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(54) **CAPSULE FOR PROTECTING AN ELECTRONIC DEVICE INSIDE A WEAR ELEMENT OF AN EARTH MOVING MACHINE**

(57) Capsule (1) for protecting an electronic device (2) inside a wear element (3) of an earth moving machine, corresponding wear element and machine. The capsule (1) has a central axis (4) defining an axial direction, a front end (8), and a rear end (9). The capsule (1) comprises a container (5), extending in the axial direction from said front end (8), provided with an inner chamber (53) for housing said electronic device (2), and has a front part (51) provided with a flange (7), and a rear part (52). The capsule (1) also comprises a cover (6) that can be removably coupled to said container (5) and configured for covering said rear part (52) of said container (5).

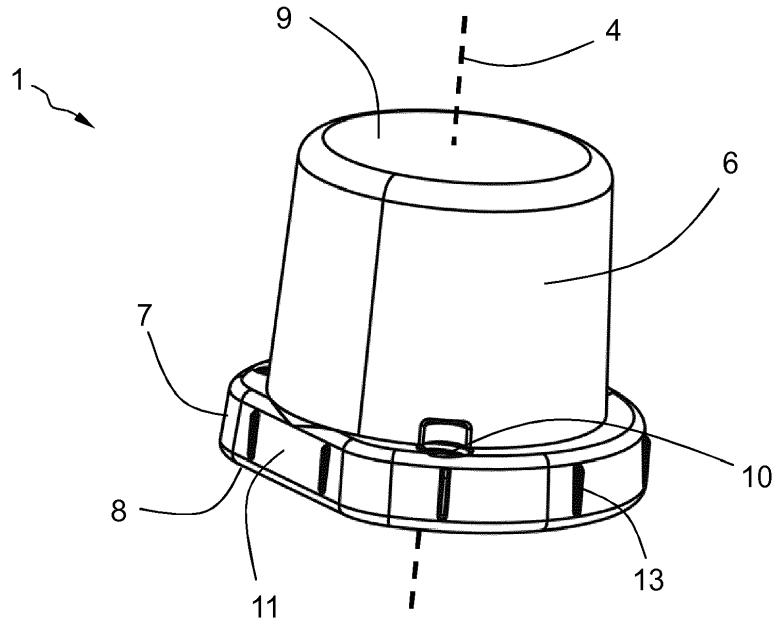

FIG. 1

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Description

Field of the Invention

[0001] The invention is comprised in the field of earth moving machines, for example, excavators, provided with replaceable wear elements that contact the earth to perform works, such as excavation works. In the field of the art, these wear elements are also known with the name ground engaging tools (GETs). They comprise elements such as:

- teeth: they have the function of penetrating the ground and protecting the blade of the excavator shovel;
- tooth holder: it has the function of protecting the blade and bearing teeth;
- front guards: they have the function of protecting the lip in the areas comprised between the teeth and also perform penetration function, but to a lesser degree than the teeth; and
- side guards: they protect the sides of the excavator bucket.

[0002] More specifically, the invention relates to a capsule for protecting an electronic device inside a wear element of an earth moving machine, having a central axis defining an axial direction, a front end, and a rear end opposite said front end in the axial direction. Electronic devices of this type are generally intended for monitoring operative parameters of the wear element, for example, for detecting accumulated wear of the element, for detecting the falling of said element, or for accumulating operation readings for subsequent analysis.

[0003] The invention also relates to a wear element comprising an electronic device protected by one of said capsules, and an earth moving machine comprising at least one of said wear elements incorporating said capsule.

State of the Art

[0004] In the sector of earth moving machines, wear elements, GETs, are starting to be provided with different types of electronic devices arranged therein. These electronic devices usually comprise sensors which are used to monitor or gather information about the operations of each wear element.

[0005] These wear elements are subjected to extreme working conditions: they are exposed to high pressures and end up withstanding high temperatures due to the friction of the wear element itself. For these reasons, there is a need to cover the electronic devices with a protective element, for example, a capsule intended for containing the electronic device. This capsule is formed complementary to an opening provided in the wear element intended for receiving the capsule.

[0006] Due to the working conditions, the capsule can end up with deformations which may even affect the electronic device. For example, dust or small particles of material are released during erosion or excavation works. These particles, known in the art as "fines," enter the exposed parts of the machinery, for example, in the attachment between the wear element and the part of the machine where said wear element is coupled, for example, between the attachment of a tooth and a tooth holder. Given that the wear end of the wear element is intended for wearing off with use, the capsule with the electronic device is usually located in the area of this attachment part between the wear element and the machine. The build-up of particles in this attachment part, together with the wear element repetitively hitting the ground during use, gradually compacts said particles, which increases pressure against the capsule and can end up deforming or even destroying it, affecting the device. Furthermore, due to their small size, the particles can also enter any inner cavity, for example, between the wear element and the capsule. All this hinders the use of electronic devices inside the wear elements.

[0007] Even if the capsule is robust enough to protect the electronic device, the effect of compacting the particles described above can end up applying so much pressure on the capsule that it is impossible to extract said capsule at the end of the service life of the wear element. The particles compacted between the wear element and the capsule also contribute to this problem, given that fines are compacted to a very high level of hardness retaining the capsule inside the wear element. This effect can be aggravated by possible capsule deformations which further hinder capsule extraction.

[0008] The fact that the capsule is fixed inside the wear element has several drawbacks. The main drawback lies in recycling, given that electronic components are not recycled the same way as the metallic material with which the wear element is manufactured. The recycling problem is particularly relevant in the case where the electronic device comprises some kind of battery. To solve this problem, one option is to destroy the capsule when use thereof has come to an end to enable extracting remnants of the destroyed capsule from inside the wear element. However, there is a risk that the batteries will end up being destroyed, which would release the contaminant products they contain.

[0009] Another drawback is the difficulty in recovering the electronic device, maintaining its integrity, when its service life has come to an end. That is particularly important for those devices that must be recovered, such as those that gather operation measurements of the wear element for subsequent study. Indeed, if the capsule and its contents are to be destroyed for extraction, the use of electronic devices of this type will be impossible.

[0010] There is therefore a need for a capsule which protects the electronic device during use of the wear element, and, where possible, allows recovering said electronic device when its service life has come to an end, maintaining the physical integrity of the electronic device

during use, and, where possible, also during extraction. Another objective is to minimize recycling problems.

