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- (71) Applicant: **TOIBOT LTD.** [IL/IL]; 13 Montifiori st., 3372516 Haifa (IL).
- (72) Inventors: **TOKAREV, Daniel**; 13 Montifiori St., 3372516 Haifa (IL). **ALLOUCH, David**; 6 Shimeon St., 2706836 Kiryat Bialik (IL).
- (74) Agents: **GOLDRAICH, Marganit** et al.; GOLD-PATENTS & FINANCIAL SERVICES LTD, 15 Yohanan Hasandlar St., P.O.B 25267, 31251 Haifa (IL).
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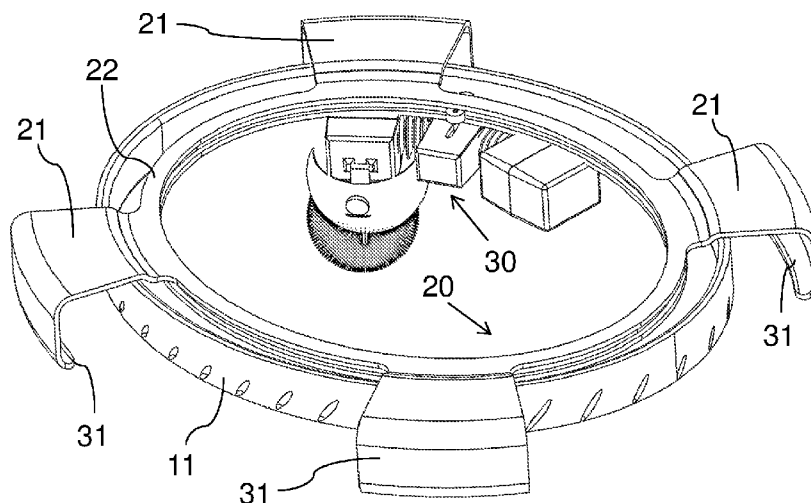


Fig. 3A

(57) Abstract: An apparatus and method for automatic cleaning a structure's inner wall having a rim that comprises a rail adjacent to the structure's rim configured to cling the rail to the rim and a cleaning system coupled to the rail and configured to move along the rail. A sanitary fixture is also disclosed that comprises an apparatus for automatic cleaning the fixture's inner wall wherein the sanitary fixture comprises a toilet bowl having a rim, a rail adjacent to the rim configured to cling the rail to the rim, and a cleaning system coupled to the rail and configured to move along the rail.



## AUTOMATIC TOILET CLEANER

### FIELD

5           The disclosure relates to toilet cleaning. More particularly, the disclosure herein relates to systems and methods for automatic toilet cleaning.

### BACKGROUND

10           The procedure of cleaning a toilet is usually time consuming and also cumbersome. This is a result of the unique structure of the toilet bowl, which requires meticulous movements and gestures by the person cleaning the toilet in order to thoroughly clean all parts of the toilet bowl. Typically, such cleaning is carried out using a toilet brush, whereby the person cleaning the toilet cleans a single toilet in up to ten minutes.

15           There are several commercially available solutions for enhanced toilet cleaning. These solutions typically involve some sort of detergent (usually in the form of a capsule) that is embedded into the toilet bowl, for example attached to the inner side of the bowl, and release a small amount of detergent with every flush of the toilet. Additionally, some  
20 solutions are embedded into the toilet tank and are directly connected to the water supply such that every flush releases a small amount of detergent from the toilet tank.

          However, such commercially available solutions cannot provide a comprehensive solution since some stains in the toilet bowl require physical contact in order to be removed  
25 (e.g. contact with a toilet brush), since some stains have a dry surface connection to the inner side of the toilet bowl while detergent material flushed into the bowl only contacts the outer surface of these stains. Therefore, manually cleaning with a toilet brush is still required.

          It is therefore an object to provide a portable device for automated toilet cleaning, to  
30 replace a manually operated toilet brush. Further objects and advantages will appear as the description proceeds.

Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which the embodiments belong. Although methods and materials similar or equivalent to those described herein can be used in the practice or testing, suitable methods and materials are described below. In case of conflict, the patent specification, including definitions, will control. In addition, the materials, methods, and examples are illustrative only and not intended to be limiting.

### SUMMARY

According to a first aspect, an apparatus for automatic cleaning a structure's inner wall, having a rim, the apparatus comprising: a rail adjacent to the structure's rim configured to cling the rail to the rim; and a cleaning system coupled to the rail and configured to move along the rail.

In some exemplary embodiments, the rail comprising at least one grasping arm configured to cling the rail to an outer edge of the structure's rim.

In some exemplary embodiments, the cleaning system comprising a cleaning segment that comprise a removable brush.

In some exemplary embodiments, the removable brush is connected to the cleaning segment by a shaft.

