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Fixing device for a module on the surface of a tyre

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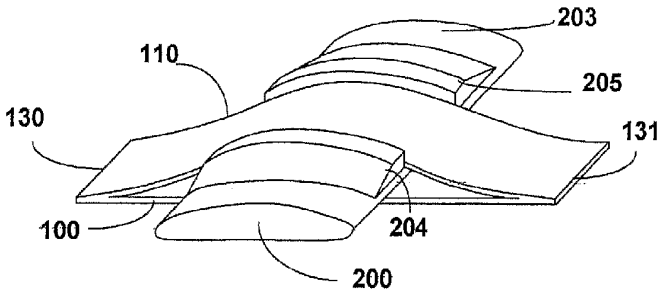
(54) Title: FIXING DEVICE FOR A MODULE ON THE SURFACE OF A TYRE

(54) Titre : DISPOSITIF DE FIXATION D'UN MODULE SUR LA SURFACE D'UN PNEUMATIQUE



(57) Abstract: The invention relates to a detachable fixing element, for a module on the surface of a tyre, comprising a base for cooperation with a module having a specially formed housing. The base comprises a plate (100) with an assembly face for permanent connection to the surface of the tyre, and an elastic strap (110), connected to the plate, by means of two opposing parts of the form thereof (130, 131). Said strap is embodied to exert retaining forces on that part of the module housing cooperating with said strap, which are sufficient to maintain the module (200) in position, having been previously arranged between the support face (102) of the plate and the strap (110).

(57) Abrégé : Elément de fixation amovible d'un module sur la surface d'un pneumatique comprenant une embase coopérant avec un module dont la forme du boîtier est spécialement adaptée. L'embase est composée d'une semelle (100) avec une face d'assemblage destinée à être liée de manière permanente à la surface du pneumatique, et d'une lanière élastique (110) liée à la semelle par deux fractions opposées de son contour (130, 13 1). Ladite lanière est adaptée pour exercer sur la partie du boîtier du module qui coopère avec ladite lanière des efforts de rappel suffisants pour maintenir en position le module (200) préalablement disposé entre la face d'appui de la semelle (102) et la lanière (110).

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En ce qui concerne les codes à deux lettres et autres abréviations, se référer aux "Notes explicatives relatives aux codes et abréviations" figurant au début de chaque numéro ordinaire de la Gazette du PCT.

DEVICE FOR FIXING A MODULE TO THE SURFACE OF A TYRE

The invention relates to a device allowing a module, comprising in general electronic elements, to be removably fixed to the surface of a tyre.

The use of electronic modules in tyres makes possible a wide range of applications comprising the acquisition, storage and transmission of information in order to track manufacturing or logistics, and more generally informing the user of changes in performance of the tyre over the course of its service life.

This electronic module may comprise passive components, such as identification chips or RFID chips, and/or active components connected to an independent system for supplying electrical energy, such as batteries, or indeed an inductive coupling system, which does not form part of the invention. The modules are designed to exchange the desired information with external modules, serving as an interface with the user, by way of radio waves whereof the frequency and power are carefully adjusted to specific transmission protocols. The modules are generally disposed inside flexible or rigid protective casings which are intended to protect the electronic components from attacks associated with shocks and the environment prevailing in the tyre and around it.

The module, which by way of example is positioned inside the cavity formed by the tyre once it is mounted on the wheel, may be disposed on a large number of supports. Thus, it may be fixed to the valve or to the rim, fixed or glued to the inner wall of the tyre cover, or indeed integrated within the components of the tyre. The selection of one of these solutions depends on the type of tyre and the stresses it must undergo, the type of power source for the electronic module, the information which is to be tracked and the desired accessibility for maintenance.

One of the difficulties to be resolved by those skilled in the art taking on these problems relates to overcoming possible interference between the radio waves and the components of

the wheel or the tyre. This problem proves particularly difficult to solve if one of these electronic modules is to be disposed inside a tyre having metal carcass reinforcement plies.

In this last case, the solution consists in disposing the module as close as possible to the wall of the tyre, while taking into account the flexibility of the tyre and the relative rigidity of the module, the resistance to shocks, the possibility of removing the module in order to perform maintenance on it, and the need to ensure that the module is kept in position whatever the speed of rotation and the conditions of use of the cover.

Ways of fixing which allow these requirements to be met are described, for example, in the publication EP 0 936 089, US 6 255 940 or indeed US 6 462 650, which describe systems for fixing a module to the inner wall of a tyre. These devices are composed of a flexible sole plate whereof one face serves to provide a connection to the inner wall of the tyre and whereof the other face has a means of fixing which cooperates with the attachment means disposed on the module.

