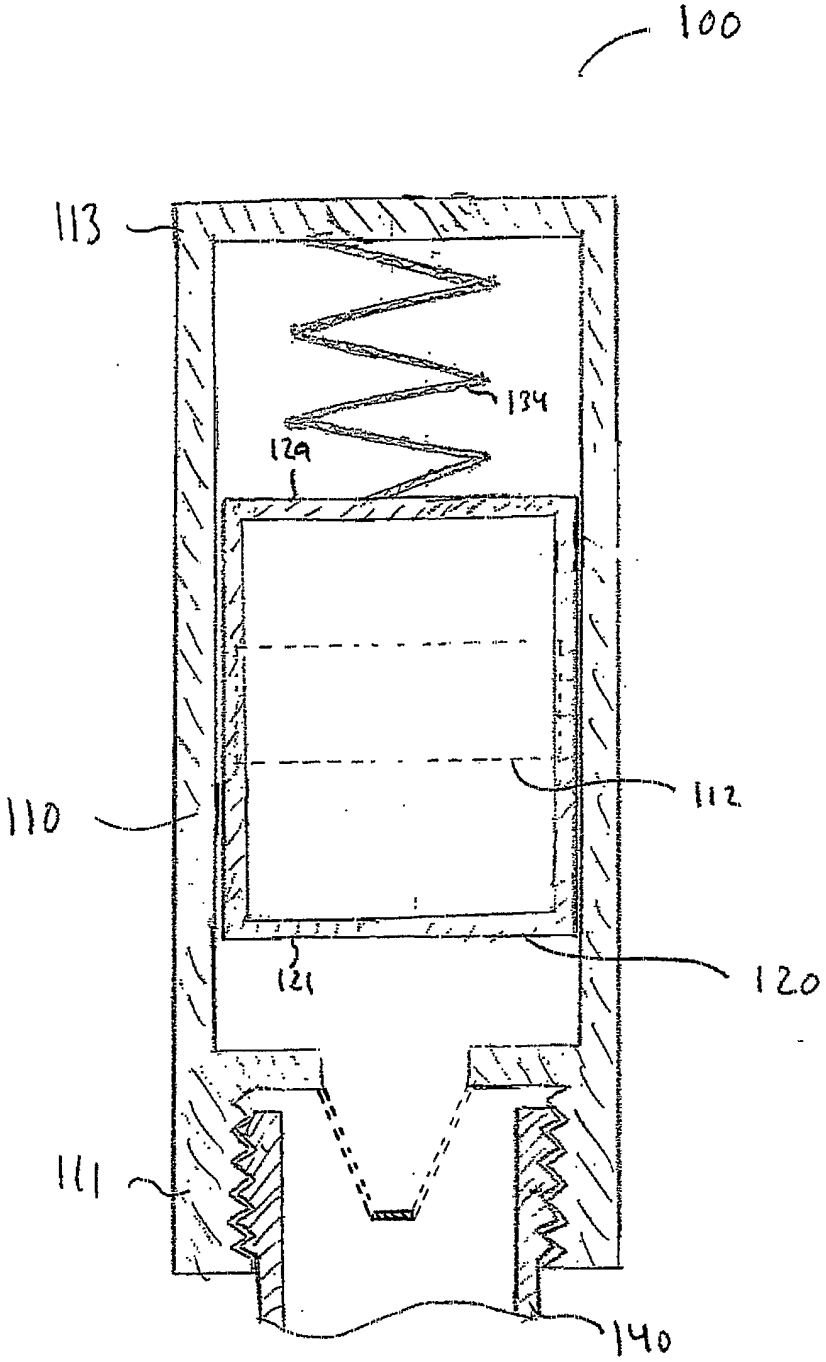

Fig. 7

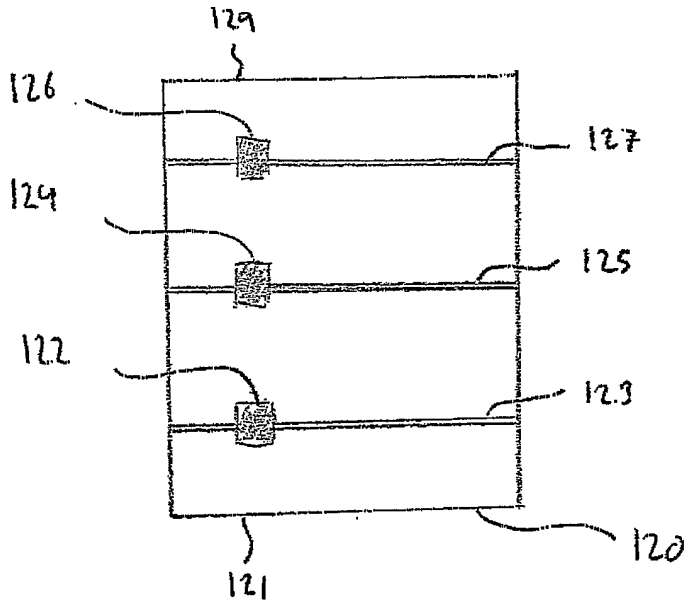

Fig 8

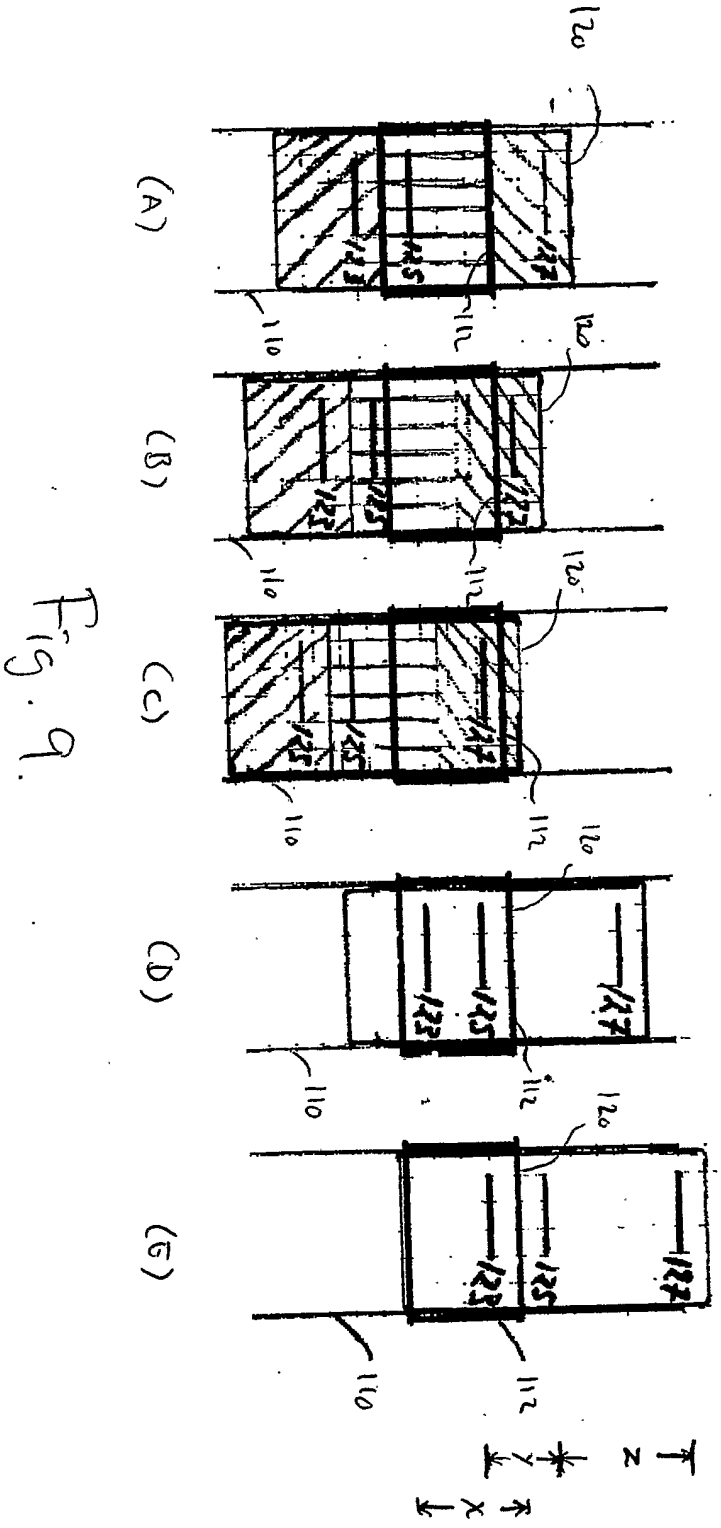

Fig. 9.

INTERNATIONAL SEARCH REPORT

International application No
PCT/NO2006/000095

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60C23/04

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

B. FIELDS SEARCHED

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

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	DE 42 42 861 A1 (DIEHL GMBH & CO, 90478 NUERNBERG) 23 June 1994 (1994-06-23) column 2, line 55 - column 4, line 16 figures 1,2	1,4-8, 10-13 2,3,9
X	US 4 363 020 A (VENEMA ET AL) 7 December 1982 (1982-12-07) column 2 - column 3 figures 1-4	1,10
A	US 3 873 965 A (GARCIA ET AL) 25 March 1975 (1975-03-25) figures 4-7	1-13

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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

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

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 June 2006	03/07/2006

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Billen, K

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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