In some exemplary embodiments, the cleaning segment is configured to spin the shaft and thus also the brush about a longitudinal axis of the brush.

In some exemplary embodiments, the brush has a rounded head.

In some exemplary embodiments, the cleaning system further comprising a rotation motor configured to spin the shaft.

In some exemplary embodiments, the cleaning system comprising a driver segment configured to move the cleaning system along the rail consequently moving the brush against the structure's inner wall, subsequently brushing an inner wall strip along the structure's inner wall.

In some exemplary embodiments, the cleaning system is configured to extend and retract the shaft along the longitudinal axis of the brush forming a linear motion of the brush.

In some exemplary embodiments, the cleaning system further comprising at least one sensor selected from a group comprising of: acoustic sensor; timer; motion sensor; proximity

sensor; presence sensor; and a combination thereof; wherein the at least one sensor is configured to initiate cleaning operation.

In some exemplary embodiments, the cleaning system further comprises a control segment.

5 In some exemplary embodiments, the control segment comprises: a power storage element; a control board; at least one sensor; and a combination thereof.

In some exemplary embodiments, the power storage element is an electrical battery configured to support electrical power requirements of the cleaning system.

10 In some exemplary embodiments, further comprising a disinfection cartridge configured to receive a capsule containing cleaning substance that can be released in portions.

In some exemplary embodiments, the cleaning substance comprises material selected from the group comprising of: a disinfecting substance; a cleaning detergent; an odor substance, and a combination thereof.

15 In some exemplary embodiments, the cleaning segment; the control segment; and the driver segment of the cleaning system are mutually connected by flexible connectors.

The apparatus of Claim 1 is an apparatus for automatic cleaning an inner wall of a toilet bowl.

20 According to a second aspect, a sanitary fixture comprising an apparatus for automatic cleaning the fixture's inner wall, the sanitary fixture comprising: a toilet bowl having a rim; a rail adjacent to the rim configured to cling the rail to the rim; and a cleaning system coupled to the rail and configured to move along the rail.

According to a third aspect, method of automatically cleaning a structure's inner wall, the method comprising: brushing the structure's inner wall with a brush articulated by a driver module on the structure's inner wall.

25 In some exemplary embodiments, further comprising spinning the brush about its longitudinal axis.

In some exemplary embodiments, further comprising linearly moving the brush along the brush longitudinal axis.

30 In some exemplary embodiments, further comprising utilizing the driver module for homing the brush to an origin position.

According to a forth aspect, a capsule comprising disinfecting substances; cleaning detergents; odor substances; and a combination thereof; wherein the capsule shape is designed to fit in the disinfection cartridge of the first aspect of the disclosed subject matter.

5

### BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments are herein described, by way of example only, with reference to the accompanying drawings. With specific reference now to the drawings in detail, it is stressed  
10 that the particulars shown are by way of example and for purposes of illustrative discussion of the preferred embodiments, and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the embodiments. In this regard, no attempt is made to show structural details in more detail than is necessary for a fundamental understanding, the description taken with the  
15 drawings making apparent to those skilled in the art how several forms may be embodied in practice.

In the drawings:

- Fig. 1 schematically illustrates a commercially available toilet.
- 20 - Fig. 2A schematically illustrates a perspective view of an automatic cleaning system assembled onto an existing commercially available toilet, according to an exemplary embodiment.
- Fig. 3A schematically illustrates a perspective view of the automatic cleaning system assembled onto a rim of the toilet bowl, according to an exemplary embodiment.
- 25 - Fig. 3B schematically illustrates a perspective view of the automatic cleaning system without the rim, according to an exemplary embodiment.
- Fig. 3C schematically illustrates a perspective view of the elements of an articulated cleaning system, according to an exemplary embodiment.
- Fig. 4A schematically illustrates a perspective view of a control segment, according to an  
30 exemplary embodiment.
- Fig. 4B schematically illustrates a cross-sectional view of the control segment, according to an exemplary embodiment.

- Fig. 5A schematically illustrates a perspective view of a driver segment, according to an exemplary embodiment.
- Fig. 5B schematically illustrates a partial cross-sectional view of the driver segment attached to the annular rail of the automatic cleaning system, according to an exemplary  
5 embodiment.
- Fig. 5C schematically illustrates a partial cross-sectional view of the driver segment, according to an exemplary embodiment.
- Fig. 6A schematically illustrates a perspective view of a cleaning segment, according to an exemplary embodiment.
- 10 - Fig. 6B schematically illustrates a partial cross-sectional view of the cleaning segment, according to an exemplary embodiment.
- Fig. 7 schematically illustrates a cleaning cover that is compatible with the cleaning segment, according to an exemplary embodiment.