However, all the solutions proposed in the cited publications relate to devices for which the base serving to provide a connection between the inner wall of the tyre and the module proper is relatively bulky and has, in particular, protruding means of connection to the module.

This latter characteristic is particularly inconvenient when the tyre has to undergo retreading in the hot condition, since this base and the means of connection to the module associated therewith run the risk of damaging the wall of the curing membranes used for this operation. Added to this inconvenience is the fact that there are local alterations in the heat exchange conditions.

It thus becomes necessary to remove this base by grinding it away before the step of vulcanisation and, given the destructive nature of the grinding operation, to replace the base after the vulcanisation operations are complete.

The object of the invention is to reduce the difficulties set out above by proposing an assembly having a fixed base on the inner wall of a tyre and a removable module held in

place by the said base. The features of the base are specifically adapted so that they do not obstruct the operations of retreading the covers in the hot condition.

More particularly, the invention relates to an assembly composed of a removable module and a fixing base, this assembly being intended to be fixed to the surface of a tyre, in which:

- the fixing base comprises a sole plate having a mounting face intended to be permanently connected to the surface of the tyre and a bearing face (102), and means of holding the said module in place; and
- the module comprises at least one electronic component and a casing in which the said component at least partially engages.

This assembly is characterised in that the means of holding in place comprise a resilient strap located opposite the bearing face of the sole plate and connected to the said sole plate by two opposite ends of its contour; and in that the shape and dimensions of the casing, the sole plate and the strap are provided such that it is possible to position the casing in at least one position of holding in place in which the casing is, under normal operating conditions of the tyre, held in place between the strap and the bearing face of the sole plate by resilient restoring forces developed by the resilient strap.

The shape of the casing of the module is adapted to cooperate with the specific profile of the base so that the module is held in place whatever the conditions of travel.

These bases are made from thin strips of rubber mix whereof the profile has the particular feature that it has no parts capable of attacking and damaging a curing membrane, and whereof the presence on the inner surface of the tyre does not significantly alter the local conditions of heat exchange during a curing operation. Once it is permanently fixed to the inner surface of the tyre there is no longer any need to grind away the base before a retreading operation in the hot condition.

The advantages and details of features of this type of base will emerge from reading the present description and from the examples or variant embodiments according to the invention, given with reference to the diagrams and drawings, in which:

- Figure 1 shows a simplified diagrammatic view of a base comprising a sole plate and a resilient strap,
- Figure 2 shows a simplified diagrammatic view of a base comprising a sole plate and a resilient strap into which a module has been introduced,
- Figure 3 shows an end view of a base comprising a sole plate and a resilient strap into which a module has been introduced,
- Figures 4a and 4b show an end view and a profile of a module capable of cooperating with a base such as that shown in Figures 1, 2 and 3,
- Figure 5 shows a simplified diagrammatic view of a first variant on fixing on a base, comprising a variant embodiment of the sole plate and a resilient strap,
- Figure 6 shows a simplified diagrammatic view of a second variant on fixing on a base, comprising another variant embodiment of the sole plate and the resilient strap,
- Figure 7 shows a simplified diagrammatic view of a base comprising a sole plate and a resilient strap divided into two sub-parts,
- Figure 8 shows a simplified diagrammatic view of a base comprising a sole plate and a resilient strap divided into two sub-parts, into which a module has been introduced,
- Figure 9 shows an end view of the base comprising a sole plate and a resilient strap divided into two sub-parts, into which a module has been introduced,
- Figures 10a and 10b show an end view and a profile of a module capable of cooperating with a base such as that shown in Figures 7, 8 and 9,
- Figure 11 shows a simplified diagrammatic view of a base which makes a third variant on fixing possible,
- Figure 12 shows a simplified diagrammatic view of a base into which a module has been introduced, in accordance with a third variant on fixing,
- Figure 13 shows an end view of the base shown in Figure 12,
- Figures 14a and 14b show an end view and a profile of a module capable of cooperating with a base such as that shown in Figures 11, 12 and 13,
- Figure 15 shows a simplified diagrammatic view of a base comprising an opening,
- Figure 16 shows a simplified diagrammatic view of a base having an opening, into which a module has been introduced,
- Figure 17 shows an end view of a base as shown in Figure 16,
- Figure 18 shows an end view of a module adapted for a base having an opening,

- Figure 19 shows an end view of a module adapted for a base having an opening and including a fourth variant on fixing, and
- Figure 20 shows a simplified diagrammatic view of a module and a base whereof the contour is of a zigzag shape.

In the text below, the same reference numerals will be used to designate identical or equivalent elements shown in Figures 1 to 20.

