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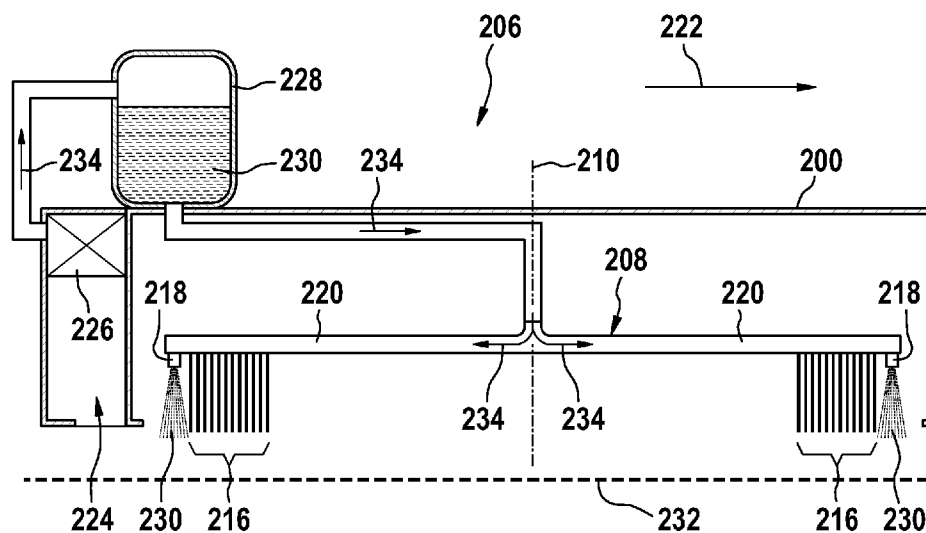
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(54) Title: ARTIFICIAL TURF CLEANER

Fig. 2



(57) **Abstract:** The invention provides for a method of cleaning algae from an artificial turf (702) using an artificial turf cleaner (200, 400, 500) configured for being propelled in a motion direction (222) when cleaning the artificial turf. The method comprises: propelling (100) the artificial turf cleaner in the motion direction across the artificial turf. The artificial turf cleaner then automatically: applies (102) a detergent mixture (230) to the artificial turf using the artificial turf cleaner and during propelling the artificial turf cleaner, wherein the artificial turf is at least partially covered with the algae; mechanically (104) brushes the artificial turf and the detergent mixture to at least partially remove the algae using the artificial turf cleaner and during propelling the artificial turf cleaner; and vacuums (106) the detergent mixture from the artificial turf using the artificial turf cleaner and during propelling the artificial turf cleaner.

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Artificial Turf Cleaner

Description

Field of the invention

The invention relates to artificial turf, in particular to the cleaning and maintenance of artificial turf

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Background and related art

Artificial turf, also known as artificial grass or synthetic turf, is a surface that is made up of fibers which is used to replace grass. The structure of the artificial turf is

designed such that the artificial turf has an appearance which resembles grass. Typically artificial turf is used as a surface for sports such as soccer, American football, rugby, tennis, golf, for playing fields, or exercise fields. Furthermore artificial turf is frequently used for landscaping applications.

5

Artificial turf may be manufactured using techniques for manufacturing carpets. For example artificial turf fibers which have the appearance of grass blades may be tufted or attached to a backing. Often times artificial turf infill is placed between the artificial turf fibers. Artificial turf infill is a granular material that covers the bottom
10 portion of the artificial turf fibers. The use of artificial turf infill may have a number of advantages. For example, artificial turf infill may help the artificial turf fibers stand up straight. Artificial turf infill may also absorb impact from walking or running and provide an experience similar to being on real turf. The artificial turf infill may also help to keep the artificial turf carpet flat and in place by weighting it down.

15

Artificial turf may also be used without artificial turf infill. Artificial turf turf carpets used without infill may be referred to as unfilled artificial turf. One usage of unfilled artificial turf is for field hockey. During the use of unfilled artificial turf for field
20 hockey, the field or pitch is flooded or filled with water using a sprinkler system.

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Drains may be used to drain the water from the unfilled artificial turf when the field is not in use. When the field is in use, the drains may also be used to control the amount of water in the field and prevent or reduce the formation of puddles.

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The guide by the International Hockey Federation July 2007, "Care and
Maintenance of Synthetic Turf Hockey Pitches, " pamphlet available online
[http://www.fih.ch/files/Sport/Pitches/Care of synthetic turf.pdf](http://www.fih.ch/files/Sport/Pitches/Care%20of%20synthetic%20turf.pdf) discloses the
maintenance for synthetic turf hockey pitches. In §2.6, This guide describes how the
pitch should be properly watered during all times of activity: both during practices
and matches. In §3.3 it is detailed how brush suction machines should be used daily
30 or once or twice a week to remove find dust from the turf surface as well as from
deeper layers of the carpet. §3.5 describes how Algae invasions of artificial turf
hockey pitches can result in a coloration change in an artificial turf that can also be
slippery. The guide recommends the use of an approved algae killer as a
preventative measure. The use of an algae killer as a prophylaxis is described as

adding a dosage system that continually adds the algae killer to the sprinkler system. Alternatively, the recommended dosage can be dispensed from a motorized high pressure sprayer.

5 **Summary**

The invention provides for a method, a turf system, and a turf cleaner in the independent claims. Embodiments are given in the dependent claims.

10 As was described above, artificial turf may become invaded with algae. The conventional means to avoid this is the prophylactic use of an algae killer to do this. A problem with the use of algae killer is that when the field is drained these chemicals are released into the environment. Embodiments may provide a way to reduce or eliminate the usage of algae killers when maintaining an artificial turf.

15 Embodiments may use an artificial turf cleaner that that applies a detergent mixture to the artificial turf at the same time as the artificial turf cleaner is mechanically brushing the artificial turf surface. After the artificial turf surface has been brushed the artificial turf cleaner vacuums the detergent mixture from the artificial turf removing at least a portion of the algae. Using such an artificial turf cleaner during
20 regular maintenance of the artificial turf may have the advantage that algae can be controlled without the use of algae killers.

A detergent mixture as used here encompasses a mixture comprising a detergent and water. Detergents which are environmentally friendly can be chosen. In any
25 case, because the detergent mixture is immediately vacuumed from the artificial turf very little of the detergent is released into the environment.

In some examples further methods may be used to reduce the environmental impact. For example as the detergent mixture and removed algae is vacuumed up it
30 can be filtered and then immediately reused to further clean algae from the artificial turf.

In one aspect, the invention provides for a method of cleaning algae from an artificial turf surface using an artificial turf cleaner configured for being propelled in a

motion direction. The artificial turf cleaner could take different forms in different examples. For example the artificial turf cleaner could be implemented as a push cart, a trailer, attached to a vehicle, or a component of a vehicle.

- 5 An artificial turf as used herein encompasses a synthetic turf that encompasses an artificial turf carpet. In many examples the artificial turf may comprise some form of backing into which artificial turf fibers have been tufted. In some examples the artificial turf may be an unfilled artificial turf. It is understood herein that references to “artificial turf” may also be interpreted as referring to “unfilled artificial turf.”

10

The method comprises propelling the artificial turf cleaner across the artificial turf in the motion direction. The method comprises applying the detergent mixture to the artificial turf using the artificial turf cleaner. The applying of the detergent mixture is performed as the artificial turf cleaner is propelled in the motion direction across the artificial turf. The artificial turf is at least partially covered with algae. The method further comprises mechanically brushing the artificial turf and the detergent mixture with the artificial turf cleaner to at least partially remove the algae. The mechanical brushing is performed as the artificial turf cleaner is propelled in the motion direction across the artificial turf. The method further comprises vacuuming the detergent mixture from the artificial turf using the artificial turf cleaner. The the vacuuming of the detergent is performed as the artificial turf cleaner is propelled in the motion direction across the artificial turf. As the detergent mixture is removed from the artificial turf the portion of the algae that was mechanically removed from the artificial turf may also be vacuumed up or at least partially vacuumed up. This embodiment may be beneficial because it may eliminate the need to spray or apply algae killer to the artificial turf.

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It should be noted that the above method and artificial turf cleaner described here refer to the removal and cleaning of algae from an artificial turf surface. In use, the artificial turf cleaner may also remove other materials from the artificial turf such as, but not limited to: lichen, mold, bacteria, moss, a biofilm, adherent deposits, and combinations thereof. Adherent deposits may include any material or staining material which adheres to or is stuck to the artificial turf.

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In another embodiment, the artificial turf is a field hockey field. It is understood that references to hockey field and field hockey field herein are equivalent. This embodiment may be beneficial because when artificial turf is used for field hockey it is typically sprayed or flooded with water to enable the puck in field hockey to travel across the surface and obtain the proper playing field characteristics. This may have the disadvantage that because the artificial turf is often kept wet an algae can invade artificial turf fibers of the field hockey field.

In another embodiment, the artificial turf comprises artificial turf fibers tufted into an artificial turf backing. The artificial turf comprises the feature of the artificial turf fiber forming a pile with a height between 10 mm and 14 mm high above the artificial turf backing. The pile has a height preferably between 11 and 13 mm high.

In another embodiment, the artificial turf comprises the feature of the artificial turf pile being tufted in rows. The rows have a spacing between 0.44 cm and 0.50 cm.

In another embodiment, the artificial turf comprises the feature of the rows having between 40 and 45 tufts of artificial turf fiber per 10 cm.

In another embodiment, the artificial turf comprises the feature of each of the tufts of the artificial turf fiber comprising between 180 and 250 artificial turf fibers.

In another embodiment, the artificial turf comprises the feature of the pile comprising at least 500,000 artificial turf fibers per square meter.

The above features of the artificial turf describe features which are typical for field hockey fields. They are on the average having much higher density of artificial turf fibers than are used for other sports such as soccer or football. The use of these higher number of artificial turf fibers per square meter may provide a space where moisture is more easily retained and algae growths more easily form. Embodiments of the invention may therefore provide for a means to maintain an artificial turf with a reduced amount of algae growth.