15

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Before explaining at least one embodiment in detail, it is to be understood that the  
embodiments is not limited in its application to the details of construction and the  
arrangement of the components set forth in the following description or illustrated in the  
20 drawings. Other embodiments can be practiced or carried out in various ways. Also, it is to be  
understood that the phraseology and terminology employed herein is for the purpose of  
description and should not be regarded as limiting. In discussion of the various figures  
described herein below, like numbers refer to like parts. The drawings are generally not to  
scale.

25

For clarity, non-essential elements were omitted from some of the drawings.

Fig. 1 schematically illustrates a commercially available toilet 10. The commercially  
available toilet 10 has a toilet bowl 12 with a rim 11 and an inner surface 13 to be cleaned by  
the user, typically with a toilet brush. The commercially available toilet 10 further has a toilet  
30 tank 14 accommodating water to be dispensed into the toilet bowl 12 with every flush, and  
also a toilet seat 15 capable of covering the toilet bowl 12.

Since manually cleaning the toilet bowl is time consuming, it would therefore be advantageous to have an automatic solution that may simulate the physical toilet cleaning operation of a toilet brush without the need of manual intervention.

5 Referring now to Fig. 2, this figure schematically illustrates a perspective view of an automatic cleaning system 20 assembled onto an existing commercially available toilet 10. The automatic cleaning system 20 may couple to the rim 11 of the toilet bowl 12, using at least one arm 21, while the other elements of the automatic cleaning system 20 remain on the inner side of the toilet bowl 12. Optionally, the at least one arm 21 may be partially elastic so  
10 as to couple to any shape of toilet bowl.

The toilet seat 15 may then be placed onto the automatic cleaning system 20 so as to allow normal use of the toilet 10 while the automatic cleaning system 20 may operate independently. It should be noted that the only element of the automatic cleaning system 20  
15 positioned between the toilet bowl 12 and the seat 15, is the at least one arm 21. Preferably, the at least one arm 21 is sufficiently thin so as to allow positioning the seat 15 onto the automatic cleaning system 20 such that a user sitting on the seat does not feel a difference after the addition of the automatic cleaning system 20.

20 It is appreciated that the automatic cleaning system 20 may be assembled onto any type of toilet, whereby the automatic cleaning system 20 is easily coupled to the rim of the toilet bowl with the at least one arm 21. Thus, the automatic cleaning system 20 may automatically clean the inner surface 13 of the toilet bowl 12 (further described hereinafter), while the seat 15 may be placed onto the automatic cleaning system 20 such that normal use  
25 of the toilet may be allowed.

The initiation of the cleaning operation may be commenced by built-in sensors in the automatic cleaning system 20, and triggered with every flushing of the toilet. For example, an acoustic sensor that triggers the cleaning operation upon recognition of the flushing sound,  
30 and/or a motion sensor that that triggers the cleaning operation upon recognition of flowing water inside the toilet. Additionally or alternatively, the cleaning operation may be commenced with a predetermined time period (for instance, once every hour). In some

exemplary embodiments, the automatic cleaning system 20 may be mutually coupled with an automatic and/or a touch-less toilet flusher, capable of flushing the toilet upon detecting motion/presence. It should be noted that, the coupling comprise wirelessly obtaining a signal, indicating that flushing has began, from the automatic/touch-less flush, thus initiation the  
5 cleaning operation. In some exemplary embodiments, the built-in sensors commencing the cleaning operation may comprise motion sensor, proximity sensor, presence sensor, a combination thereof, or the like, such as the automatic and/or a touch-less toilet flusher.

Referring now to Figs. 3A-3C, these figures illustrate the elements of the automatic  
10 cleaning system. Fig. 3A schematically illustrates a perspective view of the automatic cleaning system 20 assembled onto a rim 11 of the toilet bowl, and Fig. 3B schematically illustrates a perspective view of the automatic cleaning system 20 without the rim 11.

It should be noted that while the automatic cleaning system 20 may be assembled onto  
15 a rim 11 of the toilet bowl with at least one arm 21, the at least one arm 21 may further comprise a clinging segment 31 configured to allow clinging the at least one arm 21 onto the outer edge of the toilet bowl.

The automatic cleaning system 20 comprises an annular rail 22 configured to be  
20 adjacent to the rim 11, and an articulated cleaning system 30 that is coupled to and moving on the rail 22, further described hereinafter. Preferably, the articulated cleaning system 30 comprises three coupled segments that move together along the rail 22. Namely, a control segment 32, a driver segment 34, and also a cleaning segment 36.

Fig. 3C schematically illustrates a perspective view of the elements of the articulated  
25 cleaning system 30. The control segment 32 is coupled to the driver segment 34 with a first flexible joint 33, and the driver segment 34 is coupled to the cleaning segment 36 with a second flexible joint 35. It should be noted that among these elements only the driver segment 34 is coupled to the rail with at least one wheel 38, further described hereinafter.  
30 During the movement of the articulated cleaning system 30 along the rail, the driver segment 34 moves along the rail while the coupled control segment 32 and the cleaning segment 36 move along with the driver segment 34.