The base (1) as shown in Figure 1 is formed by a sole plate (100) and a resilient strap (110) which is generally rectangular in shape. These two parts are connected to one another at part of their contours (130 and 131), so that a closed-loop strip is formed.

The sole plate (100) and the resilient strap (110) are formed from pieces of thin elastomer material. It has been found particularly advantageous to reduce the total thickness of the base to the minimum possible in order to minimise local effects during the retreading operation in the hot condition, during which heat exchanges are performed by way of the inner surface of the tyre, inside which a curing membrane has previously been deployed. In practice, the thickness of the sole plate (100) or the resilient strap (110) is less than 5 mm, more generally between 1 and 2 mm.

The sole plate (100) is intended to be permanently connected, by means of its mounting face (101), to the surface of a tyre. To this end, it may be formed by one or more layers of materials whereof the properties are suitable for the conditions of adhesion between the sole plate (100) and the sealing rubber of the tyre, and between the sole plate (100) and the resilient strap (110).

In most cases, the base is fixed to the inner surface of the tyre. However, fixing it to an outer surface of the said tyre may readily be envisaged. The glue or the rubber mix providing the connection between the mounting face of the sole plate and the surface of the tyre will be determined from this. For example, it is possible to use a silicone glue. It is also possible to make the connection by hot or cold vulcanisation of rubber mixes well known to those skilled in the art.

In order to ensure better maintenance over time of the adhesion between the mounting face (101) and the surface of the tyre, it is possible to provide pinking around the contour of the sole plate 100. This pinking may be undulating in shape, or indeed zigzagged (103) as shown in Figure 20.

The module (2) is composed of a casing (200) which encloses all or part of an electronic component (not illustrated). The casing (200) comprises a back (203) intended to cooperate with the inner surface of the resilient strap (112), and an underside formed by one or more feet (201, 202) which are intended to come into contact with the bearing face of the sole plate (102).

The resilient strap (110) is intended to hold in place the casing of the module (200) which has previously been introduced between the bearing face of the sole plate (102) and the inner face (112) of the resilient strap (110), as illustrated in Figure 2 or Figure 3. A material whereof the resilient properties are suited to this function must therefore be sought. In practice, although this is not restrictive, the modulus of elasticity of these materials will generally be between 0.5 MPa and 5 MPa for an elongation of 10%. When the module is introduced into the base, the resilient strap (100) is tensioned resiliently, and the resultant of these forces exerts restoring forces on the back (203) of the casing (200) of the module so that the bearing feet (201, 202) as illustrated in Figures 3, 4 and 4a are in permanent contact with the bearing face (102) of the sole plate (100).

The rubber mix forming the strap (110) will preferably be resistant to flow and to the environmental conditions to which the base is subject.

Experiments have shown that to obtain good results in endurance tests, an anchoring rubber mix containing at least one synthetic elastomer from the family comprising EPDMs, SBRs, polybutadienes or butyls may be used. The rubber mix moreover contains reinforcement fillers such as carbon black and a vulcanisation system which are suitable for obtaining the desired rigidity, and additives such as antioxidants in appropriate quantities. These mixes have good resistance to flow and to oxidation.

A rectangular shape for the sole plate or the resilient strap (100) has proved to be the most convenient for making and fixing the sole plate to the inner surface of the tyre and for introducing the module. However, without departing from the spirit of the invention, this shape may be adapted to meet the demands of adhesion or bulk at the point of adhesion to the inner surface of the tyre, as illustrated in Figures 5 and 6. Thus, the width of the resilient strap (110) may be smaller in some parts than the width of the sole plate (100).

Made in this way, the base (1) is capable of holding in place a module (2, 3) of any shape. In practice, however, it has proved necessary to adapt the shape of the casing (200) inside which the electronic part proper of the module is clasped, so that holding in place of the module is ensured whatever the conditions of travel of the tyre. It is advisable to avoid any risk that the module will come out once it has been introduced between the bearing face of the sole plate (102) and the inner face of the resilient strap (112) of the base. To this end, it is possible to provide shoulders (204 and 205) on the back (203) of the body of the module, between which the resilient strap is arranged in order to prevent any possibility that the module will slide out of the base. The spacing between the two shoulders will be adapted to correspond substantially to the width of the said resilient strap (110) in the zone of contact between the resilient strap (110) [lacuna] the back (203) of the casing (200).