In another embodiment, the method is repeated daily.

In another embodiment, the method is repeated once or twice a week.

5 In another embodiment, the artificial turf cleaner comprises a reservoir configured for storing the detergent mixture. The reservoir is at least partially filled with the detergent mixture. The method further comprises at least one rotatable brush configured for brushing the artificial turf surface by rotating. The term "rotatable" is used to indicate that the brushes are configured for rotating when the artificial turf cleaner is operated. Each of the at least one rotatable brush is configured for
10 receiving the detergent mixture from the reservoir and applying the detergent mixture to the artificial turf surface. The artificial turf cleaner further comprises a vacuum system configured for removing the detergent mixture from the artificial turf surface. The vacuum system is mounted behind the multiple rotatable brushes in the motion direction. Having the rotatable brush receive the detergent mixture may
15 provide for reduced waste of the detergent and enable a larger fraction of it to be vacuumed up after the mechanical brushing .

In another embodiment, each of the at least one rotatable brush is configured for receiving the detergent mixture from the reservoir and applying the detergent
20 mixture to the artificial turf using at least one pressure nozzle. For example each rotatable brush may have one or more pressure nozzles mounted on it so that as the brush rotates the pressure nozzle rotates also. This may cause a high pressure stream of detergent mixture to move in a circular fashion over the surface of the artificial turf. This may assist the mechanical brushing in removing the algae.

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The at least one rotatable brush could rotate such that it rotates parallel to a horizontal plane when the artificial turf cleaner is in an operating position. The one or more high pressure nozzles could be aimed at the horizontal plane. As the brush rotates, the stream of detergent mixture would follow a circular trajectory on the
30 artificial turf and would assist in the removal of algae. A further advantage of this arrangement is that the number of high pressure nozzles may be reduced in comparison to the use of a spray bar in front of the at least one rotatable brush. If a spray bar is used, a larger number of pressure nozzles may be needed to completely spray the artificial turf ahead of the at least one rotatable brush. This

could result in the need for more and/or stronger compressor to provide pressure for the pressure nozzles. A pressure nozzle attached to a rotatable brush moves and is able to clean (or assist in cleaning) a larger area.

- 5 In another embodiment, the at least one pressure nozzle is configured for applying the detergent mixture using a pressure between 30 and 350 bar. In other embodiments, the pressure is between 80 and 300 bar. In yet other embodiments, the pressure is between 100 and 250 bar.
- 10 In another embodiment, the artificial turf is an unfilled artificial turf.

In another aspect, the invention provides for a turf system which comprises an artificial turf. The turf system further comprises an artificial turf cleaner for cleaning algae from the artificial turf surface. The artificial turf cleaner is configured for being
15 propelled in a motion direction when cleaning the artificial turf. The artificial turf cleaner comprises a reservoir configured for storing a detergent mixture. The artificial turf cleaner is configured for applying the detergent mixture to the artificial turf surface. The artificial turf cleaner further comprises at least one rotatable brushes configured for brushing the artificial turf surface. The artificial turf cleaner
20 further comprises a vacuum system configured for removing the detergent mixture and at least some of the algae from the artificial turf. The vacuum system is mounted behind the multiple rotatable brushes in the motion direction.

In another embodiment, the at least one rotatable brush comprises multiple
25 rotatable brushes. Adjacent brushes of the multiple rotatable brushes rotate in opposite directions. This may result in reduced vibrations being generated in the artificial turf cleaner.

In another embodiment, each rotatable brush is configured for receiving the
30 detergent mixture from the reservoir and applying the detergent mixture to the artificial turf surface. For example each rotatable brush may comprise one or more nozzles mounted to it for dispensing the detergent mixture. In some examples the one or more nozzles are pressure nozzles.

In another embodiment, the artificial turf cleaner further comprises an applicator mounted in front of the at least one rotatable brush in the motion direction for applying the detergent mixture from the reservoir to the artificial turf. In some examples the applicator may be a spray bar with multiple nozzles. In some further
5 examples, the multiple nozzles of the spray bar may be pressure nozzles.

In another embodiment, the artificial turf surface is a field hockey field.

In another embodiment the field is an artificial turf field for soccer, rugby, American
10 football, or multi-sports field.

In another embodiment the field is a 4th generation artificial turf field for soccer, rugby, American Football or multi-sports field.

In another embodiment the artificial turf surface is used as leisure and landscaping
15 surface.

In another embodiment, the turf cleaner is configured for being pulled behind a vehicle. For example the turf cleaner could be implemented as a trailer.
20

In another embodiment, the turf cleaner is integrated into a vehicle. For example the turf cleaner may be an attachment which can be attached to or integrated into a vehicle. A concrete example would be an attachment that is connected to a tractor or the front of a truck.
25

In another embodiment, the vehicle is an autonomous vehicle. For example the vehicle may be able to drive or follow a path on the artificial turf to automatically clean and remove the algae from the artificial turf.

In another embodiment, the autonomous vehicle comprises a positioning system for determining a current location. The autonomous vehicle is configured for automatically cleaning the artificial turf using the turf cleaner according to the current location and a map of the artificial turf. In some examples the autonomous vehicle may also be able to travel between different artificial turfs or hockey fields.
30

In another embodiment, the turf system further comprises a detergent mixture tower and a spigot arm. The detergent mixture tower is filled with the detergent mixture. The reservoir is configured for receiving the spigot arm before filling the reservoir.

5 For example if the turf systems comprise an autonomous vehicle the autonomous vehicle may be configured for moving the artificial turf cleaner automatically to the detergent mixture tower and using the spigot arm. This may enable the artificial turf cleaner to function in a fully automatic mode.

10 In another embodiment, the artificial turf comprises a sprinkler system for flooding or watering the artificial turf. The artificial turf further comprises at least one drain for draining the water from the artificial turf. The at least one drain may be controllable so that the at least one drain can be closed to enable flooding of the artificial turf. The drain may also be controllable so that the at least on drain can be opened to
15 drain water from the artificial turf.

In another aspect, the invention provides for an artificial turf cleaner for cleaning an artificial turf surface. The artificial turf cleaner is configured for being held in a motion direction when cleaning the artificial turf. The artificial turf cleaner comprises
20 a reservoir configured for storing a detergent mixture. The detergent mixture comprises water and a detergent. The artificial turf cleaner is configured for applying the detergent mixture to the artificial turf surface. The artificial turf cleaner further comprises at least one rotatable brush configured for brushing the artificial turf surface. The artificial turf cleaner further comprises a vacuum system configured for
25 removing the detergent mixture form the artificial turf surface. The vacuum system is mounted behind the at least one rotatable brush in the motion direction.

In another embodiment, the at least one rotatable brush is multiple rotatable brushes.

30

In another embodiment, adjacent brushes of the multiple rotatable brushes rotate in opposite directions. This may reduced vibrations in the artificial turf cleaner.

In another embodiment, each of the multiple brushes has a center of rotation.

In another embodiment, each of the at least one brushes comprises two extensions extending in opposite directions from the center of rotation. Each of the two extensions comprises a brushing surface with bristles.

5

In another embodiment, each of the at least one brushes comprises at least two extensions extending from the center of rotation. At least one of the at least two extensions comprises a brushing surface with bristles.

10 The at least two extensions could for example be two extensions and form a bar like structure that rotates. In another example there could be four extensions that form a cross like structure.

15 In another embodiment, a pressure nozzle for dispensing the detergent mixture is mounted at least one of the at least two extensions. In some examples there is a pressure nozzle mounted on each of the at least two extensions distal to the brushing surface.

20 In another embodiment, the at least one brush are configured for rotating perpendicular to the motion direction.

In another embodiment, the at least one rotatable brush is configured to rotate parallel to a horizontal plane when the artificial turf cleaner is in an operating position.

25

In another embodiment each of the at least one rotatable brush is configured for receiving the detergent mixture from the reservoir and applying the detergent mixture to the artificial turf surface. For example the detergent mixture could be dispensed within the brush or adjacent to the brush.

30

In another embodiment each center of rotation lies along a line perpendicular to the motion direction.

In another embodiment at least one of the at least two extensions comprises at least one nozzle configured for spraying the detergent mixture onto the artificial turf surface. This embodiment may be beneficial because the detergent mixture is only applied where the at least one rotatable brush is actively cleaning the artificial turf surface.

In another embodiment, the artificial turf cleaner further comprises a spray bar with additional pressure nozzles. The spray bar is mounted in front of the at least one rotatable brush in the motion direction. In this embodiment the pressure nozzles are used to pressure clean the artificial turf initially. Then the brushes and the pressure nozzles on the brushes clean the artificial turf additionally.

In another embodiment the vacuum system is configured for returning the vacuumed detergent mixture into the reservoir. This may be beneficial because it may reduce the amount of time before the artificial turf cleaner needs to refill with the detergent mixture.

In another embodiment the vacuum system comprises a filter for filtering the vacuum detergent mixture before returning the vacuumed detergent mixture into the reservoir. This may be beneficial because it may help prevent the debris, artificial turf infill or other material from damaging the artificial turf cleaner.

In another embodiment the artificial turf cleaner further comprises a magnetic materials removal component for removing magnetic materials from the artificial turf surface. For example a high power magnet may be used for picking up and removing magnetic materials from the artificial turf surface.

It is understood that one or more of the aforementioned embodiments of the invention may be combined as long as the combined embodiments are not mutually exclusive.

Brief description of the drawings

In the following embodiments of the invention are explained in greater detail, by way of example only, making reference to the drawings in which:

- Fig. 1 shows a flow chart which illustrates a method of removing algae from artificial turf
- Fig. 2 illustrates an example of an artificial turf cleaner;
- Fig. 3 shows a cross sectional view of the artificial turf cleaner of Fig. 2;
- 5 Fig. 4 shows a cross sectional view of an alternative artificial turf cleaner;
- Fig. 5 illustrates a further example of an artificial turf cleaner;
- Fig. 6 shows a cross sectional view of the artificial turf cleaner of Fig. 5;
- Fig. 7 illustrates an example of a turf system;
- Fig. 8 illustrates a further example of a turf system;
- 10 Fig. 9 illustrates a further example of an turf system;
- Fig. 10 illustrates a further example of an turf system;
- Fig. 11 illustrates a further example of an turf system; and
- Fig. 12 illustrates an example of a rotatable brush.