Description of the Invention

[0011] Unless specified otherwise, this document will make use of the coordinate system relative to the capsule described above and defined by said central direction, said front end, and said rear end. The skilled person will understand that the choice of the terms "front" and "rear" is used herein for the sake of clarity to establish a reference coordinate system. However, given the nature of the capsule and its usage positions, this choice of terms is, in fact, arbitrary and other terms could be used for the coordinates. In the naming convention used herein, references to the term "front" shall be understood to be relative to said front end, whereas references to the term "rear" are relative to said rear end. For example, when talking about the front end of an element of the capsule, it will refer to the end of the element closest to the front end of said capsule, whereas when talking about the rear end of an element of the capsule, it will refer to the end of the element closest to the rear end of said capsule. Concepts such as front part, rear part, front side, rear side, front face, rear face, etc., will be understood the same way. Moreover, the term "longitudinal" must be interpreted as being relative to the axial direction, but it may not be completely parallel to said direction. For example, it can be slightly oblique with respect to said axial direction.

[0012] The purpose of the invention is to provide a protective capsule of the type indicated above, which allows solving the problems described above.

[0013] This purpose is fulfilled by means of a capsule of the type indicated above, characterized in that it comprises:

- a container, extending in the axial direction from said front end, provided with an inner chamber configured for housing said electronic device, wherein said container has a front part provided with a flange, and a rear part; and
- a cover that can be removably coupled to said container and configured for covering said rear part of said container.

[0014] Splitting the capsule into an inner container and an outer cover covering the inner container provides the capsule with greater tolerance to the working conditions of the wear element. The cover of the invention is coupled to said container by means of any removable coupling means known in the art, such as a snap-fit or click-fit. Therefore, the possible deformations mainly affect the cover, whereas the inside of the container is less affected. In turn, the rear face of the flange is in contact with a support surface in the wear element. The flange at the front end therefore has the technical effect of attenuating the forces due to pressure exerted by the particles built up between the wear element and the machine, and deviating part of said forces to said support surface of the wear element instead of the capsule itself. Furthermore, it hinders the passage of particles to the contact areas between the capsule and the wear element, which further reduces the problems associated with compaction. The capsule is therefore more suitable for protecting the electronic device.

[0015] Preferred embodiments the features of which are set forth in the dependent claims have been provided based on the invention defined in the main claim.

[0016] Preferably, said flange has extraction means configured for extracting said container from said wear element. In this manner, even if the capsule cannot be extracted directly from the wear element, the extraction means allow extracting the container which is the part containing the electronic device. In this case, only the cover, instead of the whole capsule, would remain inside the wear element, unlike what occurs in the products of the known state of the art. This solution also favors the ability to maintain the integrity of the electronic device, even when the capsule is removed from the wear element.

[0017] Preferably, said extraction means are additionally configured for extracting said container from said cover. This further facilitates the extraction of the container: indirectly by means of extracting the container from the cover, and directly by means of extracting the container from the wear element. This minimizes the possibility of the container being lodged inside the wear element.

[0018] Preferably, said extraction means are configured for extracting said container by means of pushing in the axial direction, which facilitates a smooth extraction, minimizing the possibility of generating lateral pushes which may end up causing damage to the container or its contents, and which may furthermore cause it to become lodged during extraction.

[0019] Preferably, said extraction means comprise at least two threaded through holes, which allows extracting said container in the following manner:

- introducing a screw into each of said threaded through holes, said screw having a thread complementary to the thread of said threaded through hole;
- screwing in each screw at least partially, causing an axial push; and
- repeating the screwing in step until the push of said screws causes the extraction of said container.

[0020] Generally, when more threaded holes are provided, the force equilibrium that can be obtained during extraction will be greater, so said extraction is smoother. In contrast, with more threaded holes, the flange will have less structural integrity and the extraction will require more steps given that more screws must be tightened. Preferably, said extraction means comprise three threaded through holes, such that an optimum trade-off is ob-

tained between the conditioning factors described above.

[0021] Preferably, said threaded holes are arranged in the axial direction parallel to said central axis, which allows extraction by means of axial pushes, such that said extraction is smoother.

[0022] Preferably, said threaded holes are all arranged at the same distance from said central axis, preferably separated from one another at regular intervals, which allows a homogeneous force equilibrium during extraction. The skilled person will understand that regular intervals refer to fact that the threaded holes, which are contiguous in a circumferential direction with respect to the central axis, are arranged at the same distance from one another. For example, in the case of a circumferentially symmetrical flange with three holes, each of these holes would be located at 120°.

[0023] Preferably, said container is open at its rear end, which facilitates the introduction of the electronic device in the capsule, given that the capsule does not have to be molded around said electronic device. Therefore, it is possible to introduce the electronic device in the container and then cover the container with the cover, thereby closing the compartment containing the electronic device.

[0024] Preferably, the capsule has a diameter with respect to said central axis that decreases, preferably in a uniform manner, between said front end and said rear end of said capsule, facilitating both the introduction of the capsule in and the extraction thereof from the device.

[0025] Preferably, the capsule has a frustum shape such that the inner part thereof can house the device, minimizing at the same time the length in the axial direction. Preferably, the capsule has a frustoconical shape which simplifies the design and facilitates extraction, particularly if the capsule did not undergo deformations.

[0026] Preferably, the capsule further comprises first positioning means configured for cooperating with respective positioning means of said wear element for positioning said capsule inside said wear element. This is particularly advantageous when the capsule must be positioned in a specific position with respect to the wear element, for example, in the case where the electronic device comprises elements that require specific relative positions. Preferably, said positioning means of said capsule comprise the outer shape of said capsule, and said respective positioning means of said wear element comprise an opening intended for receiving said capsule having a shape complementary to the shape of said capsule.

[0027] In an advantageous embodiment, said first positioning means are provided on said flange. This has the advantage of being able to create capsules with circumferentially symmetrical shapes with respect to the central axis, and at same the time precisely positioning the capsule in the wear element. In the case where the opening of the wear element where the capsule is introduced is made by machining, the use of circumferentially symmetrical shapes also simplifies machining. Preferably, said positioning means comprise the shape of the flange, particularly for an advantageous embodiment in the case of a capsule with circumferential symmetry, the flange is in the form of a circumference with a substantially straight arch on its periphery acting as positioning means by means of the complementary shape in said wear element. Other preferred shapes have other positioning means such as recesses or notches intended for the same function.