Moreover, the attempt should be made to adapt the shape of the underside of the casing of the casing of the module (200, 300, 400) in contact with the bearing face of the sole plate (102), so that premature wear of these contact surfaces, resulting from the differences in the viscoelastic properties between the casing of the module and the tyre, are avoided. The casing of the module should thus be rested on one or more bearing feet (201, 202, 301, 302, 401, 402) as illustrated, by way of example, in Figures 3, 4a and 4b, 9, 10a and 10b, 13, 14a and 14b or indeed in Figures 17, 18 and 19, whereof the shape will be adapted advantageously so that there is a convex contact surface which is not aggressive towards the bearing face of the sole plate (102) or the inner surface of the tyre, whatever vibrations arise in the module or whatever deformations the tyre undergoes in the zone where the base and the module are disposed, each time the tyre rotates. In practice, the variations in curvature in this contact surface will as far as possible be progressive, so that they do not have sharp or aggressive edges giving rise to localised positive pressure. The number of bearing feet will preferably be between one (Figures 10a, 10b, 14a, 14b, 18, 19) and two (Figures 4a, 4b) so that the greatest

possible independence of movement of the module (2, 3, 4) with respect to the tyre is possible during use.

It is also possible, without departing from the scope of the invention, and using a base comprising a sole plate and a resilient strap, to dispense with the shoulders (204, 205) and to fix the module in a different way.

A first variant on the fixing consists in providing a removable fixing means. This means may be formed, by way of example, by a screw (206) passing through the resilient strap (110) and a thread made in the body of the module, as illustrated in Figure 5.

A second variant on the fixing may consist in covering all or part of the outer face (111) of the resilient strap in the contact zone between the back (203) of the casing of the module (200) and the resilient strap (110) with the aid of a means (207) which follows the shape of the casing and is held on the latter with the aid of removable fixing means, such as fixing screws (208, 209), firmly immobilising the resilient strap (110) between the said means (207) and the back (203) of the casing of the module, as illustrated in Figure 6.

It is also possible to arrange the holding feet (201 and 202) at a spacing such that they clasp the sole plate (100) between their points of contact with the inner surface of the tyre (not illustrated). However, this embodiment does not enable perfect holding in place if the intention is to minimise the height of the sole plate (100).

A second variant embodiment, and one which is particularly robust, for bringing about cooperation between a resilient strap and the casing of the module (3) consists in making a base in which the resilient strap is divided into two sub-parts (115, 116). The features of the sole plate (100) are similar to those described above. The two sub-parts of the resilient strap (115 and 116 respectively) are disposed facing one another and connected to the sole plate by a part of their contours (130 and 131 respectively), as illustrated in Figure 7.

Each of the other two ends (117, 118) of the two sub-parts of the resilient strap are anchored to the casing (300) of the module (3) so that the said restoring forces of the strap (115, 116) are transmitted to the casing (300) of the said module.

By way of example, an embodiment of this variant consists in providing a holding rod (117, 118) at the ends of each of the two sub-parts of the resilient strap (115 and 116); the said holding rods (117, 118) are disposed opposite the connection (130, 131) between the sole plate (100) and each of the sub-parts (115, 116) of the resilient strap. The rod may be cylindrical in shape, or of any other suitable shape.

The casing (300) of the module (3) has two receivers (303 and 304 respectively) which are located laterally on either side of the said casing and whereof the profile is adapted to receive the holding rods (117 and 118) as illustrated in Figures 10a, 10b, 14a and 14b. Introducing the holding rods (117 and 118) into the receivers (303 and 304 respectively) ensures that the module (300) is kept upright and in contact with the bearing face (102) of the sole plate (100).

To do this, the length and resilience of the sub-parts of the resilient strap (115, 116) must be adapted accordingly.

Once the module is mounted, the two sub-parts (115 and 116) of the resilient strap are put under resilient tension, and the resultant of these forces exerts restoring forces which are transmitted, as a result of the fact that the holding rods (117, 118) are fitted into the receivers (303, 304), to the casing of the module so that the bearing feet (301, 302) illustrated in Figures 9 and 13 are in permanent contact with the bearing face (102) of the sole plate (100).

Similarly, and for the same reasons as those described above, it is recommended to provide one or more bearing feet (301, 302) on that part of the casing which is in contact with the bearing face of the sole plate or the inner surface of the tyre. These bearing feet must be adapted to have a contact surface which is as unaggressive as possible.

It may also prove necessary, in order to limit movement of the module, to provide slightly elevated portions (105) on the bearing face (102) of the sole plate (100) which are intended to cooperate with the bearing feet (301), as shown in Figures 7 or 9, preventing the foot from slipping on the bearing face (102) of the sole plate. In practice, the height of these elevated portions (105) does not exceed 1 to 2 mm. This elevated portion (105) may be made such that

it surrounds the contact zone of the bearing foot, as shown in Figure 7 or Figure 9, but it may also take the form of a slight boss (not shown) on which the foot comes to bear, the concave shape of this foot corresponding, at the point of contact with the second face (102) of the sole plate, to the shape of the boss made on the latter.