15 Detailed description

Like numbered elements in these figures are either equivalent elements or perform the same function. Elements which have been discussed previously will not necessarily be discussed in later figures if the function is equivalent.

- 20 Fig. 1 shows a flowchart which illustrates a method of cleaning algae from an artificial turf. First in step 100 an artificial turf cleaner is propelled across the artificial turf. Next, in step 102 a detergent mixture is applied to the artificial turf using the artificial turf cleaner. Step 102 is performed at the same time as step 100. Steps 102 and 102 and 104 may be performed at the same time. Then in step 104 the artificial
- 25 turf is brushed mechanically along with the detergent mixture to at least partially remove the algae. Step 104 is performed at the same time as step 100. Then finally in step 106 the detergent mixture and at least some of the removed algae is vacuumed from the artificial turf using the artificial turf cleaner.
- 30 Figs. 2 and 3 shows a top view 202 and a side view 206 of a turf cleaner 200. There is a section line 204. The side view 206 of the turf cleaner 200 is shown along the section line 204. The turf cleaner 200 is illustrated without motors for the brushes or without wheels. It is understood that the turf cleaner 200 could be incorporated into a number of different types of vehicles or trailers or push carts.

The turf cleaner comprises three rotatable brushes 208. Each of the rotatable brushes has a center of rotation 210. It can be seen that each of the rotatable brushes 208 is moving in a rotational direction 212. The rotational direction of adjacent rotatable brushes 208 is reversed. This may be beneficial for reducing the amount of vibrations that are generated. Each of the rotatable brushes 208 comprises two extensions 214 that form a bar-like structure. The rotatable brushes 208 however may comprise more than two extensions. For example there may be for extensions that form a cross like structure.

At the end of each extension is a bristle 216 and a nozzle 218. Having the nozzle 218 at the end of each extension 220 has the benefit that it reduces the number of nozzles that are necessary. Because the rotatable brushes 208 rotate the nozzle 218 is rotated over the entire surface of the artificial turf that is brushed. In some examples the detergent mixture is pressurized and sprayed at approximately a pressure of 200 bar. For example a pressure of 100 to 250 bar may be typically used. The reduction in the number of nozzles 218 reduces the size of the pump necessary to maintain this pressure. Having the nozzle 218 adjacent to or within a bristle may be beneficial because it may reduce the amount of detergent mixture needed to clean the artificial turf.

The turf cleaner 200 is configured for moving in a motion direction 222 when in the operating position. It can be seen that there is a vacuum system 224 located behind the rotatable brushes 208 in the motion direction 222. After the detergent mixture has been sprayed and brushed the vacuum system 224 removes any algae and possibly adherent deposits that have been removed and also detergent mixture. The detergent mixture may for example be stored in a reservoir 228. The reservoir 228 is shown as being partially filled with the detergent mixture 230. In this example the vacuum system 224 runs recovered detergent mixture 230 through a filter 226 and then returns the used detergent mixture back into the reservoir 228. This may be beneficial because it may reduce how often the reservoir 228 needs to be refilled. There are a number of pipes which show a flow of the detergent fluid 230 from the reservoir 228 through the extensions 220 to the two nozzles 230 that are mounted at the end of the extensions 220.

There are bristles 216 that are mounted at the ends of each of the extensions 220. The dashed line 232 shows the location of a plane that would be parallel to an artificial turf surface being cleaned by the turf cleaner 200. It can be seen that the rotatable brushes 208 rotate in a plane parallel to the horizontal plane 232. In the example shown in Fig. 3 the center of rotations 210 of each of the rotatable brushes 208 is shown as being perpendicular to the motion direction 222. This is one configuration. In other examples the center of rotations 210 of the rotatable brushes 208 could be staggered according to alternate brushes so that there is more of an overlap between areas that are cleaned by each of the rotatable brushes 208.

Fig. 4 shows a cross-sectional view 206 of a turf cleaner 400. The turf cleaner 400 illustrated in Fig. 4 is similar to the turf cleaner 200 illustrated in Figs. 2 and 3. In the example shown in Fig. 4 when fluid is recovered by the vacuum system 224 it is not returned to the reservoir 228, it is returned instead to a waste tank 402. The waste tank 402 is shown as being filled with waste fluid 404. Adjacent to the vacuum 224 there is an optional magnetic material removal component 406 for removing magnetic or ferric materials from the artificial turf. The magnetic material removal component 460 may be incorporated into the other examples as well.

Figs. 5 and 6 show a top 202 and a side view 206 of an alternate artificial turf cleaner 500. The examples shown in Figs. 5 and 6 are similar to the examples shown in Figs. 2, 3 and 4 except instead of having nozzles 118 at the tips of the extensions 120 there is instead a spray bar 502. The spray bar 502 is shown as being connected to the reservoir 128. The filter 226 may be an optional component in Figs. 4, 5, and 6.

The features of the embodiment shown in Figs 5 and 6 may be combined with the features of the embodiments shown in Figs. 2 and 3. Figs 2 and 3 shows the nozzles 218 being mounted on the extensions 220. Figs. 5 and 6 shows the nozzles 218 being mounted on the spray bar 502. A combination could have the spray bar 502 with nozzles 218 as well as nozzles 218 on the extensions 220. This could improve the cleaning ability of the artificial turf cleaner.

Fig. 7 illustrates an example of a turf system 700. The turf system 700 comprises an artificial turf 702 and a vehicle 704 pulling a trailer 706. The artificial turf cleaner 100 is integrated into the trailer 706. The other artificial turf cleaners illustrated in the other Figs. could also be integrated into the trailer 706. The same is true for Figs. 7,
5 8, 9, 10 and 11.

Fig. 8 illustrates a further example of a turf system 800. In the example in Fig. 8 the turf cleaner 100 is either integrated into or attached directly to the vehicle 704.

10 Fig. 9 shows a further example of the turf system 800. In this example the vehicle 704 of Fig. 8 has been modified and turned into an autonomous vehicle 704'. The autonomous vehicle 704' now comprises a positioning system 900 and a controller 902. The positioning system 900 could for example be a GPS system or other radio location system for determining the location of the autonomous vehicle 704'. The
15 controller 902 may then use the current location of the autonomous vehicle 704 and a map of the artificial turf surface 702 to automatically guide the autonomous vehicle 704' to clean the artificial turf 702.

Fig. 10 shows a further view of the turf system 800. In the example shown in Fig. 10
20 the turf system further comprises a detergent mixture tower 1000 which comprises a spigot arm 1002. The spigot arm 1002 can be placed in a retracted position 1004 or a filling position 1006. In the filling position 1006 the detergent mixture tower 1000 is able to automatically dispense detergent mixture 130 to the reservoir 128 of the autonomous vehicle 704'. This may enable the fully automated cleaning of the
25 artificial turf 702.

Fig. 11 shows a further view of the turf system 800. This shows a top view where the artificial turf 702 is a field hockey field 1100. The autonomous vehicle 704' is able to automatically clean the field hockey field 1100. Although the example in Fig.
30 11 is shown with an autonomous vehicle 704 pulling a trailer 200 any of the other examples of the artificial turf cleaner could be used or substituted into Fig. 11. The autonomous vehicle 704 has the positioning determining system 900. In some examples the positioning determining system 900 is a GPS system. In other

examples the hockey field 1100 comprises a transmitter 1102 that provides a locator signal to the positioning system 900.

The artificial turf 702 of Fig. 11 is shown as optionally having sprinklers 1104 at its edges for wetting or flooding the artificial turf. The sprinklers could alternatively be located within the playing surface. The artificial turf 702 may also optionally comprise one or more drains 1106 for draining the artificial turf 702 from water. The drain 1106 could for example be connected to a drainage system beneath the artificial turf 702. The drain 1106 could, for example, be switchable so that the drain can be closed to allow the artificial turf to flood with water or to be opened to allow a flooded artificial turf to drain.

Fig. 12 illustrates an alternative rotatable brush 208 that could be used in any of Figs. 2 through 6. In the rotatable brush 208 shown in Fig. 12, there are four extensions 214 that form a cross-like structure. The arrangement of the nozzles 218 and bristles 216 is equivalent to that which is shown in Figs. 3 and 6. In Fig. 12 as well as in Figs. 3 and 6, the bristles need not be located on every extension. They could be present on one or more extension.

The nozzles 218 may also be located in alternative positions 218' and 218''. The nozzle can be located within the structure of the bristle 216 as is shown by position 218'. In Fig. 12 the nozzle 218 is distal to the bristle 216. However, the position of the bristle and the nozzle can be swapped so that the bristle is distal to the nozzle 218''.

Further the relative positioning of the nozzles 218, 218', 218'' and bristles 216 relative to each other may be different on different extensions 214. One extension may possible only have a bristle 216. Another extension may possibly only have one or more nozzles 218, 218', and/or 218''. Another extension may have a bristle 216 and then one or more nozzles at positions 218, 218', and/or 218''.

The differences described in Fig. 12 are also applicable to the rotatable brushes 208 shown in Figs. 2 through 6.