In some embodiments, the first and second flexible joints 33, 35 are hollow elastic joints that protect electric cables passing through them, for instance protect from damages of water flow in the toilet. Specifically, the first flexible joint 33 protects a first electric cable passing from the control segment 32 to the driver segment 34 such that the control segment 32 may control the motion of the driver segment 34. Similarly, the second flexible joint 35 protects a second electric cable passing from the driver segment 34 to the cleaning segment 36, such that the control segment 32 may in turn control the operation of the cleaning segment 36.

Referring now to Figs. 4A-4B, these figures illustrate the elements of the control segment 32. Fig. 4A schematically illustrates a perspective view of the control segment 32, and Fig. 4B schematically illustrates a cross-sectional view of the same.

The control segment 32 comprises a first connection element 41 configured to allow connection to the first flexible joint 33 and/or the driver segment 34 (for instance as shown in Fig. 3C). Additionally, the control segment 32 further comprises a power compartment with at least one power storage element 43 (typically a standard battery), and also a control board 42 (e.g. a PCB) configured to control the movement of the entire articulated cleaning system 30 along the rail, and particularly control the motion of the driver segment and the operation of the cleaning segment via electric cables passing from the control segment 32 and to the driver and cleaning segments.

Referring now to Figs. 5A-5C, these figures illustrate the operation of the driver segment. Fig. 5A schematically illustrates a perspective view of the driver segment 34, and Fig. 5B schematically illustrates a partial cross-sectional view of the driver segment 34 attached to the annular rail 22 of the automatic cleaning system 20.

Similarly to the control segment, the driver segment 34 has at least one second connection element 51 configured to allow connection to the first flexible joint 33 and/or the control segment 32 (for instance as shown in Fig. 3C). Optionally, the driver segment 34 has

additional second connection element 51 configured to allow connection to the second flexible joint 35 and/or the cleaning segment 36.

5 The at least one wheel 38 of the driver segment 34 is configured to fit into a track of the rail 22. The driver segment 34 may comprise a built-in motor (further described hereinafter) that rotates the at least one wheel 38. Rotation of the at least one wheel 38 onto the rail 22 may therefore move the driver segment 34 along the rail 22, and consequently the control 32 and cleaning 36 segments that are coupled to the driver segment 34.

10 It should be noted that the operation of the motor of the driver segment 34, and thereby the movement of the automatic cleaning system 20 along the rail 22, may be controlled by the control segment 32.

15 Fig. 5C schematically illustrates a partial cross-sectional view of the driver segment 34. The driver segment 34 may comprise a built-in motor 54 (e.g. a step motor), that is coupled to the at least one wheel 38 and capable of rotating the at least one wheel 38.

20 In some embodiments, the driver segment 34 may also comprise a first elastic element 55 (e.g. a spring) that is coupled to an additional wheel 38 in order to allow corresponding rotation of the two wheels 38 onto the rail 22 such that a desired motion of the driver segment 34 may be achieved. Preferably, the position of the additional wheel 38 relatively to the driver segment 34 is not fixed such that both wheels may move along the rail 22 with a changing distance between them, for example may be required as some portions of the angular rail 22 may be curved and in order to move there the wheels 38 must slightly change  
25 the distance between them. The first elastic element 55 may keep a minimal distance between the wheels 38 such that both wheels about the rail 22.

It is appreciated that the driver segment 34 thus provides the desired horizontal movement along the annular rail 22, wherein the control segment controls the motion.

Referring now to Figs. 6A-7, these figures illustrate the elements of the cleaning segment. Fig. 6A schematically illustrates a perspective view of the cleaning segment 36, and Fig. 6B schematically illustrates a partial cross-sectional view of the same.

5 Similarly to the control segment, the cleaning segment 36 has at least one third connection element 61 configured to allow connection to the second flexible joint 35 and/or the driver segment 34 (for instance as shown in Fig. 3C). Optionally, the cleaning segment 36 may also have at least one cover connector 63 configured to allow connection of the cleaning segment 36 to the cleaning cover (for instance as shown in Fig. 7).

10 Preferably, the cleaning segment 36 is coupled to a brush 64 having a rounded ball-like head, configured to simulate the brushing operation while manually cleaning a toilet bowl. The cleaning segment 36 may be coupled to the brush 64 with shaft 62 configured to change the length and thus change the vertical position of the brush 64, further described hereinafter. Optionally, the operation of the shaft 62 is controlled by the control segment.