It should be noted that these provisions may be applied to any type of resilient strap of the base.

It is also possible, in this configuration of the resilient strap, to use a third variant on removable fixing of the module. To this end, apertures (119, 120) may be made in the holding rods (117, 118) and may cooperate with fixing screws (305, 306) provided in the body of the module, as illustrated in Figures 11, 12, 13, 14a and 14b.

A third variant embodiment on the means of bringing about cooperation between the resilient strap (1) and the module (4) consists in making an opening (121) in the resilient strap, as illustrated in Figure 15. The edges of the opening are adapted so that they clasp an advantageously selected contour of the casing (400) of the module, as illustrated in Figures 16 and 17. To hold the module in place better, it is advantageous to provide a groove (403) in the casing (400), intended to receive the edges of the opening made in the resilient strap, as illustrated in Figure 18. The module (4) is introduced into the opening by working on the resilience of the material used to make the resilient strap. Once the module is in position, the resilient strap is put under tension and firmly holds the module in place at the groove (403), while exerting on the module the restoring forces required to maintain the contact between the bearing foot (401) of the module (400) and the bearing face (102) of the sole plate (100).

The circular shape of the opening is given here by way of example, and may equally be adapted to a particular shape of the casing of the module.

An alternative embodiment consists in supplying the casing with a removable cap (405) which may be screwed onto the body of the said casing. Once the body of the module is in position, it is possible to fix the module to the resilient strap, as illustrated in Figure 19, by screwing the cap (405) onto the body of the casing. This variant may prove particularly advantageous for easy access to the battery powering the module.

The example embodiments of the principles of the invention, namely the capacity of a resilient membrane put under tension to hold in place the module pressed against the inner wall of a tyre, allow those skilled in the art to combine at will, without departing from the spirit of the said invention, each of the variant embodiments, illustrated in the description above, of the sole plate, the resilient strap, the bearing feet or the removable fixing means.

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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. An assembly including a removable module and a fixing base, said assembly being intended to be fixed to a surface of a tyre, in which:

the fixing base comprises a sole plate having a mounting face intended to be permanently connected to the surface of the tyre and a bearing face, and means of holding the said module in place; and

the module comprises at least one component and a casing in which the said component at least partially engages;

characterised in that the said means of holding said module in place comprises a resilient strap located opposite the bearing face of the sole plate and connected to the said sole plate by two opposite ends of its contour; and in that the shape and dimensions of the said casing, the said sole plate and the said strap are provided such that it is possible to position the said casing in at least one position of holding in place in which the casing is, under normal operating conditions of the tyre, held in place between the said strap and the said bearing face of the sole pate by resilient restoring forces developed by the said resilient strap.

2. An assembly according to Claim 1, in which the resilient restoring forces developed by the resilient strap when the casing is put in position are such that the said casing is in constant contact with the resilient strap and the bearing face of the sole plate when the tyre is used in normal operating conditions.

3. An assembly according to Claim 1 or Claim 2, in which the fixing base and the casing, are adapted to allow the said module to be put in position by insertion between the said resilient strap and the said bearing face of the sole plate.

4. An assembly according to Claim 3, in which the casing of the said module includes a back intended, when it is in the holding position, to be in contact with the resilient strap and shoulders which are disposed facing one another on a back of the casing of the module, between which the resilient strap is intended to be positioned, and are placed at a spacing corresponding substantially to the width of the said resilient strap in a zone of contact between the resilient strap and the back of the casing of the module.

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5. An assembly according to Claim 1 or Claim 2, in which the resilient strap of the base is divided into two sub-parts which are disposed facing one another, each of the sub-parts being connected to the sole plate by one of its ends and anchored to the casing of the module by its other end so that the said restoring forces of the strap are transmitted to the casing of the said module.

6. An assembly according to Claim 5, in which anchoring of the strap to the casing of the module is ensured by holding rods disposed at the ends of the two sub-parts, with the holding rods introduced into grooves in the casing of the module.

7. An assembly according to Claim 1 or Claim 2, in which the resilient strap of the base has an opening allowing a contour of the casing of the module to be clasped.

8. An assembly according to Claim 7, in which the casing of the said module has a groove on one of its contours which is intended to receive the edge of the opening made in the resilient strap.

9. An assembly according to any one of Claims 1 to 8, in which the said casing of the said module has a base with bearing feet which are intended to be in contact with the bearing face of the sole plate, and in which the said sole plate has on its said bearing face one or more slightly elevated portions, intended to cooperate with the said bearing feet, located on the underside of the casing of the module.