Various embodiments may possibly be described by one or more of the following features specified in the following numbered clauses:

1. A feature comprising a method of cleaning algae from an artificial turf (702)
5 using an artificial turf cleaner (200, 400, 500) configured for being propelled in a motion direction (222) when cleaning the artificial turf, wherein the artificial turf is at least partially covered with the algae, wherein the method comprises propelling (100) the artificial turf cleaner in the motion direction across the artificial turf while the artificial turf cleaner performs:
 - 10 - applying (102) a detergent mixture (230) to the artificial turf;
 - mechanically (104) brushing the artificial turf and the detergent mixture to at least partially remove the algae; and
 - vacuuming (106) the detergent mixture from the artificial turf.
- 15 2. The method of clause 1, wherein the artificial turf is a field hockey field (1100).
3. The method of clause 1 or 2, wherein the artificial turf comprises artificial turf fibers tufted into an artificial turf backing, wherein the artificial turf comprises any one of the following features:
 - 20 - the artificial turf fiber forms a pile with a height between 10 mm and 14 mm high above the artificial turf backing, preferably between 11 mm and 13 mm high;
 - the artificial turf pile is tufted in rows, wherein the rows have a spacing between 0.44 cm and 0.50 cm;
 - the rows have between 40 and 45 tufts of artificial turf fiber per 10 cm;
 - 25 - each of the tufts of artificial turf fiber comprise between 180 and 250 artificial turf fibers;
 - the pile comprises greater than 500000 artificial turf fibers per square meter; and
 - combinations thereof.
- 30 4. The method of any one of the preceding clauses, wherein the artificial turf cleaner comprises:
 - a reservoir (228) configured for storing the detergent mixture, wherein the reservoir is at least partially filled with the detergent mixture, wherein the artificial turf cleaner is configured for applying the detergent mixture to the artificial turf;

- at least one rotatable brush (208) configured for brushing the artificial turf; and
- a vacuum system (224) configured for removing the detergent mixture from the artificial turf, wherein the vacuum system is mounted behind the at least one rotatable brush in the motion direction.

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5. The method of clause 4, wherein the at least one rotatable brush is configured for receiving the detergent mixture from the reservoir and applying the detergent mixture to the artificial turf using at least one pressure nozzle (218).

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6. The method of clause 5, wherein the at least one pressure nozzle is configured for applying the detergent mixture using a pressure between 30 bar and 350 bar.

7. The method of any one of the preceding clauses, wherein the artificial turf is an unfilled artificial turf.

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8. A feature comprising a turf system (700, 800) comprising:

- an artificial turf (702); and
- an artificial turf cleaner (200, 400, 500) for cleaning the artificial turf, wherein the artificial turf cleaner is configured for being propelled in a motion direction (222) when cleaning the artificial turf, wherein the artificial turf cleaner comprises:

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- a reservoir (228) at least partially filled with a detergent mixture (230), wherein the artificial turf cleaner is configured for applying the detergent mixture to the artificial turf;

- at least one rotatable brush (208) configured for brushing the artificial turf; and

25

- a vacuum system (224) configured for removing the detergent mixture from the artificial turf, wherein the vacuum system is mounted behind the at least one rotatable brush in the motion direction.

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9. The turf system of clause 8, wherein the artificial turf is a field hockey field (1100).

10. The turf system of clause 8 or 9, wherein each of the at least one rotatable brush is configured for receiving the detergent mixture from the reservoir and

applying the detergent mixture to the artificial turf using at least one pressure nozzle (218).

11. The turf system of clause 8, 9, or 10, wherein the turf cleaner is configured for
5 being pulled behind a vehicle (704) or being integrated into the vehicle.

12. The turf system of clause 11, wherein the vehicle is a autonomous vehicle,
wherein autonomous vehicle comprises a positioning system (900) for determining a
current location, wherein the autonomous vehicle is configured for automatically
10 cleaning the artificial turf using the turf cleaner according to the current location and
a map of the artificial turf.

13. The turf system of any one of clauses 8 through 12, wherein the turf system
further comprises a detergent mixture tower (1000) with a spigot arm (1002),
15 wherein the detergent mixture tower is filled with the detergent mixture, and wherein
the reservoir is configured for receiving the spigot arm for filling the reservoir.

14. The turf system of any one of clauses 8 through 13, wherein the artificial turf
comprises a sprinkler system for flooding the artificial turf, wherein the artificial turf
20 further comprises at least one drain for draining the artificial turf, wherein the at least
one drain is configured for closing during flooding of the artificial turf, and wherein
the at least one drain is configured for opening during draining of the artificial turf.

15. An feature comprising an artificial turf cleaner (200, 400, 500) for cleaning an
25 artificial turf (702), wherein the artificial turf cleaner is configured for being propelled
in a motion direction (222) when cleaning the artificial turf, wherein the artificial turf
cleaner comprises:

- a reservoir (228) configured for storing a detergent mixture (230);
- at least one rotatable brush (208) configured for brushing the artificial turf,
30 wherein the at least one rotatable brush is configured for receiving the detergent
mixture from the reservoir and applying the detergent mixture to the artificial turf;
and

- a vacuum system (224) configured for removing the detergent mixture from the artificial turf, wherein the vacuum system is mounted behind the multiple rotatable brushes in the motion direction.

5 16. The artificial turf cleaner of clause 15, wherein the at least one rotatable brush is multiple rotatable brushes, and wherein adjacent brushes of the multiple rotatable brushes rotate in opposite directions.

10 17. The artificial turf cleaner of clause 15 or 16, wherein each of the at least one rotatable brushes is configured for receiving the detergent mixture from the reservoir and applying the detergent mixture to the artificial turf using at least one pressure nozzle (218).

15 18. The artificial turf cleaner of clause 17, wherein the artificial turf cleaner further comprises a spray bar with additional pressure nozzles (218), wherein the spray bar is mounted in front of the at least one rotatable brush in the motion direction.

20 19. The artificial turf cleaner of clause 18, wherein the at least one rotatable brush is configured to rotate parallel to a horizontal plane (232) when the artificial turf cleaner is in an operating position, wherein each of the at least one rotatable brush has a center of rotation, wherein each of the at least one rotatable brush comprises at least two extensions extending from the center of rotation, wherein at least one of the at least two extensions comprises a brushing surface with bristles (216), and wherein the at least one pressure nozzle is mounted on at least one of the at least
25 two extensions.

20. The turf cleaner of any one of clauses 15 through 19, wherein the vacuum system is configured for returning vacuumed detergent mixture into the reservoir.

30 21. the turf cleaner of clause 20, wherein the vacuum system comprises a filter (226) for filtering the vacuumed detergent mixture before returning the vacuumed detergent mixture into the reservoir.

22. The turf cleaner of any one of clauses 15 through 21, wherein the turf cleaner further comprises a magnetic material removal component (406) for removing magnetic material from the artificial turf.

List of reference numerals

5	100 propelling the artificial turf cleaner in the motion direction across the artificial turf
	102 applying a detergent mixture to the artificial turf using the artificial turf cleaner and during propelling the artificial turf cleaner
10	104 mechanically brushing the artificial turf and the detergent mixture to at least partially remove the algae using the artificial turf cleaner and during propelling the artificial turf cleaner
15	106 vacuuming the detergent mixture from the artificial turf using the artificial turf cleaner and during propelling the artificial turf cleaner
	200 turf cleaner
	202 top view
	204 section line
	206 side view
20	208 rotatable brush
	210 center of rotation
	212 rotational direction
	214 extension
	216 bristle
25	218 nozzle
	218' nozzle
	218'' nozzle
	220 extension
	222 motion direction
30	224 vacuum system
	226 filter
	228 reservoir
	230 detergent mixture
	232 horizontal plane

	234	flow of detergent mixture
	400	turf cleaner
	402	waste tank
	404	waste fluid
5	406	magnetic material removal component
	500	artificial turf cleaner
	502	spray bar
	700	turf system
	702	artificial turf
10	704	vehicle
	706	trailer
	800	turf system
	900	positioning system
	902	controller
15	1000	detergent mixture tower
	1002	spigot arm
	1004	retracted position
	1006	filling position
	1100	field hockey field
20	1102	transmitter
	1104	sprinkler
	1106	drain

C l a i m s

1. A method of cleaning algae from an artificial turf (702) using an artificial turf
5 cleaner (200, 400, 500) configured for being propelled in a motion direction (222)
when cleaning the artificial turf, wherein the artificial turf is at least partially covered
with the algae, wherein the method comprises propelling (100) the artificial turf
cleaner in the motion direction across the artificial turf while the artificial turf cleaner
performs:
- 10 - applying (102) a detergent mixture (230) to the artificial turf;
- mechanically (104) brushing the artificial turf and the detergent mixture to at least
partially remove the algae; and
- vacuuming (106) the detergent mixture from the artificial turf.
- 15 2. The method of claim 1, wherein the artificial turf is a field hockey field (1100).
3. The method of claim 1 or 2, wherein the artificial turf comprises artificial turf
fibers tufted into an artificial turf backing, wherein the artificial turf comprises any
one of the following features:
- 20 - the artificial turf fiber forms a pile with a height between 10 mm and 14 mm high
above the artificial turf backing, preferably between 11 mm and 13 mm high;
- the artificial turf pile is tufted in rows, wherein the rows have a spacing between
0.44 cm and 0.50 cm;
- the rows have between 40 and 45 tufts of artificial turf fiber per 10 cm;
25 - each of the tufts of artificial turf fiber comprise between 180 and 250 artificial turf
fibers;
- the pile comprises greater than 500000 artificial turf fibers per square meter; and
- combinations thereof.
- 30 4. The method of any one of the preceding claims, wherein the artificial turf
cleaner comprises:
- a reservoir (228) configured for storing the detergent mixture, wherein the
reservoir is at least partially filled with the detergent mixture, wherein the artificial
turf cleaner is configured for applying the detergent mixture to the artificial turf;

- at least one rotatable brush (208) configured for brushing the artificial turf; and
- a vacuum system (224) configured for removing the detergent mixture from the artificial turf, wherein the vacuum system is mounted behind the at least one rotatable brush in the motion direction.

5

5. The method of claim 4, wherein the at least one rotatable brush is configured for receiving the detergent mixture from the reservoir and applying the detergent mixture to the artificial turf using at least one pressure nozzle (218, 218', 218").

10

6. The method of claim 5, wherein the at least one pressure nozzle is configured for applying the detergent mixture using a pressure between 30 bar and 350 bar.