[0028] Preferably, said capsule further comprises second positioning means configured for cooperating with respective positioning means of said electronic device for positioning said electronic device inside said capsule. This is advantageous when said electronic device must be positioned in a specific manner with respect to the capsule. It is particularly advantageous in combination with said first positioning means of said capsule with respect to said wear element. Indeed, in these cases, the combination allows a precise positioning of the electronic device inside the wear element, which may be required for the case where the device has elements such as positioning sensors, directional antennas, etc. Preferably, said second positioning means comprise a rib in the axial direction configured for fitting into a groove complementary to said rib provided in said electronic device.

[0029] Preferably, said capsule further comprises capsule fixing means configured for fixing said capsule to said wear element. The presence of extraction means allows using the fixing means which would otherwise hinder the extraction of the capsule. Therefore, safety is improved and the risk of the capsule falling during transport is minimized.

[0030] Preferably, said capsule fixing means comprise projections provided on the perimeter of said flange, which allows snap-fitting into the part of the flange. Preferably, said projections are longitudinally arranged, perpendicular to said perimeter. Therefore, in the case where the flange is substantially cylindrical, said projections extend in the axial direction, parallel to the central axis. If the flange has a frustum shape, the projections are arranged in a longitudinal manner, but oblique to the axial direction. This arrangement facilitates the insertion and extraction of the capsule while at the same time providing a level of coupling suitable for common wear element handling operations.

[0031] Preferably, said capsule is manufactured in a polymer material, which facilitates its manufacture and minimizes costs, while at the same time providing a suitable level of protection. Preferably, said material is biodegradable such that in the event that the cover cannot be removed, it will break down, minimizing the environmental impact. The invention also relates to a wear element, GET, comprising an electronic device protected by a capsule according to any of the embodiments indicated above. The capsule is preferably arranged in an opening located inside the wear element.

[0032] The invention also relates to an earth moving machine comprising at least one wear element of the type described above. Preferably, said machine is an ex-

cavator comprising a shovel provided with several of said wear elements.

[0033] The invention also covers other detail features illustrated in the detailed description of an embodiment of the invention and in the attached drawings.

Brief Description of the Drawings

[0034] The advantages and features of the invention can be seen from the following description in which preferred embodiments of the invention are described in a non-limiting manner with respect to the scope of the main claim in reference to the drawings.

Figure 1 is a perspective view of a capsule according to one embodiment.

Figure 2 shows another perspective view of the same capsule of Figure 1.

Figure 3 is a view of the capsule according to the invention from the rear end.

Figure 4 is a section of a capsule according to the invention, protecting an electronic device.

Figure 5 is an exploded view of a capsule according to the invention, with an electronic device to be protected by the capsule.

Figure 6 shows the capsule of Figure 5 in which the electronic device has already been introduced in the container.

Figures 7, 8, 9, and 10 show different views of the container of the capsule according to one embodiment. Figures 7 and 8 show perspective views, Figure 9 shows a view from the rear end, and Figure 10 shows a section view. The place where the section is performed is labeled with a horizontal line in Figure 9.

Figure 11 shows a perspective view of a wear element having incorporated therein a capsule according to the invention, in which the front end of said capsule can be seen.

Figure 12 is a section of the wear element of Figure 11.

Detailed Description of Several Embodiments of the Invention

[0035] The drawings show an embodiment of a capsule 1 for protecting an electronic device 2 inside a wear element 3 of an earth moving machine. It can be seen in Figure 1 that the capsule 1 has a central axis 4, represented by a discontinuous line. Said central axis 4 defines an axial direction. The capsule also has a front end 8 and a rear end 9 opposite said front end 8 in the axial direction. As indicated above, the terms "front" and "rear" are used only as a naming convention for describing the coordinates relative to the capsule 1 itself, given that it can be in different positions during use, storage, and transport.

[0036] The capsule 1 with the electronic device 2 is shown in Figures 4, 5, and 6. Figure 5 shows an exploded view of the capsule 1, Figure 6 shows the capsule 1 not yet closed but with the electronic device 2 already introduced therein. Figure 4 shows a sectional view of the capsule 1 assembled with the electronic device 2 inserted therein. Moreover, Figures 11 and 12 show the capsule 1 inside a wear element 3 of an earth moving machine. These wear elements 3 are also known as GETs.

[0037] The capsule 1 of the drawings comprises a container 5 shown separately in Figures 7 to 10. As shown in Figure 7, said container 5 extends in the axial direction from said front end 8 of the capsule 1, such that the front end of the container 5 corresponds to the front end 8 of the capsule. The container 5 is provided with an inner chamber 53 configured for housing said electronic device 2. Figures 5, 6, and 10 show that said container 5 has a front part 51 and a rear part 52, the front part 51 being provided with a flange 7. For the example, both front part 51 and rear part 52 are integrally attached forming single body, particularly they are manufactured as a single part.

[0038] For the example of the drawings, the container 5 is open at its rear end such that the electronic device 2 can be introduced into said container 5 through its rear end. In other embodiments, the rear end of the container 5 is not open.

[0039] The capsule also comprises a cover 6 that can be removably coupled to said container 5 and configured for covering said rear part 52 of said container 5. For the example, the rear part 52 of the container 5 has an annular recess 54 in the area where it is attached with the front part 51. In turn, the cover 6 has an annular protuberance 64 at its front end. Said annular recess 54 and said annular protuberance 64 cooperate with one another as coupling means, allowing the cover 6 to be removably coupled to the container 5. Other embodiments have several of said annular recesses in the rear part 52 and several corresponding annular protuberances in the cover 6, thereby achieving a stronger coupling. Other embodiments have other types of coupling between the cover 6 and the container 5.