15 The cleaning segment 36 may optionally comprise a spring 65 configured to maintain a predefined distance between the cleaning segment 36 and the brush 64. In some exemplary embodiments the spring 65 may assist in raising the brush towards the cleaning segment 36 and therefore allow lower power consumption of the system in order to overcome the gravitational force pulling the brush 64 downwards. Alternatively, spring 65 may be assembled in a way that assists lowering the brush away from the cleaning segment 36.

25 In some exemplary embodiments, the brush may be coated with hydrophobic and oleophobic material, which repel water, mud, other liquids, sticky materials, a combination thereof, or the like. These hydrophobic and oleophobic coatings cause liquids to form nearly perfect spheres, which roll off the surface of the coated substrate, thus keeping the brush dry and clean. Optionally, the brush may be a separate element and replaced by the user after a certain period of time (e.g. replaced once a year).

30

The operation of the brush 64 may be achieved with two corresponding motors. Namely, a rotation motor 66 and a height motor 68 that may operate separately or alternatively operate simultaneously in order to achieve a desired motion.

5 The rotation motor 66 may be directly coupled to the shaft 62 and rotate the shaft 62 around its axis in order to rotate the brush 64 such that a brushing procedure may occur. Alternatively, the height motor 68 is directly coupled to the shaft 62 and the rotation motor 66 may be coupled to the shaft 62 with an elastic belt 67.

10 Thus, the height motor 68 may move the shaft 62 so as to change the distance between the cleaning segment 36 and the brush 64, for example by winding the shaft 62 onto a reel, and the rotation motor 66 may in turn move the belt 67 so as to rotate the shaft 62 around its axis. It should be noted that the cleaning segment 36 thus provides the desired vertical movement for the brushing procedure, wherein the control segment controls the  
15 motion by controlling the rotation motor 66 and the height motor 68.

Optionally, the brush 64 may be lowered by the height motor 68 until it contacts the bottom of the toilet bowl such that the entire toilet may be cleaned.

20 It is appreciated that as different countries use different structures of toilet bowls, the automatic toilet cleaner may be adapted for specific toilet structures, for instance with elongated brush movements such that the entire toilet bowl may be cleaned.

Fig. 7 schematically illustrates a cleaning cover 70 that is compatible with the  
25 cleaning segment 36. The cover 70 may at least partially cover the cleaning segment 36 such that water flowing after flushing of the toilet does not damage the mechanical elements (e.g. the shaft and motors). Additionally, the cover 70 may protect the cleaning segment 36 from damages caused by physical contact with the toilet bowl.

30 The cover 70 comprises a connector 71 configured to allow connection to the at least one cover connector of the cleaning segment 36. It should be noted that the connection to the

cleaning segment 36 is flexible, and the position of the cover 70 relatively to the cleaning segment 36 may change according to the contact of the cover 70 with the toilet bowl.

In some embodiments, the cover 70 further comprises a disinfection cartridge 72, 5 having an aperture 73. The disinfection cartridge 72 may be filled (e.g. by the user) with a capsule (not shown). The capsule may be comprised of material, such as a disinfecting substance, a cleaning detergent, a combination thereof, or the like. A portion of capsule material may be released into the toilet bowl during the brushing procedure (cleaning operation). Preferably, the physical contact between the cover 70 and the toilet bowl may 10 press the disinfection cartridge 72 so as to release a portion of capsule material through the aperture 73 such that the material may reach the brush cleaning the toilet.

It is appreciated that such automated toilet cleaning may be particularly advantageous in public facilities having numerous toilets, for example large sport stadiums having hundreds of toilets. In order to manually clean all of these toilets (wherein daily cleaning is required) it 15 may take several hours and employ several workers. However, using the abovementioned automatic cleaning system, all of the toilets are automatically cleaned such that the requirement to employ an entire cleaning crew to clean every toilet bowl in the facility may be eliminated.

In some exemplary embodiments of the disclosed subject matter, the automatic 20 cleaning process of a structure's inner wall may comprise operations such as; brushing the inner wall with a brush that articulated, by driver segment 34, on the structure's inner wall; spinning the brush about its longitudinal axis; linearly moving the brush along the brush longitudinal axis; homing the brush to an origin position; a combination thereof, or the like.

It should be noted that while the above discusses cleaning of toilet, the same methods 25 may be applied for automatic cleaning of other objects that are commonly cleaned with a brush, wherein the structure of the rail may require adaptation for the new object. It should be also noted that, no attempt is made to show structural details in more detail than is necessary for a fundamental understanding of the disclosed subject matter. Furthermore the apparatus 30 structure and its method of operation, described in the preferred embodiment above, may be altered (redesign) due to ongoing effort of cost reduction; performance, reliability, and maintenance improvements; a combination thereof, or the like. As an example, the control

module may be relocated to the toilet outer wall. Another example, the apparatus may utilize an external power supply for its operation. As yet another example, the cleaning operation may be initiated manually by a push of a button.