7. The method of any one of the preceding claims, wherein the artificial turf is an unfilled artificial turf.

15

8. A turf system (700, 800) comprising:

- an artificial turf (702); and
- an artificial turf cleaner (200, 400, 500) for cleaning the artificial turf, wherein the artificial turf cleaner is configured for being propelled in a motion direction (222)

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when cleaning the artificial turf, wherein the artificial turf cleaner comprises:

- a reservoir (228) at least partially filled with a detergent mixture (230), wherein the artificial turf cleaner is configured for applying the detergent mixture to the artificial turf;
- at least one rotatable brush (208) configured for brushing the artificial turf;
- a vacuum system (224) configured for removing the detergent mixture from the artificial turf, wherein the vacuum system is mounted behind the at least one rotatable brush in the motion direction.

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9. The turf system of claim 8, wherein the artificial turf is a field hockey field (1100).

10. The turf system of claim 8 or 9, wherein each of the at least one rotatable brush is configured for receiving the detergent mixture from the reservoir and

applying the detergent mixture to the artificial turf using at least one pressure nozzle (218, 218', 218").

11. The turf system of claim 8, 9, or 10, wherein the turf cleaner is configured for being pulled behind a vehicle (704) or being integrated into the vehicle, wherein the vehicle is a autonomous vehicle, wherein autonomous vehicle comprises a positioning system (900) for determining a current location, wherein the autonomous vehicle is configured for automatically cleaning the artificial turf using the turf cleaner according to the current location and a map of the artificial turf.

12. The turf system of any one of claims 8 through 11, wherein the artificial turf comprises a sprinkler system for flooding the artificial turf, wherein the artificial turf further comprises at least one drain for draining the artificial turf, wherein the at least one drain is configured for closing during flooding of the artificial turf, and wherein the at least one drain is configured for opening during draining of the artificial turf.

13. An artificial turf cleaner (200, 400, 500) for cleaning an artificial turf (702), wherein the artificial turf cleaner is configured for being propelled in a motion direction (222) when cleaning the artificial turf, wherein the artificial turf cleaner comprises:

- a reservoir (228) configured for storing a detergent mixture (230);
- at least one rotatable brush (208) configured for brushing the artificial turf, wherein the at least one rotatable brush is configured for receiving the detergent mixture from the reservoir and applying the detergent mixture to the artificial turf; and
- a vacuum system (224) configured for removing the detergent mixture from the artificial turf, wherein the vacuum system is mounted behind the multiple rotatable brushes in the motion direction.

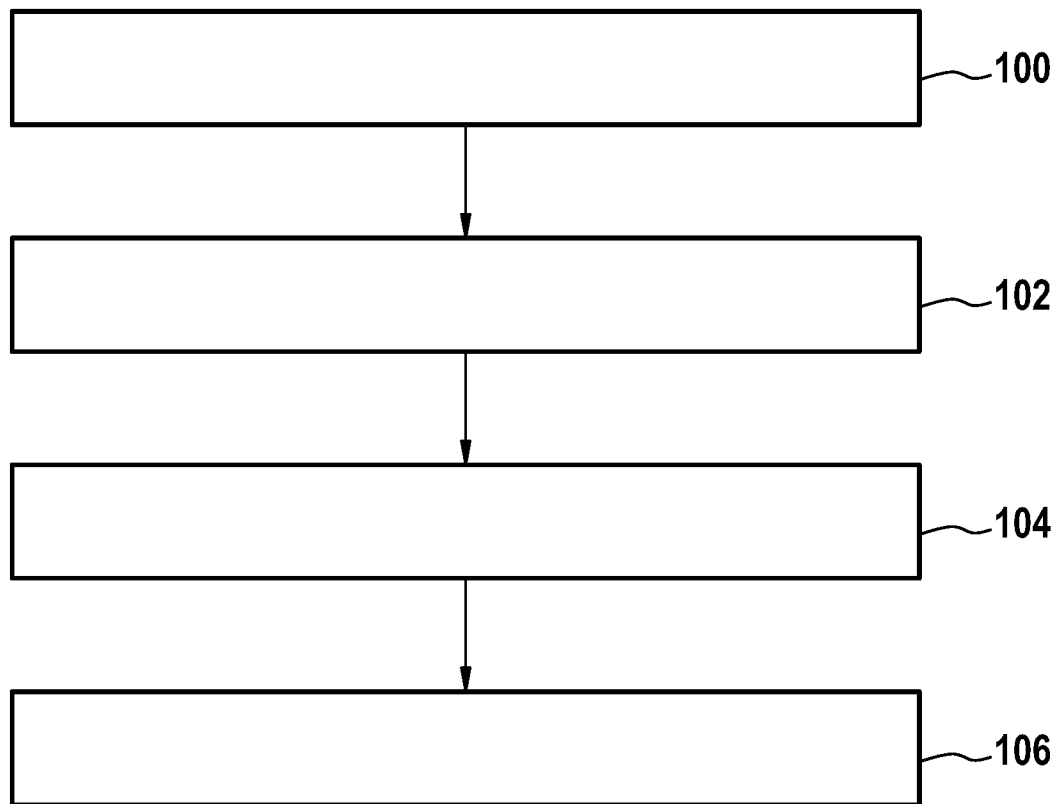
14. The artificial turf cleaner of claim 13, wherein each of the at least one rotatable brushes is configured for receiving the detergent mixture from the reservoir and applying the detergent mixture to the artificial turf using at least one pressure nozzle (218, 218', 218").

15. The artificial turf cleaner of claim 14, wherein the artificial turf cleaner further comprises a spray bar with additional pressure nozzles (218), wherein the spray bar is mounted in front of the at least one rotatable brush in the motion direction.

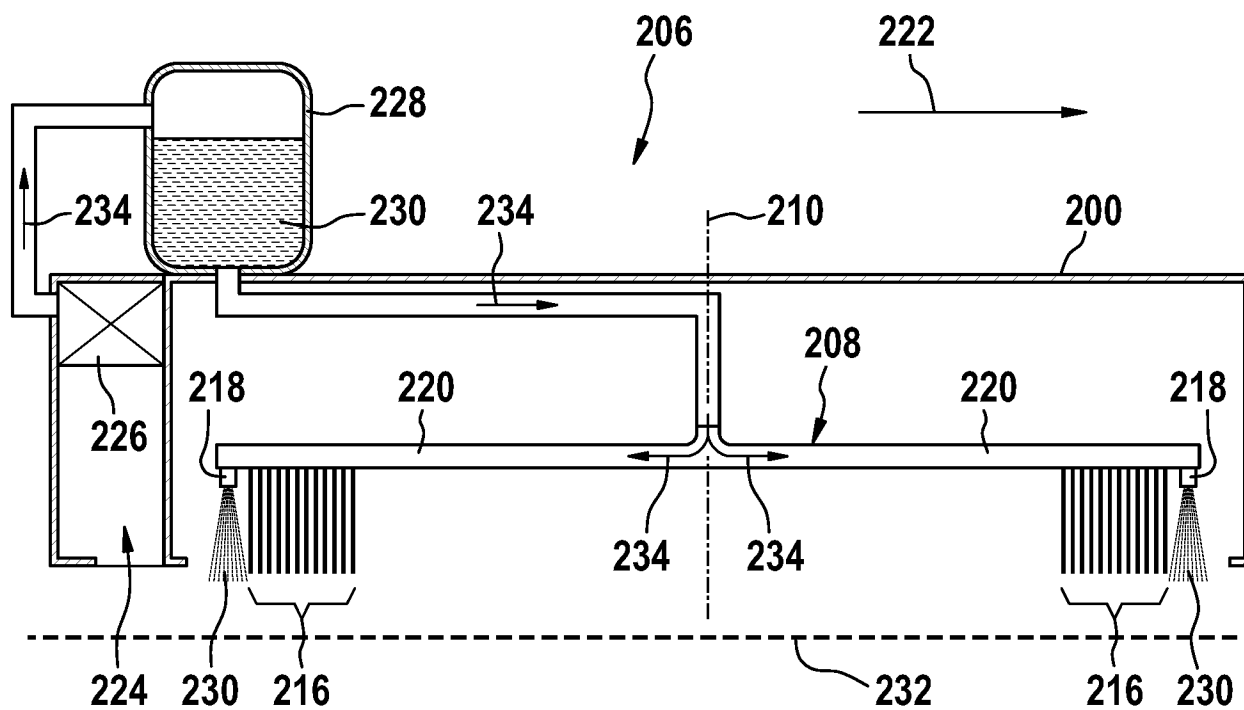
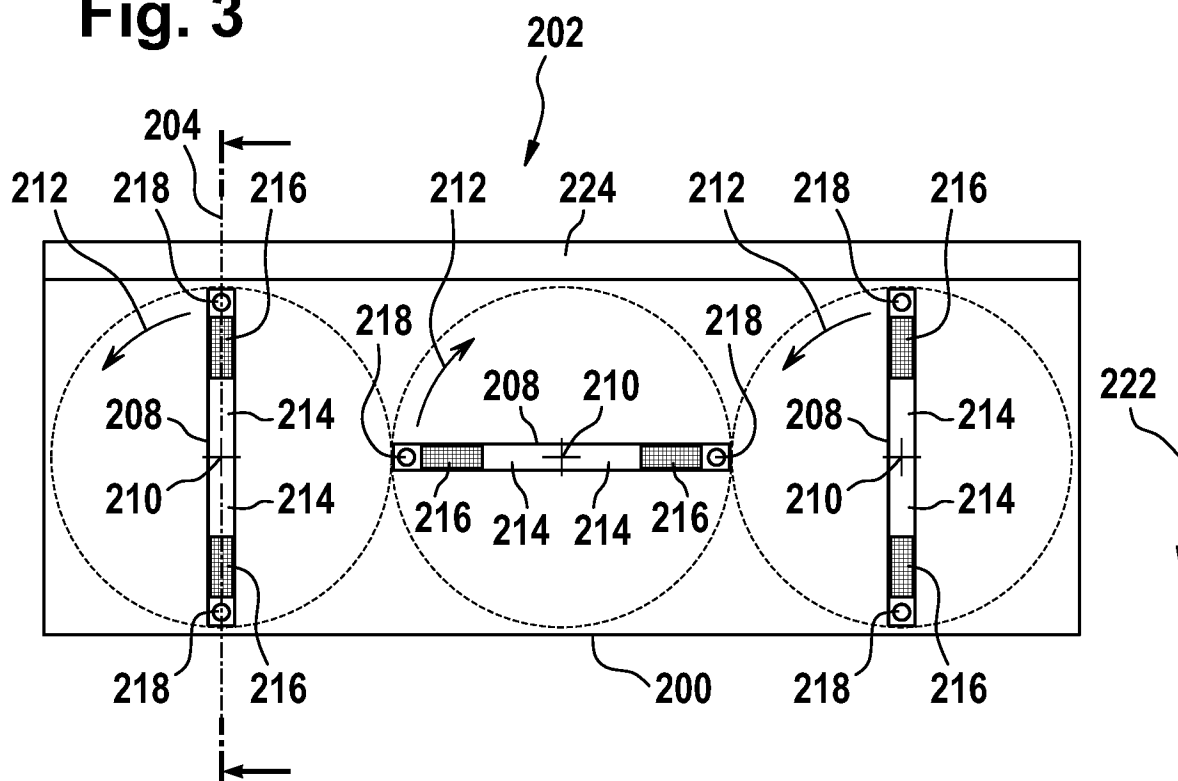
- 5 16. The artificial turf cleaner of claim 15, wherein the at least one rotatable brush is configured to rotate parallel to a horizontal plane (232) when the artificial turf cleaner is in an operating position, wherein each of the at least one rotatable brush has a center of rotation, wherein each of the at least one rotatable brush comprises at least two extensions extending from the center of rotation, wherein at least one of
- 10 the at least two extensions comprises a brushing surface with bristles (216), and wherein the at least one pressure nozzle is mounted on at least one of the at least two extensions.