[0040] Therefore, in the examples of the drawings, the cover 6 covers the container 5 right up to the rear end of the flange 7: the container 5 can be inserted into the cover 6 and said cover 6 acts like a cap, tightly covering the container 5. A section view showing the interaction and the relative positions between the container 5 and the cover 6 can be seen in Figure 4. It is seen in the same Figure 4, and separately in Figure 10, that the rear part 52 of the container 5 has a cylindrical tubular shape, whereas the cover 6 has a frustum shape, particularly a frustoconical shape which facilitates the extraction of the

capsule from inside the wear element 3. This embodiment allows the capsule 1 to have a diameter with respect to the central axis 4 that decreases between the front end 8 and the rear end 9. Other embodiments have other profile types, for example, partially staggered profiles, profiles having a frustum shape but without circumferential symmetry, etc.

[0041] For the embodiment of the drawings, said flange 7 has extraction means 10 configured for extracting said container 5 from said wear element 3. Other embodiments do not have extraction means 10.

[0042] For the example of the drawings, the extraction means 10 comprise three threaded through holes in the axial direction located at regular intervals of 120° and at the same distance from the central axis 4, all of them being parallel to said central axis 4, as shown in Figure 9. Once the capsule 1 is inserted in the wear element 3, said through holes are arranged facing the wear element 3 on the support surface for the flange 7. In this manner, extraction from inside the wear element 3 comprises introducing screws into said through holes and screwing them in. When the screws contact the wear element 3, an axial push which allows extracting said container 5 from the wear element 3 is produced. Indeed, for this example, as each screw is being screwed in for the extraction operation, said screw first contacts the support surface for the flange of the wear element 3, and as the screwing in continues the axial push which starts to separate the container 5 from the wear element 3 is initiated. As each screw continues to be screwed into the threaded hole, the extraction continues until said container 5 is completely extracted. In the case where the cover 6 has been fixed to the wear element 3, this extraction also separates the container 5 from the cover 6.

[0043] For some embodiments such as the one shown in the drawings, the capsule 1 further comprises first positioning means 11 configured for cooperating with respective positioning means of said wear element 3 for positioning said capsule 1 inside said wear element 3. Figure 11 shows the capsule 1 inserted into the wear element 3. The way in which said first positioning means 11 are provided on said flange 7 and comprise the shape of the flange 7 can be seen in said figure, for the case of the example. In particular, the flange 7 of the example is in the form of a circumference with a substantially straight arch on the periphery thereof acting as first positioning means 11. It can be seen in Figures 2, 3, 8, and 9 that said arch is arranged between two of the through holes. Therefore, given that the wear element 3 has a complementary shape, the capsule 1 can only be inserted into the wear element 3 in a specific position. Other preferred shapes have other positioning means such as recesses, notches, or even combinations thereof.

[0044] In some embodiments like the one shown in Figures 8, 9, and 10, the capsule 1 further comprises second positioning means 12 configured for cooperating with respective positioning means of said electronic device 2 for positioning said electronic device 2 inside said capsule 1. Figure 8 shows a perspective view in which the inner chamber 53 of the container 5 can be seen. For the example, the chamber 53 has an annular rim 14 on which the electronic device 2 is supported when it is arranged inside the capsule 1. The same drawing also shows an axial rib acting as second positioning means 12, cooperating with an axial groove provided in the electronic device 2. Other embodiments have other types of positioning means 12, for example, based on the geometry of the electronic device 2 or on elements expressly provided for such purpose.

[0045] Figures 8, 9, and 10 also show how, for the embodiment of the example, the inner chamber 53 has reinforcement ribs 15. For the sake of clarity, only some of said reinforcement ribs 15 have been marked with reference numbers in the drawings.

[0046] In some advantageous embodiments like the one shown in the drawings, the capsule 1 further comprises capsule fixing means 13 configured for fixing said capsule 1 to said wear element 3. In particular, for the example said capsule fixing means 13 comprise scores provided on the perimeter of said flange 7, arranged perpendicular to said perimeter. In the example, given that the flange has a slightly frustoconical profile, the scores extend axially, not completely parallel to the central axis 4, but rather slightly oblique thereto.

[0047] In some embodiments, the capsule 1 is manufactured in a polymer material such as polyamide. In other embodiments, the capsule is manufactured in polyamide with glass fiber filler, particularly PA6.6+30%GF. In other embodiments, the material is biodegradable.

[0048] The embodiments described up until now represent non-limiting examples, such that one skilled in the art will understand that besides the examples shown, various combinations of the features claimed within the scope of the invention are possible.

Claims

1. A capsule (1) for protecting an electronic device (2) inside a wear element (3) of an earth moving machine, having a central axis (4) defining an axial direction, a front end (8), and a rear end (9) opposite said front end (8) in the axial direction;
   characterized in that it comprises:

   - a container (5), extending in the axial direction from said front end (8), provided with an inner chamber (53) configured for housing said electronic device (2), wherein said container (5) has a front part (51) provided with a flange (7), and a rear part (52); and
   - a cover (6) that can be removably coupled to said container (5) and configured for covering said rear part (52) of said container (5).

2. The capsule (1) according to claim 1, **characterized**

in that said flange (7) has extraction means (10) configured for extracting said container (5) from said wear element (3), preferably by means of pushing in the axial direction.

3. The capsule (1) according to claim 2, **characterized in that** said extraction means (10) comprise at least two threaded through holes, preferably three threaded holes.

4. The capsule (1) according to claim 3, **characterized in that** said threaded holes are arranged in the axial direction, parallel to said central axis (4).

5. The capsule (1) according to claim 4, **characterized in that** said threaded holes are all arranged at the same distance from said central axis (4), preferably separated from one another at regular intervals.

6. The capsule (1) according to any one of claims 1 to 5, **characterized in that** said container (5) is open at its rear end.

7. The capsule (1) according to any one of claims 1 to 6, **characterized in that** it has a diameter with respect to said central axis (4) that decreases between said front end (8) and said rear end (9), said capsule (1) preferably having a frustum shape, more preferably a frustoconical shape.

8. The capsule (1) according to any one of claims 1 to 7, **characterized in that** it further comprises first positioning means (11) configured for cooperating with respective positioning means of said wear element (3) for positioning said capsule (1) inside said wear element (3).

9. The capsule (1) according to claim 8, **characterized in that** said first positioning means (11) are provided on said flange (7).

10. The capsule (1) according to any one of claims 1 to 9, **characterized in that** it further comprises second positioning means (12) configured for cooperating with respective positioning means of said electronic device (2) for positioning said electronic device (2) inside said capsule (1).