10. An assembly according to Claim 9, in which the said bearing feet of the underside of the casing of the module have a convex surface with a progressive curvature.

11. An assembly according to one of Claims 1 to 10, in which the width of the resilient strap of the said base is smaller in some parts than the width of the sole plate.

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12. An assembly according to one of Claim 1 to 11, in which the fixing base has a means of immobilising the resilient strap on the back of the casing of the module.

13. An assembly according to Claim 12, in which the means of immobolising is in the form of a screw.

14. An assembly according to any one of Claims 1 to 13, in which the sole plate and the resilient straps are formed from a piece of elastomer material which is less than 5 mm thick.

15. An assembly according to any one of Claims 1 to 13, in which the sole plate and the resilient straps are formed from a piece of elastomer material which is less than 2 mm thick.

16. An assembly according to any one of Claims 1 to 15, in which the elastomer material forming at least the resilient strap of the base is a rubber mix including at least one synthetic elastomer selected from the group comprising EPDMs, SBRs, polybutadienes or butlys.

17. An assembly according to one of Claims 1 to 16, in which the external contour of the sole plate is indulating.

18. An assembly according to one of Claims 1 to 17, in which the external contour of the sole plate is of a zigzag shape.

19. A module intended to form, with a fixing base, an assembly according to one of Claims 1 to 18.

20. A fixing base intended to form, with a module, an assembly according to one of Claims 1 to 18.

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21. A tyre having on one of its surfaces an assembly according to one of Claims 1 to 18.

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WATERMARK PATENT & TRADE MARK ATTORNEYS

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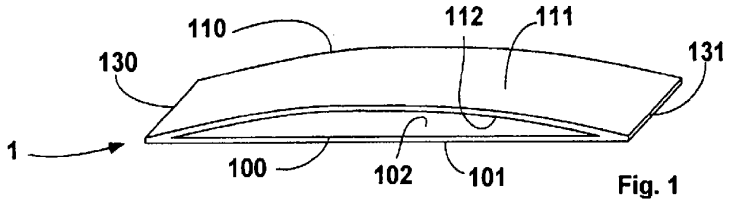