17. The turf cleaner of any one of claims 13 through 16, wherein the vacuum
- 15 system is configured for returning vacuumed detergent mixture into the reservoir.

Fig. 1

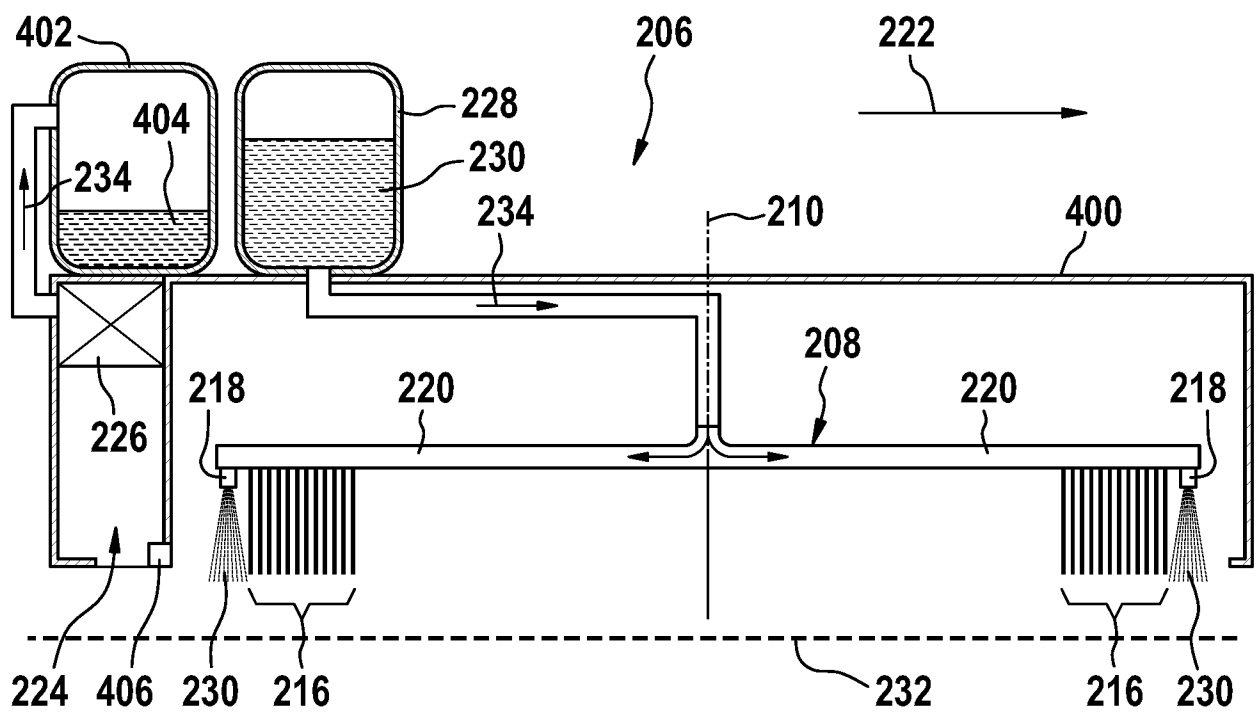


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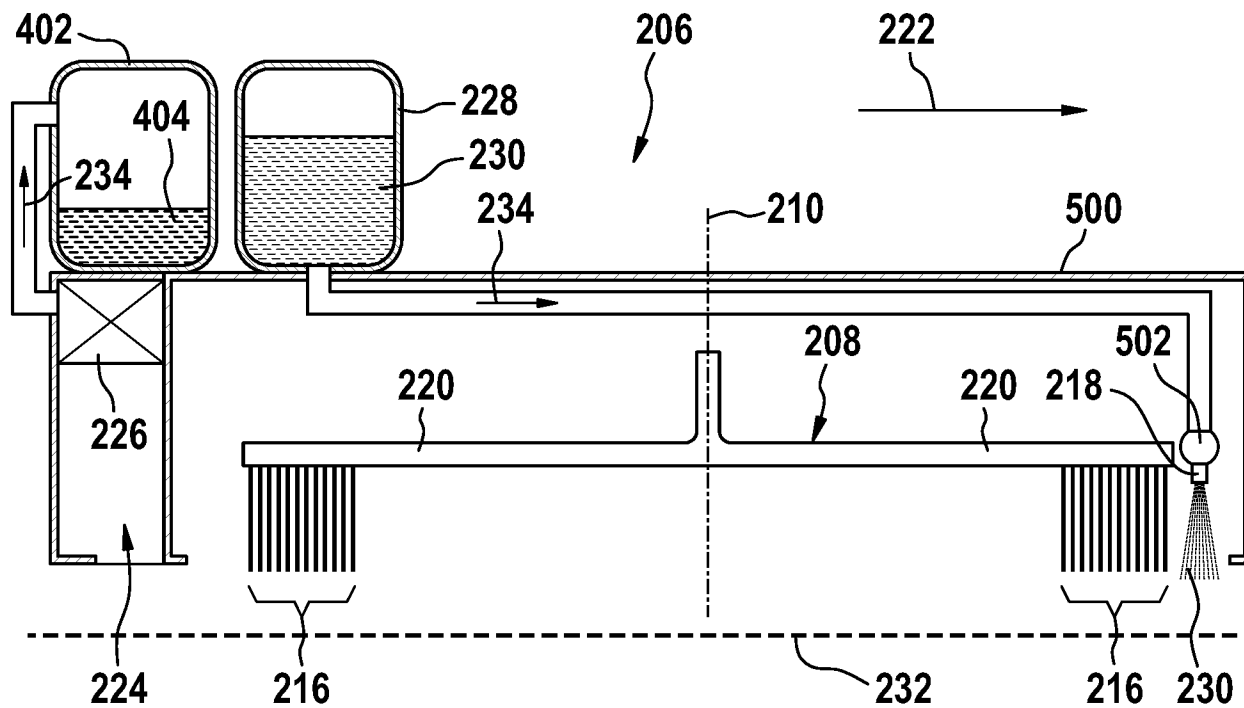
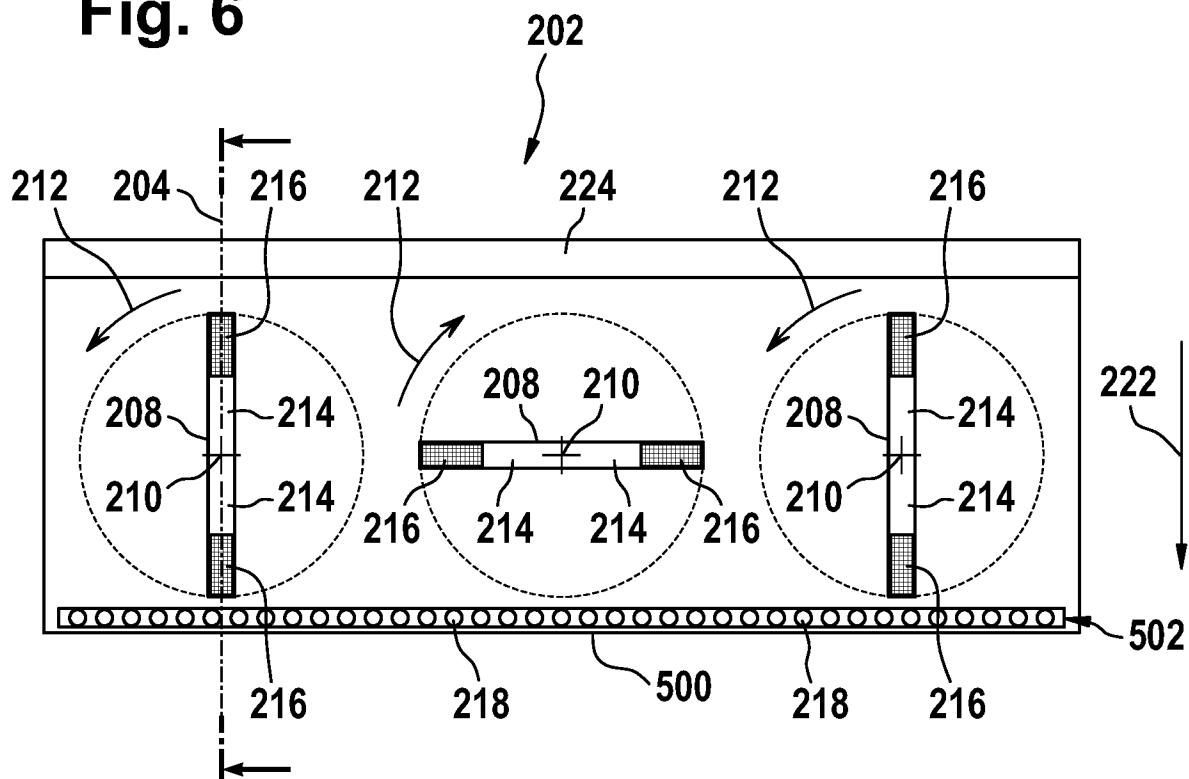
Fig. 2**Fig. 3**