5           It is appreciated that certain features of the embodiments, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the embodiments, which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable sub combination.

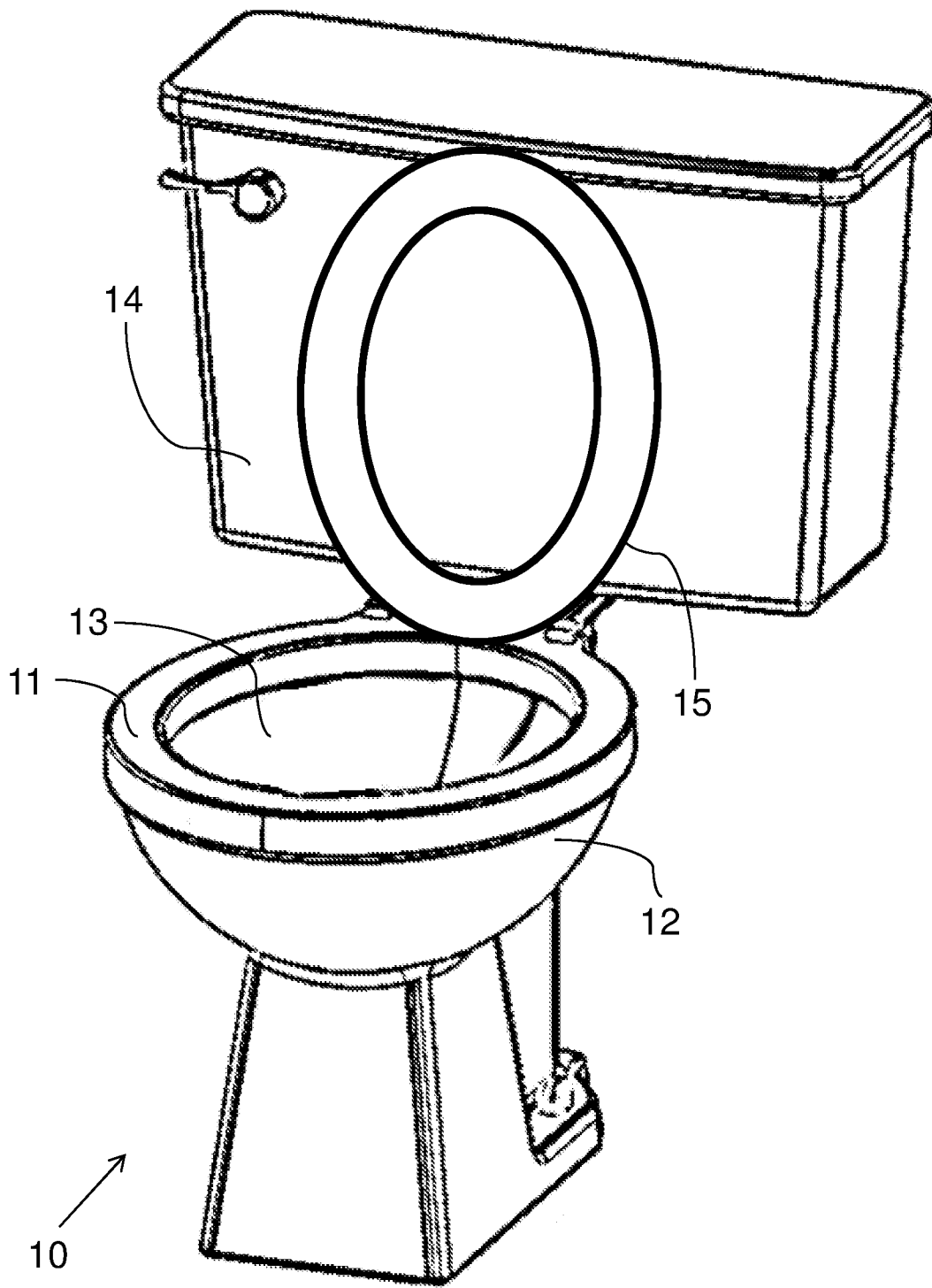
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Although it been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, it is intended to embrace all such alternatives, modifications and variations that fall within the spirit and broad scope of the appended claims.