Fig. 1

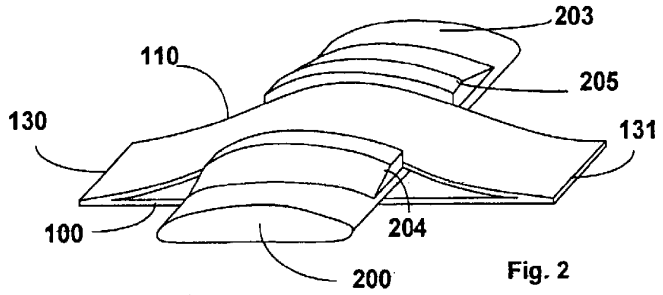


Fig. 2

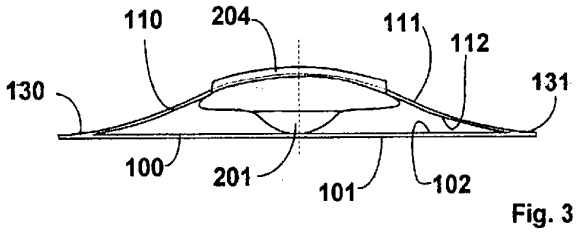


Fig. 3

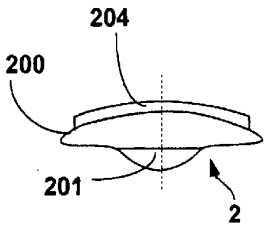


Fig. 4a

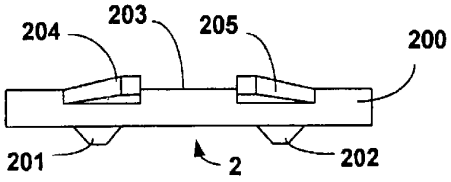


Fig. 4b

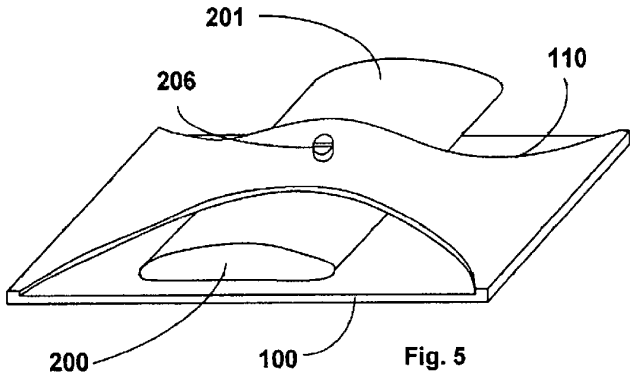


Fig. 5

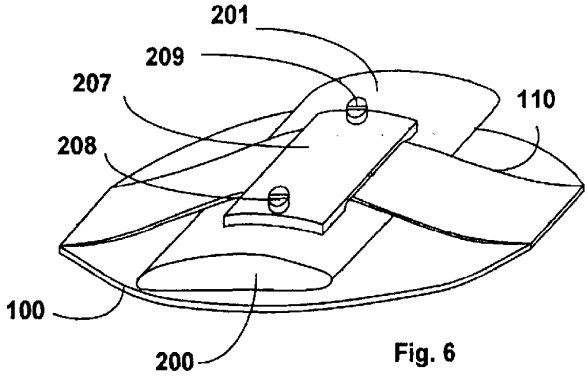
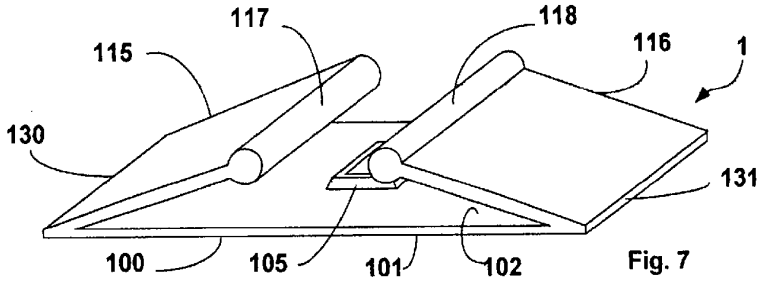


Fig. 6



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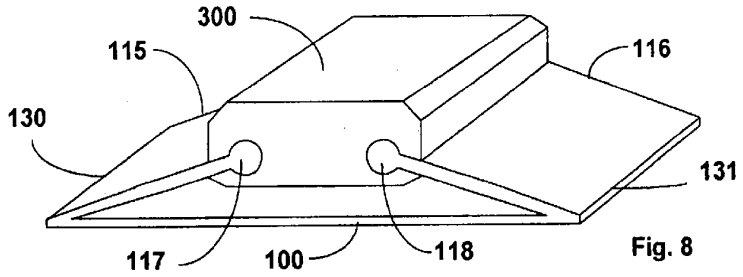