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Fig. 4



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Fig. 5**Fig. 6**

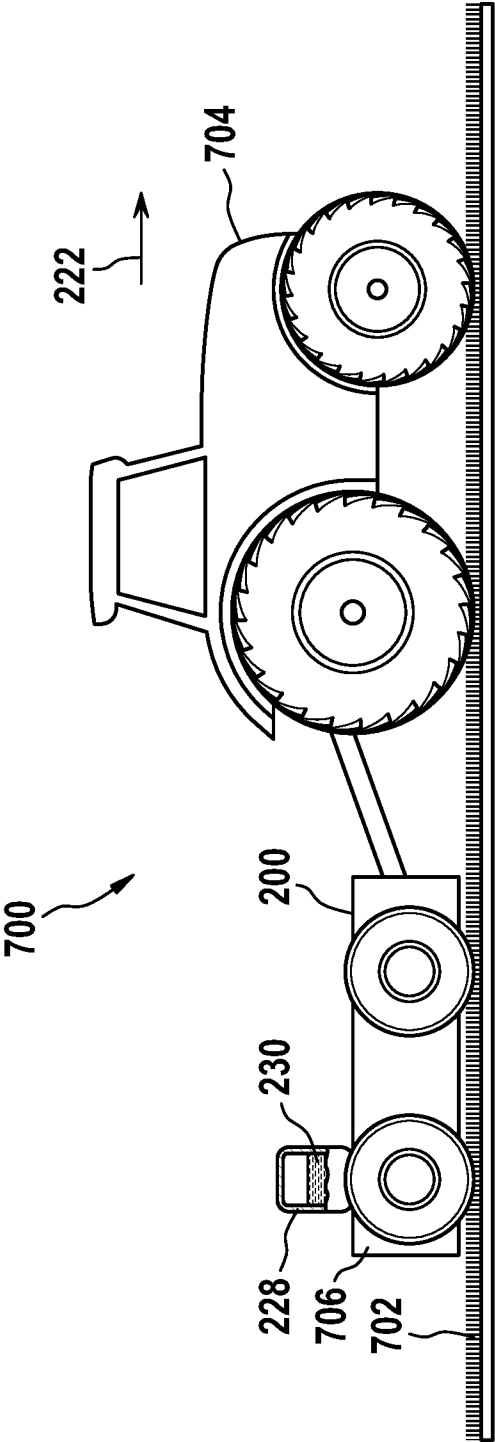


Fig. 7

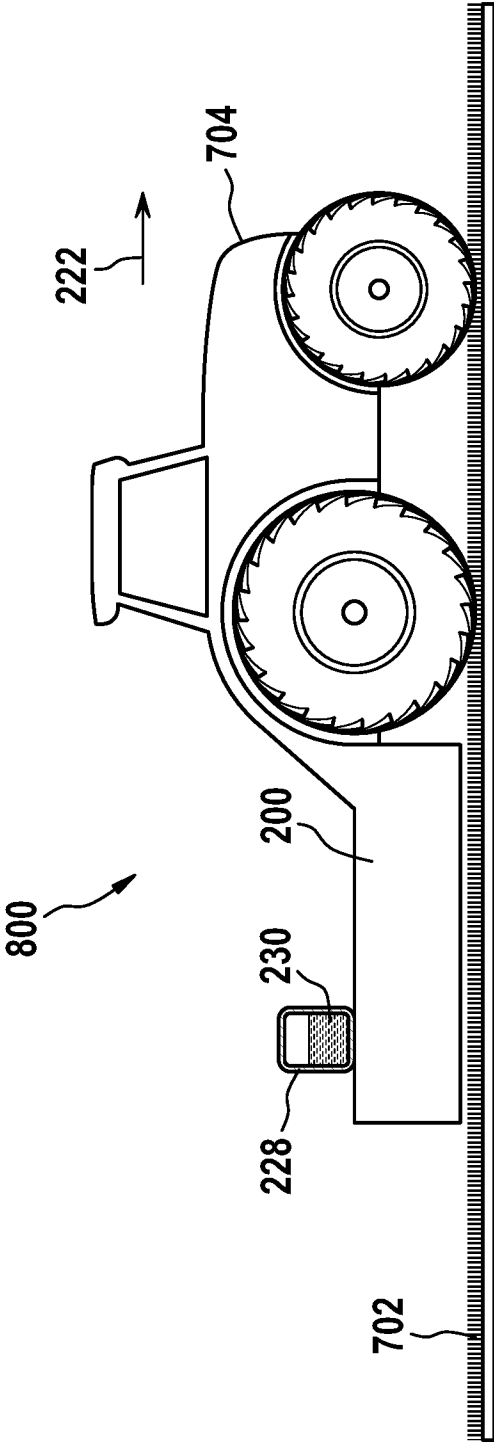


Fig. 8

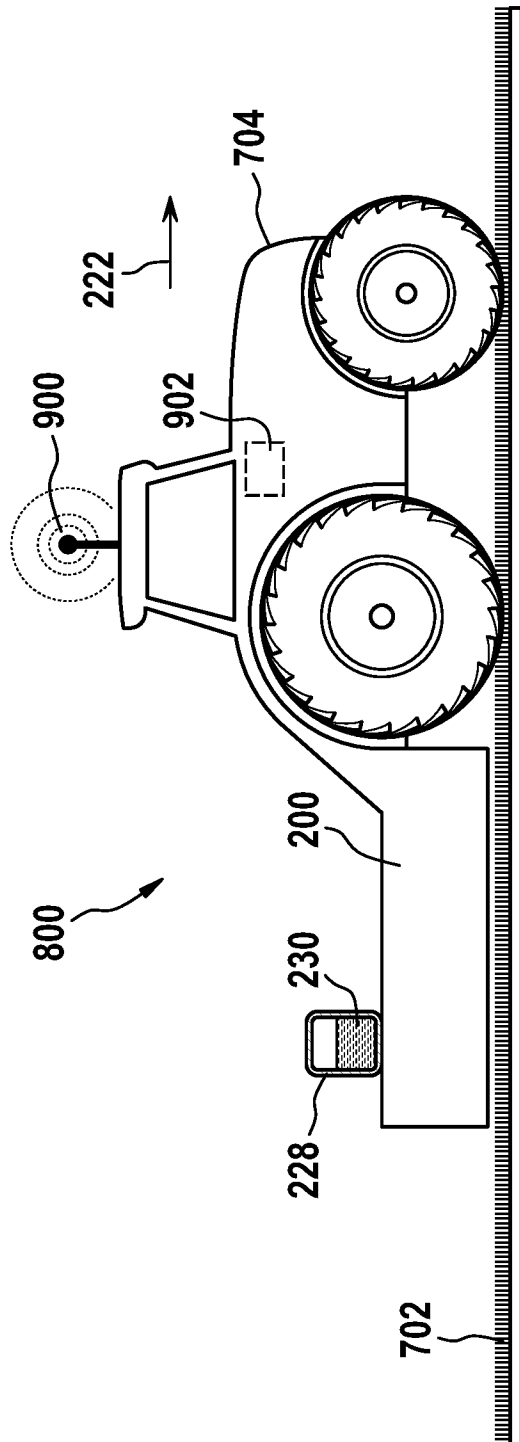


Fig. 9

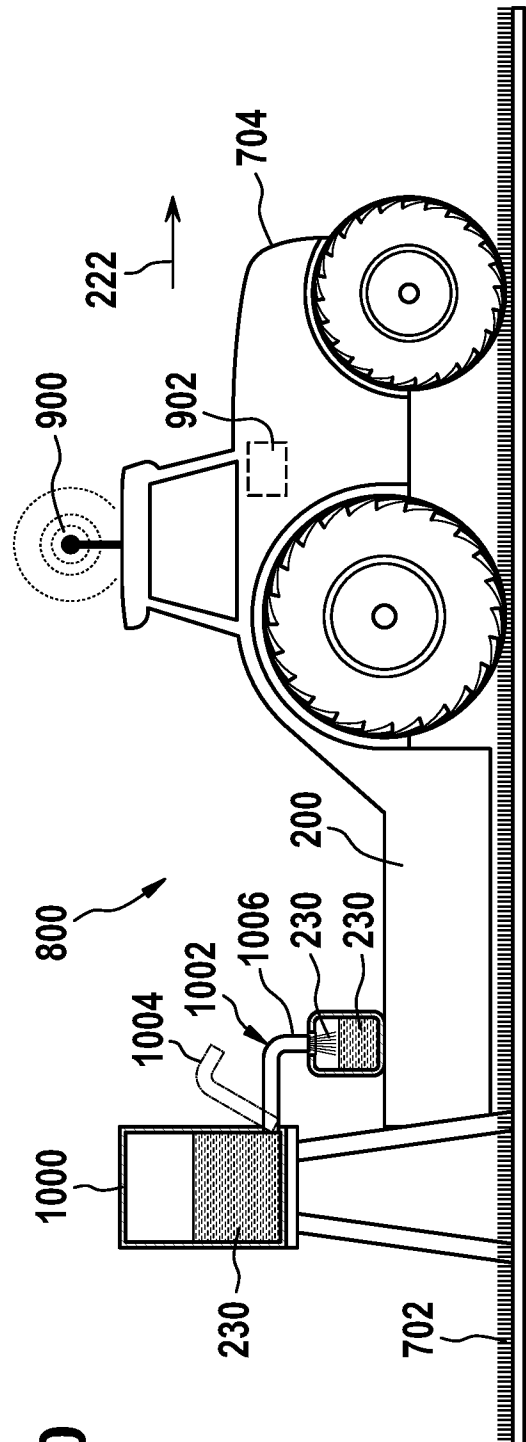


Fig. 10

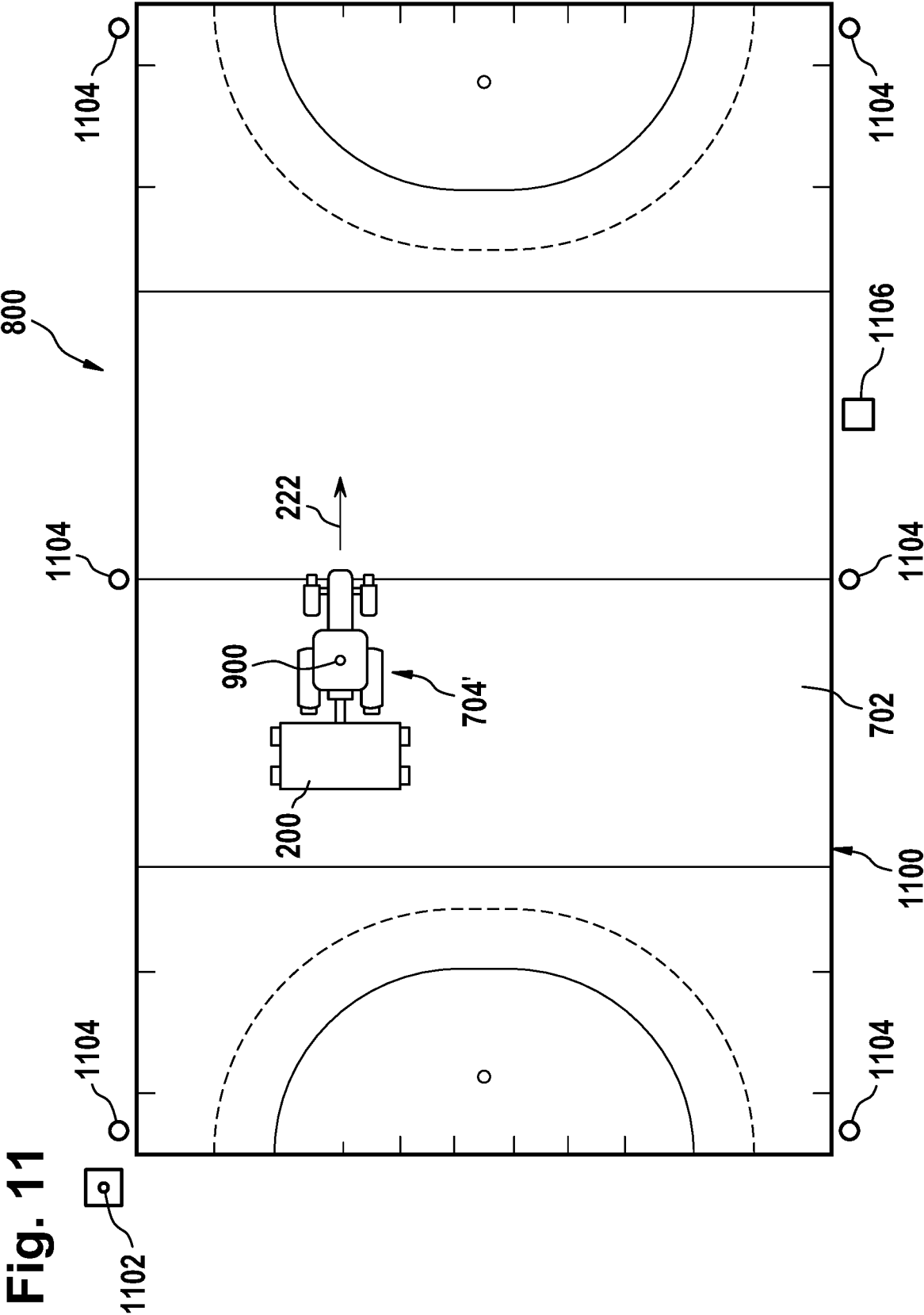
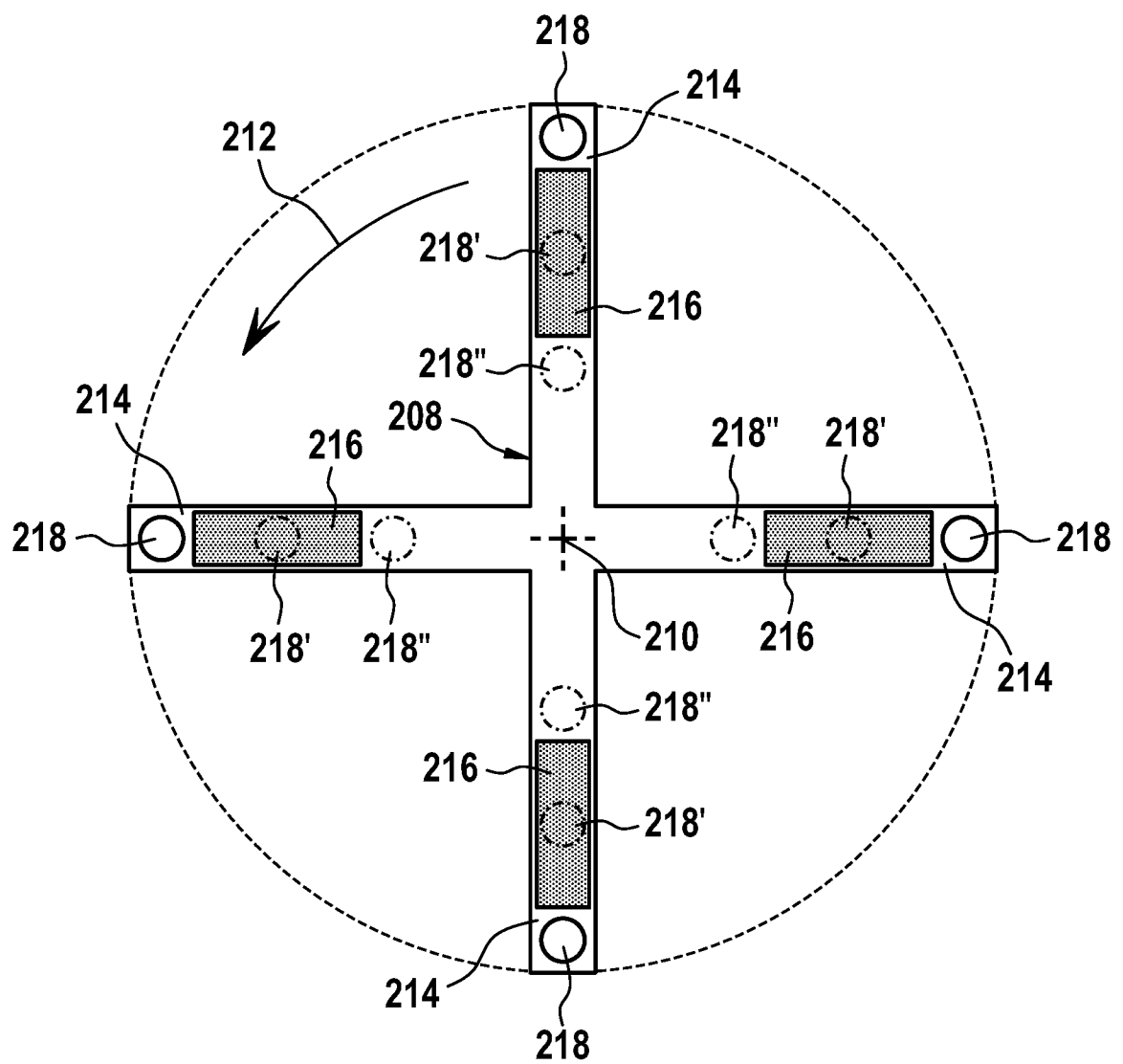


Fig. 12

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/079986

A. CLASSIFICATION OF SUBJECT MATTER
INV. E01H1/05 E01H1/08 E01H1/10
ADD.

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)
E01H A01G

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 practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2017/260704 A1 (DE GEYTER NICOLAS [BE]) 14 September 2017 (2017-09-14) paragraphs [0001], [0002], [0004], [0006], [0009], [0029], [0030], [0032], [0035], [0037] figures 1,2 -----	1-17
Y	EP 2 230 357 A2 (CRAWFORD CONTRACTS LTD [GB]) 22 September 2010 (2010-09-22) paragraphs [0001], [0005], [0012] - [0016], [0018], [0025], [0026], [0029] claims 1,15; figures 1-3 ----- -/-	1-17



Further documents are listed in the continuation of Box C.



See patent family annex.

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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

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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

"&" document member of the same patent family

Date of the actual completion of the international search

24 January 2019

Date of mailing of the international search report

04/02/2019

Name and mailing address of the ISA/

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Authorized officer

Kremsler, Stefan

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/079986

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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Y	column 1, lines 15-24 column 2, lines 23-27 column 2, line 65 - column 3, line 56 page 4, line 53 - page 5, line 21 figure 1 -----	1-12,15, 16
X	US 2006/236494 A1 (NELSON DAVID A [US] ET AL) 26 October 2006 (2006-10-26)	13-15
Y	paragraphs [0002], [0009], [0021], [0022], [0028], [0030], [0032], [0033], [0039], [0042], [0043] claims 1,4; figures 1-8 -----	1-17
Y	NL 1 023 007 C1 (MERKUS BEHEER B V [NL]) 30 September 2004 (2004-09-30)	6,16,17
A	the whole document -----	1-5,7-15
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A,P	paragraphs [0002], [0006] - [0009], [0021] - [0028], [0031], [0041] figures 1-6,11 -----	16

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Information on patent family members

International application No

PCT/EP2018/079986

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