11. The capsule (1) according to any one of claims 1 to 10, **characterized in that** it further comprises capsule fixing means (13) configured for fixing said capsule (1) to said wear element (3).

12. The capsule (1) according to claim 11, **characterized in that** said capsule fixing means (13) comprise projections provided on the perimeter of said flange (7), preferably longitudinally arranged.

13. The capsule (1) according to any one of claims 1 to 12, **characterized in that** it is manufactured in a polymer material, preferably biodegradable.

14. A wear element (3) comprising an electronic device (2) protected by the capsule (1) according to any one of claims 1 to 13.

15. An earth moving machine comprising at least one wear element (3) according to claim 14.

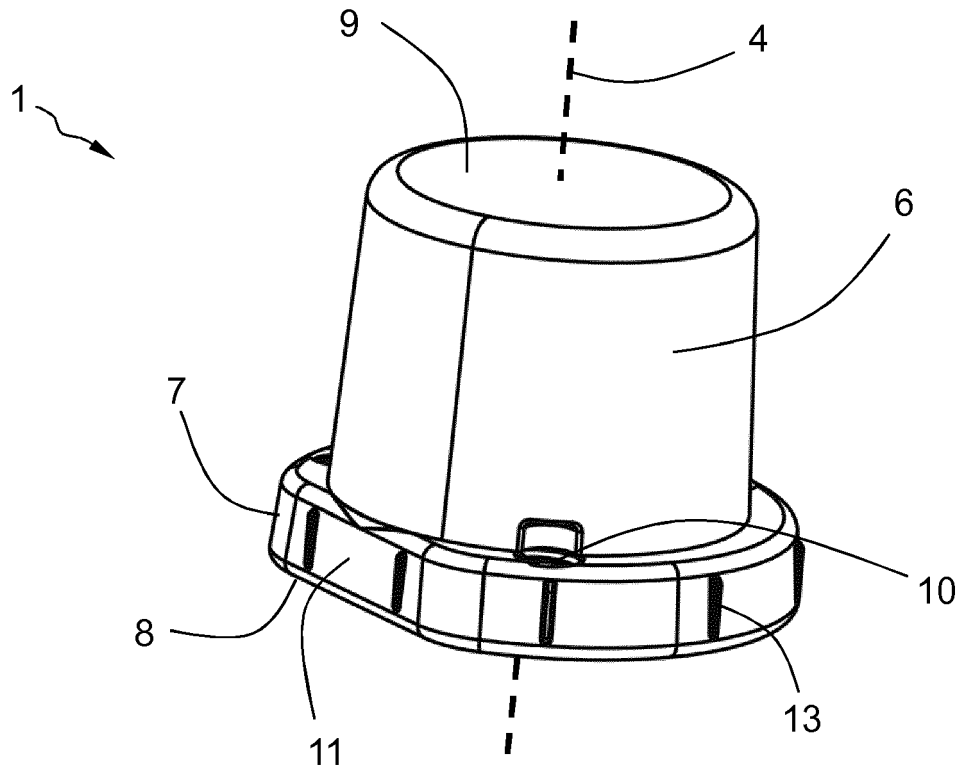

FIG. 1

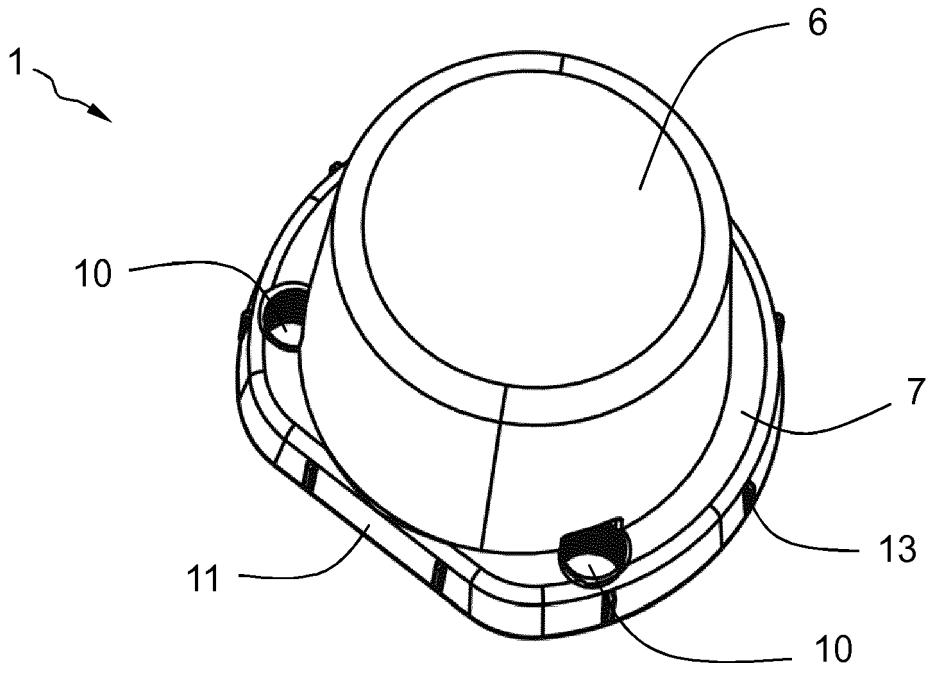

FIG. 2

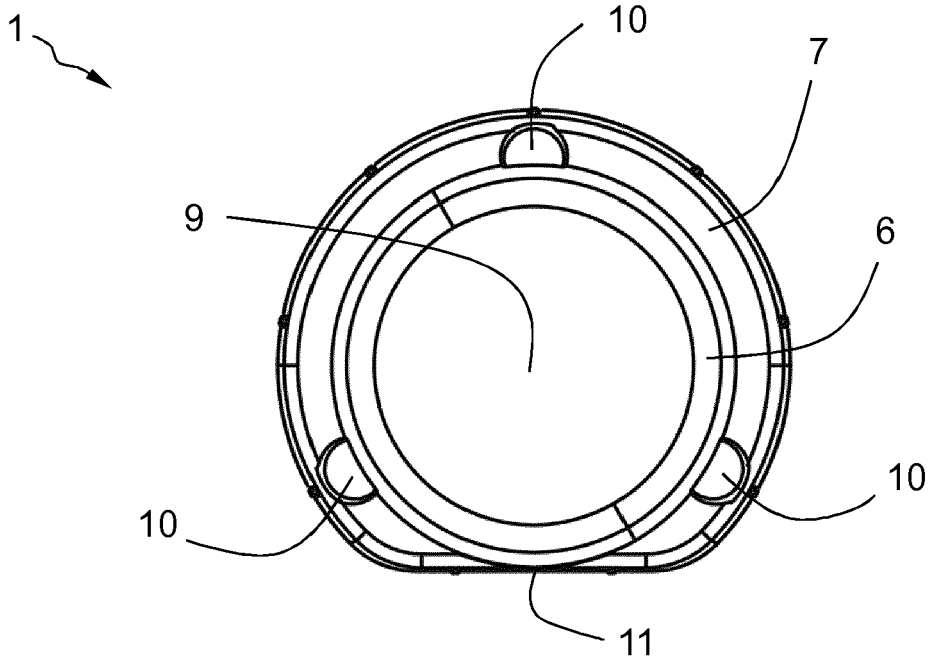

FIG. 3

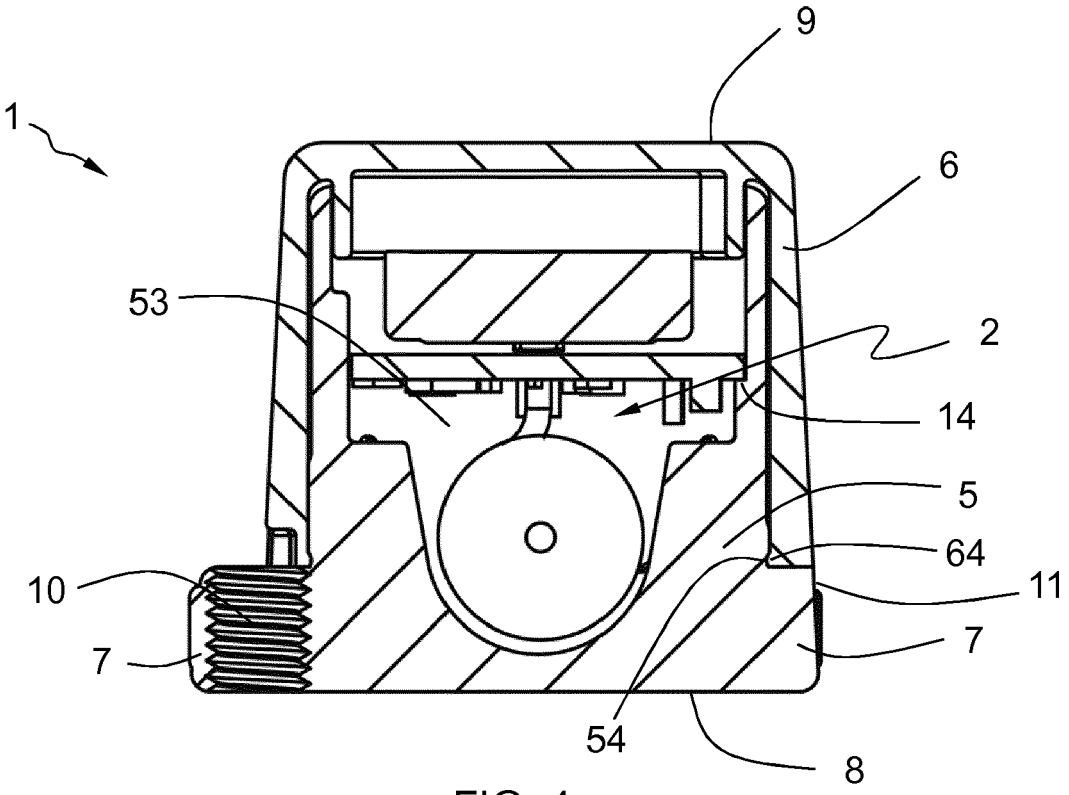

FIG. 4

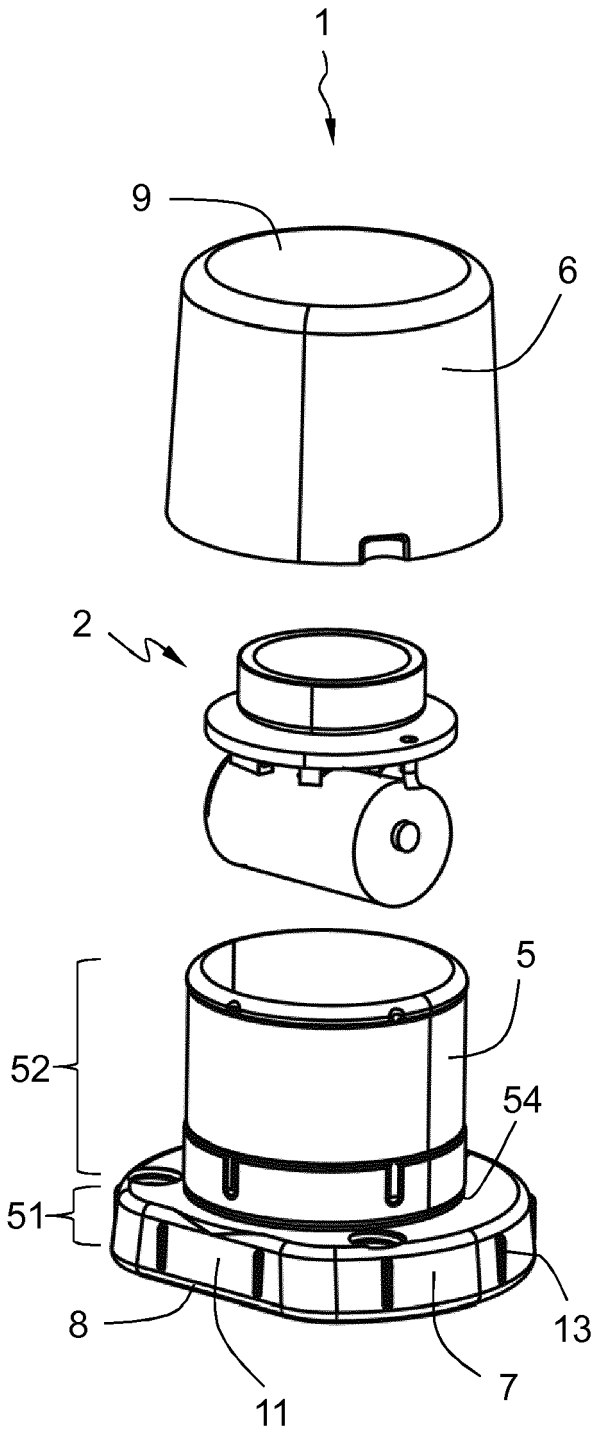

FIG. 5

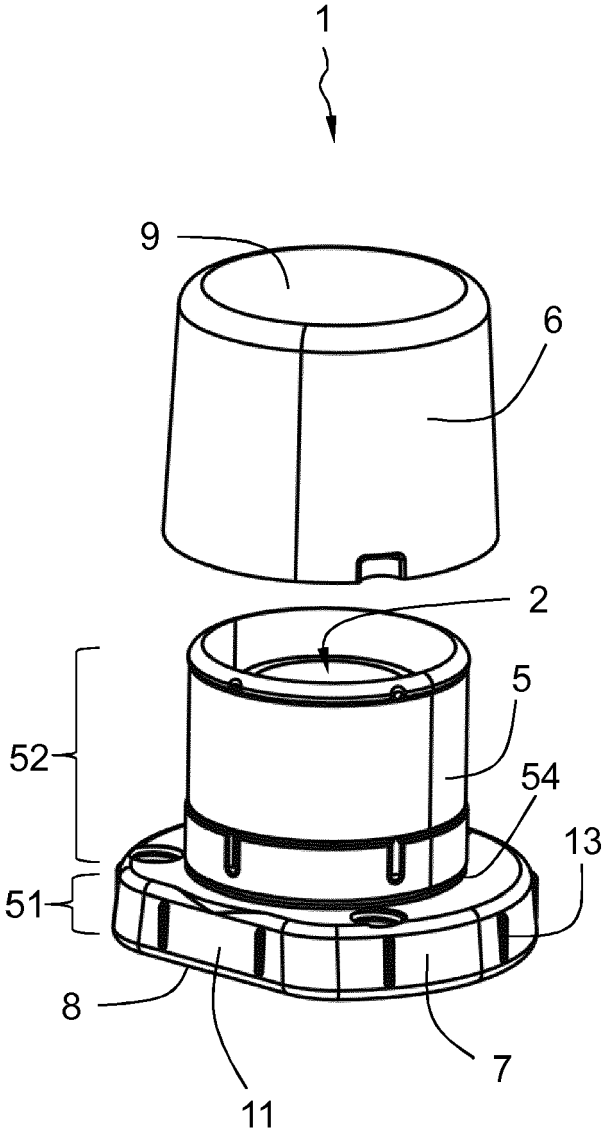

FIG. 6

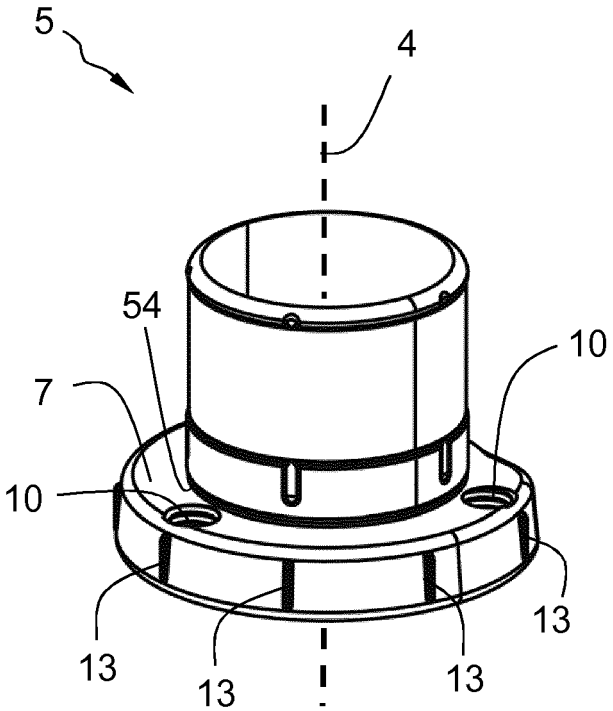

FIG. 7

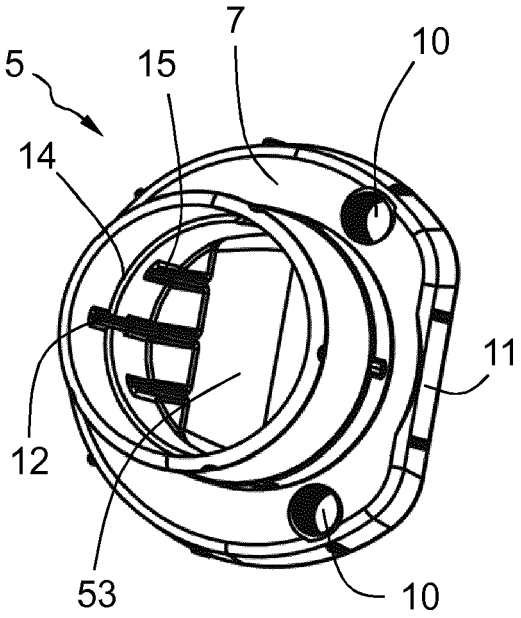

FIG. 8