**Claims:**

1. An apparatus for automatic cleaning a structure's inner wall having a rim, the apparatus comprising:
  - a rail adjacent to the structure's rim configured to cling the rail to the rim; and
  - a cleaning system coupled to the rail and configured to move along the rail.
2. The apparatus of Claim 1, wherein the rail comprising at least one grasping arm configured to cling the rail to an outer edge of the structure's rim.
3. The apparatus of Claims 1-2, wherein the cleaning system comprising a cleaning segment that comprise a removable brush.
4. The apparatus of claim 3, wherein the removable brush is connected to the cleaning segment by a shaft.
5. The apparatus of Claim 4, wherein the cleaning segment is configured to spin the shaft and thus also the brush about a longitudinal axis of the brush.
6. The apparatus of Claims 2-4, wherein the brush has a rounded head.
7. The apparatus of Claims 1-6, wherein the cleaning system further comprising a rotation motor configured to spin the shaft.
8. The apparatus of Claims 1-7, wherein the cleaning system comprising a driver segment configured to move the cleaning system along the rail consequently moving the brush against the structure's inner wall, subsequently brushing an inner wall strip along the structure's inner wall.
9. The apparatus of Claims 5-8, wherein the cleaning system is configured to extend and retract the shaft along the longitudinal axis of the brush forming a linear motion of the brush.
10. The apparatus of Claims 1-9, wherein the cleaning system further comprising at least one sensor selected from a group comprising of: acoustic sensor; timer; motion sensor; proximity sensor; presence sensor; and a combination thereof; wherein the at least one sensor is configured to initiate cleaning operation.
11. The apparatus of Claims 1-9, wherein the cleaning system further comprising a control segment.
12. The apparatus of Claim 11, wherein the control segment comprises: a power storage element; a control board; at least one sensor; and a combination thereof.

13. The apparatus of Claim 12, wherein the power storage element is an electrical battery configured to support electrical power requirements of the cleaning system.
14. The apparatus of Claims 1-13, further comprising a disinfection cartridge configured to receive a capsule containing cleaning substance that can be released in portions.
15. The apparatus of Claim 14, wherein said cleaning substance comprises material selected from the group comprising of: a disinfecting substance; a cleaning detergent; an odor substance, and a combination thereof.
16. The apparatus of Claims 3-11, wherein the cleaning segment; the control segment; and the driver segment of the cleaning system are mutually connected by flexible connectors.
17. The apparatus of Claim 1 is an apparatus for automatic cleaning an inner wall of a toilet bowl.
18. A sanitary fixture comprising an apparatus for automatic cleaning the fixture's inner wall, the sanitary fixture comprising:
  - a toilet bowl having a rim;
  - a rail adjacent to the rim configured to cling the rail to the rim; and
  - a cleaning system coupled to the rail and configured to move along the rail.
19. A method of automatically cleaning a structure's inner wall, the method comprising:
  - brushing the structure's inner wall with a brush articulated by a driver segment on the structure's inner wall.
- 5 20. The method of Claims 19 further comprising spinning the brush about its longitudinal axis.
21. The method of Claims 19-20 further comprising linearly moving the brush along the brush longitudinal axis.
22. The method of Claims 19-21 further comprising utilizing the driver segment for  
10 homing the brush to an origin position.
23. A capsule comprising disinfecting substances; cleaning detergents; odor substances; and a combination thereof; wherein the capsule shape is designed to fit in the disinfection cartridge of claim 14.