Fig. 8

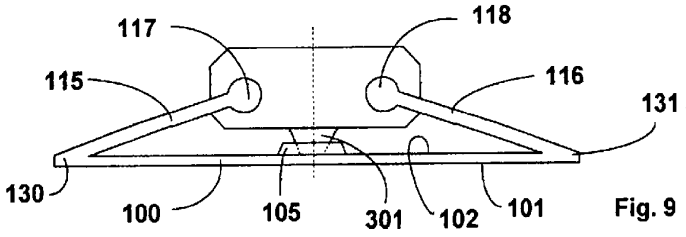

Fig. 9

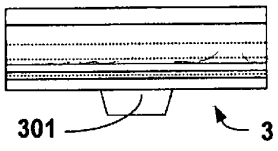

Fig. 10a

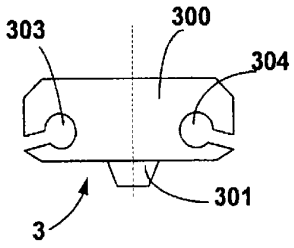

Fig. 10b

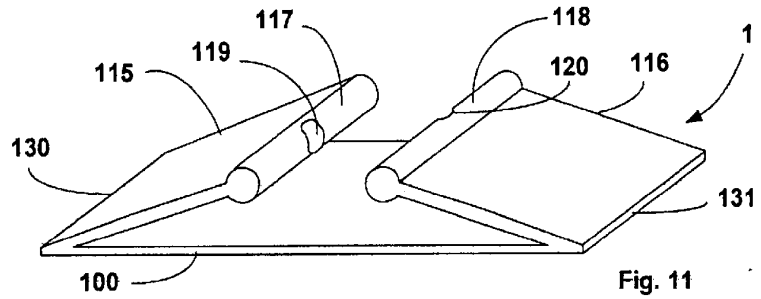

Fig. 11

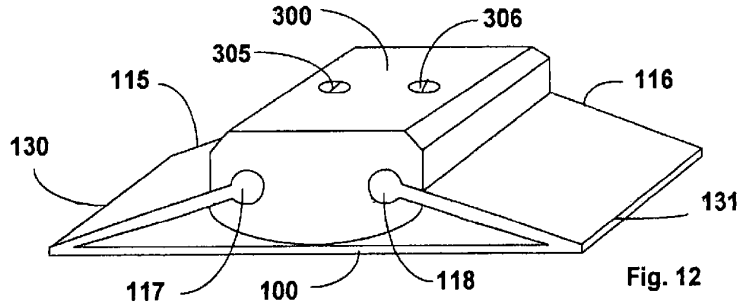

Fig. 12

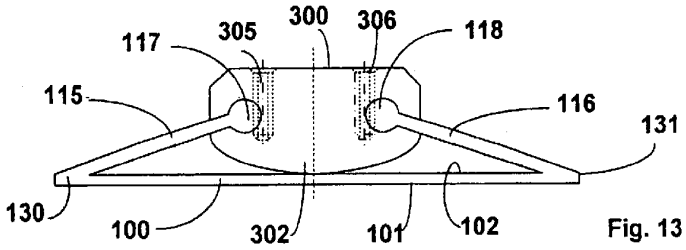

Fig. 13

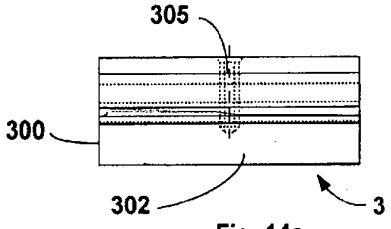

Fig. 14a

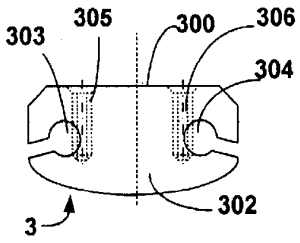

Fig. 14b

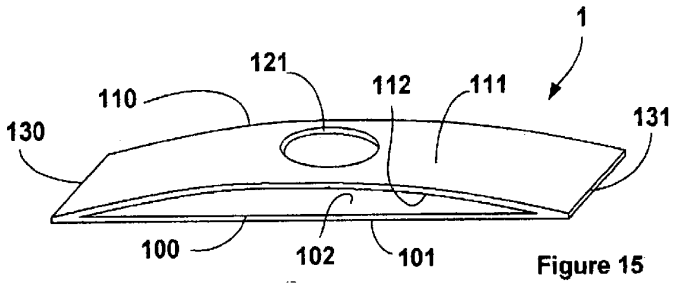

Figure 15

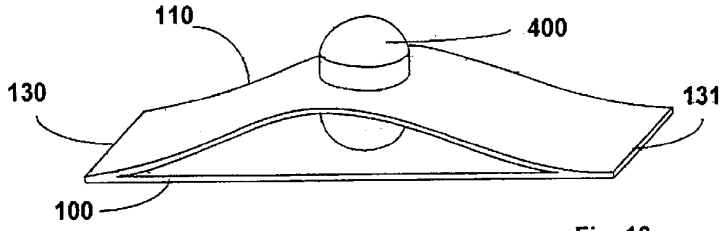

Fig. 16

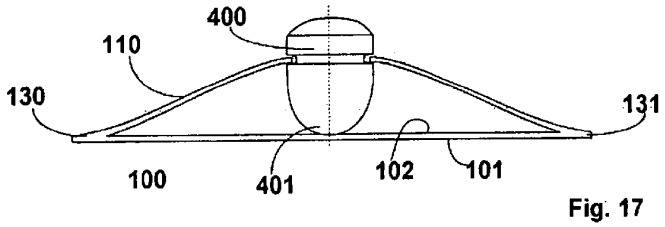

Fig. 17

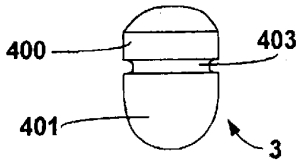

Fig. 18

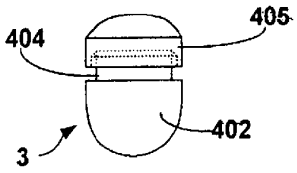

Fig. 19

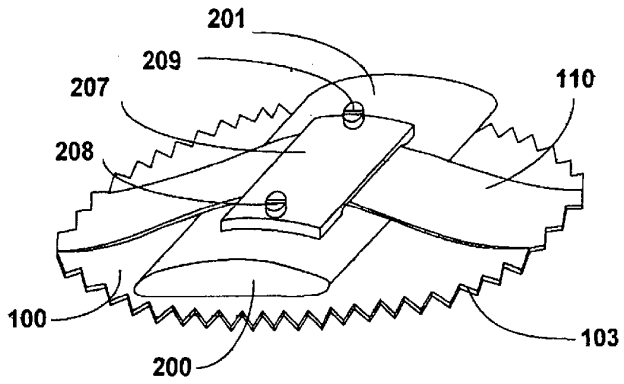

Fig. 20