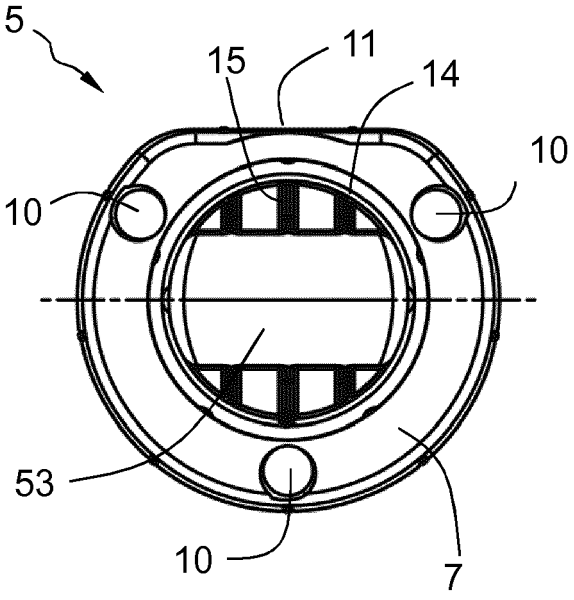

FIG. 9

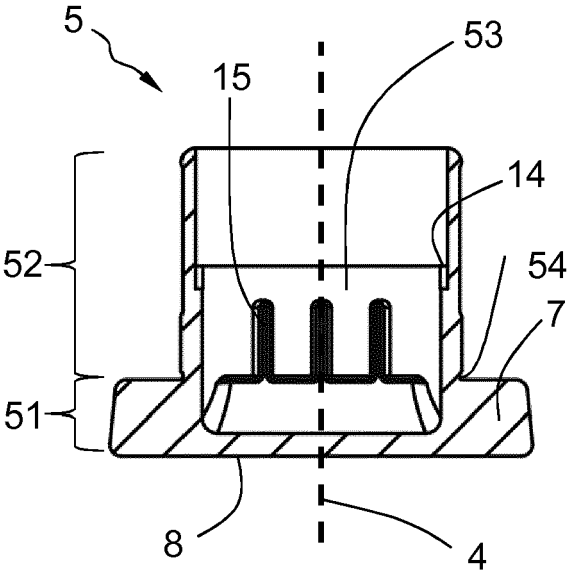

FIG. 10

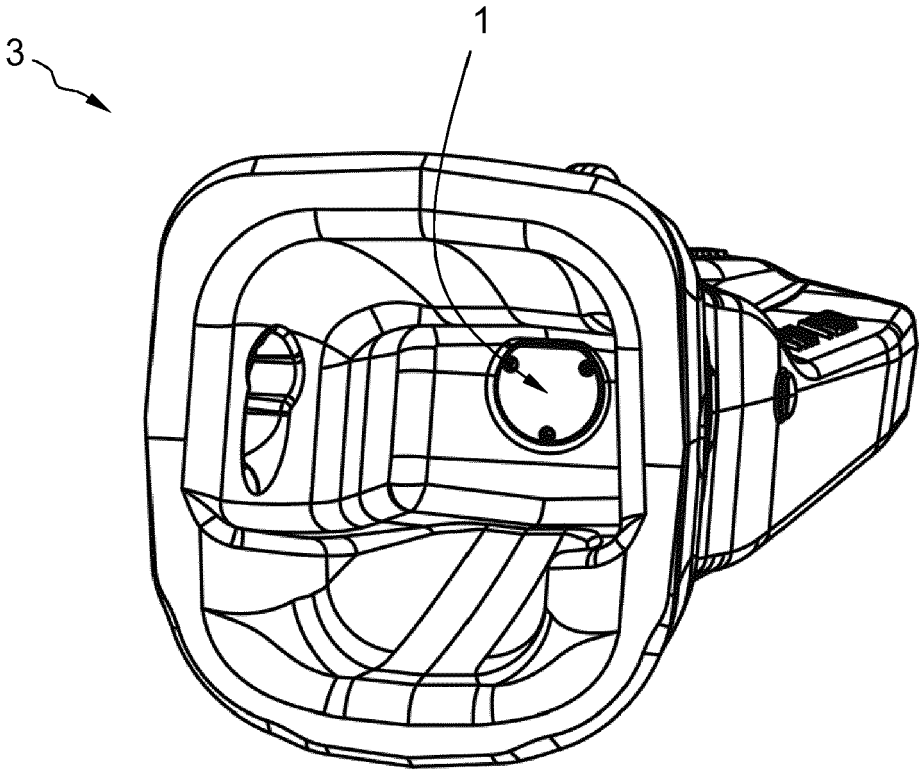

FIG. 11

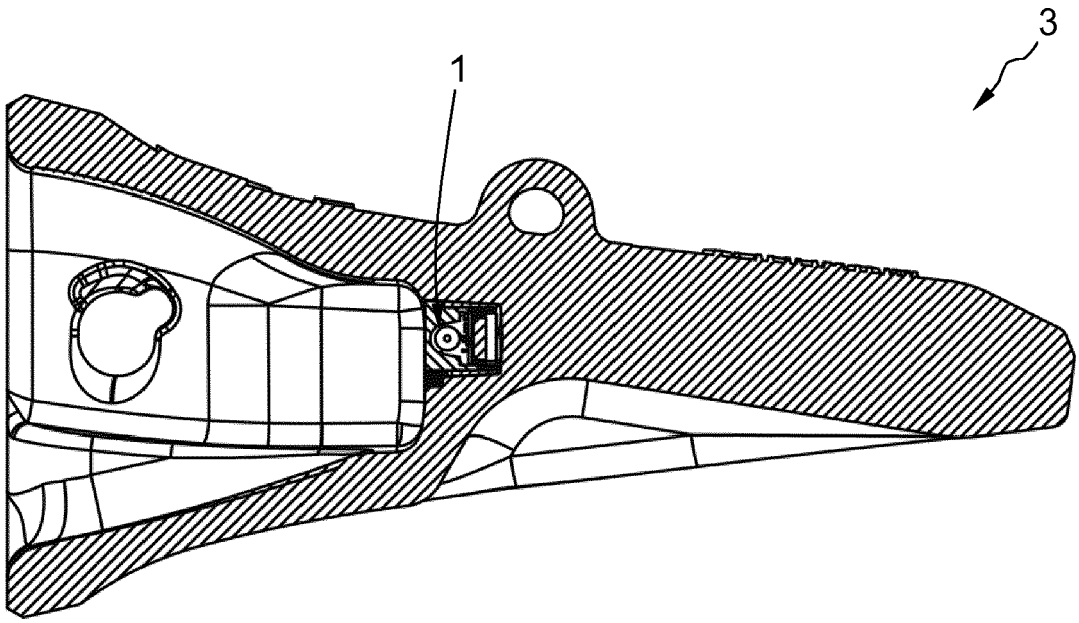

FIG. 12

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EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	30 August 2019	Clarke, Alister

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