PRIOR ART  
Fig. 1

2 / 11

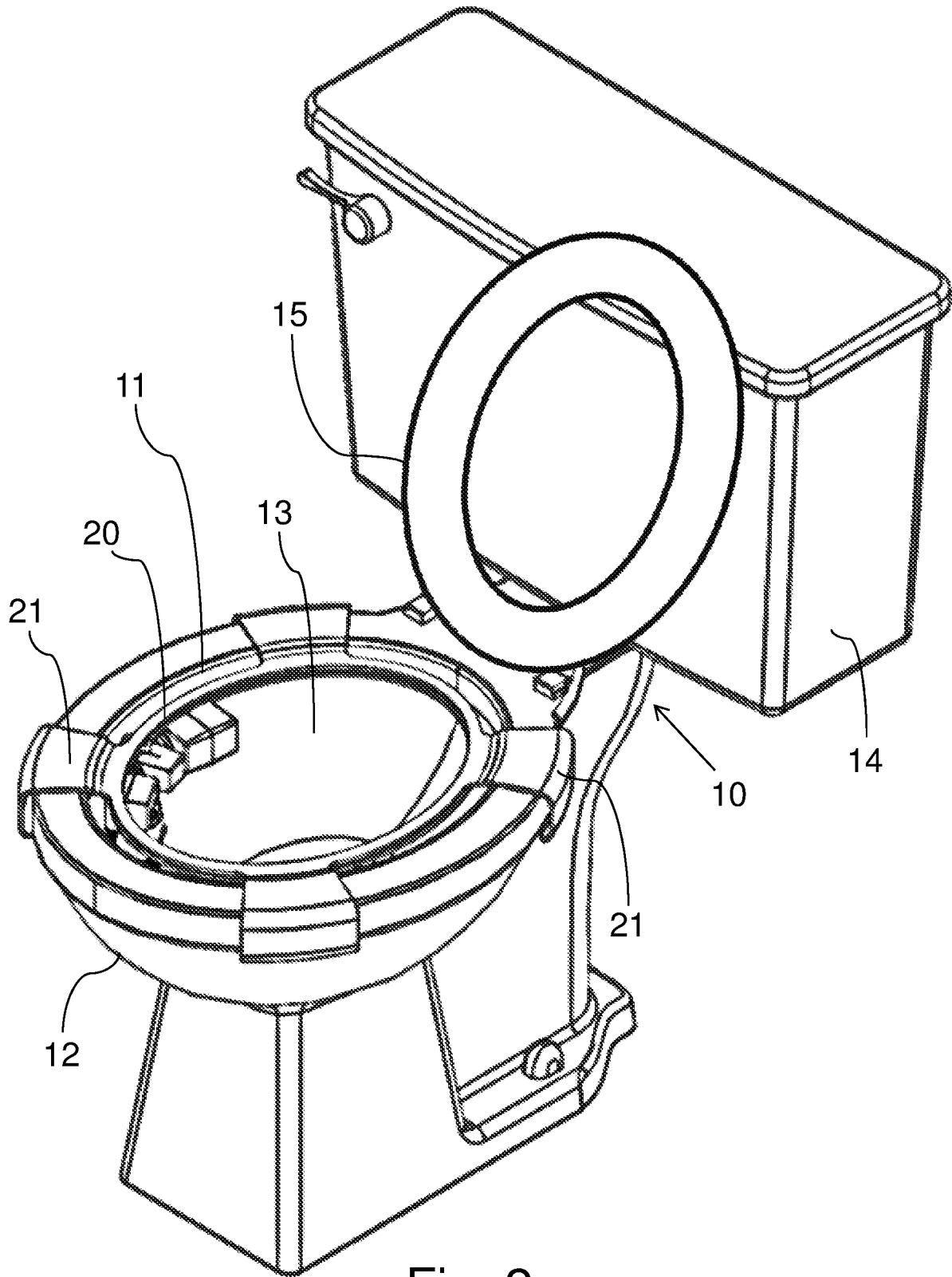


Fig. 2

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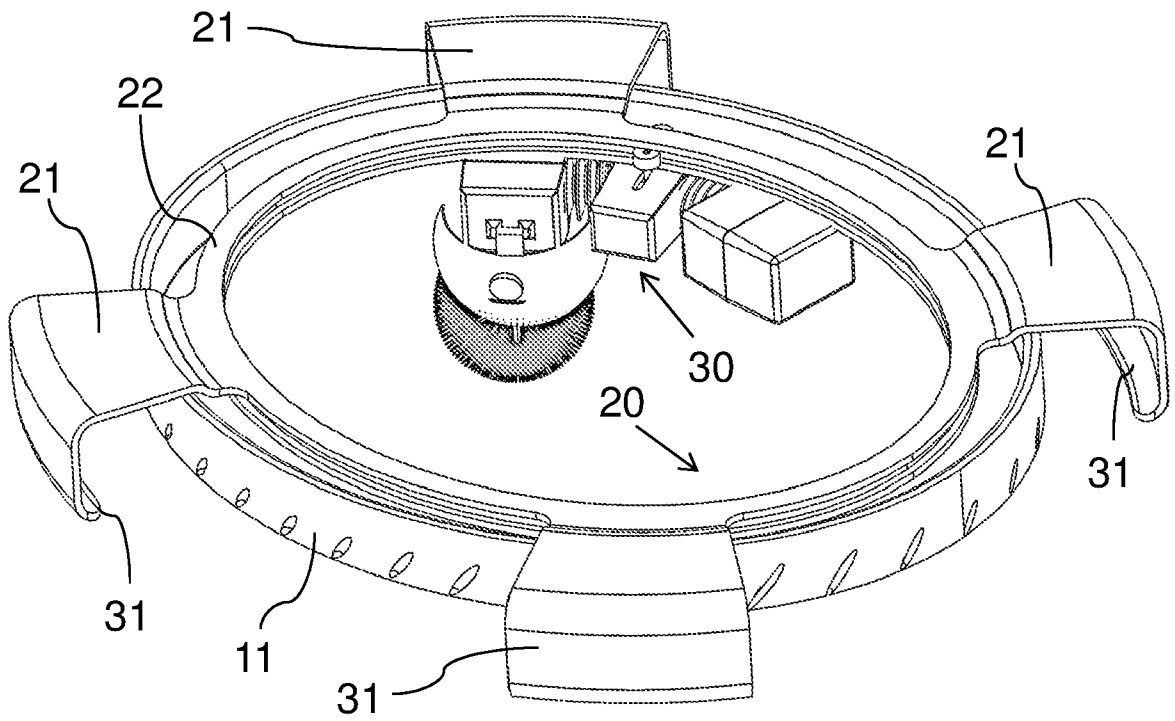


Fig. 3A

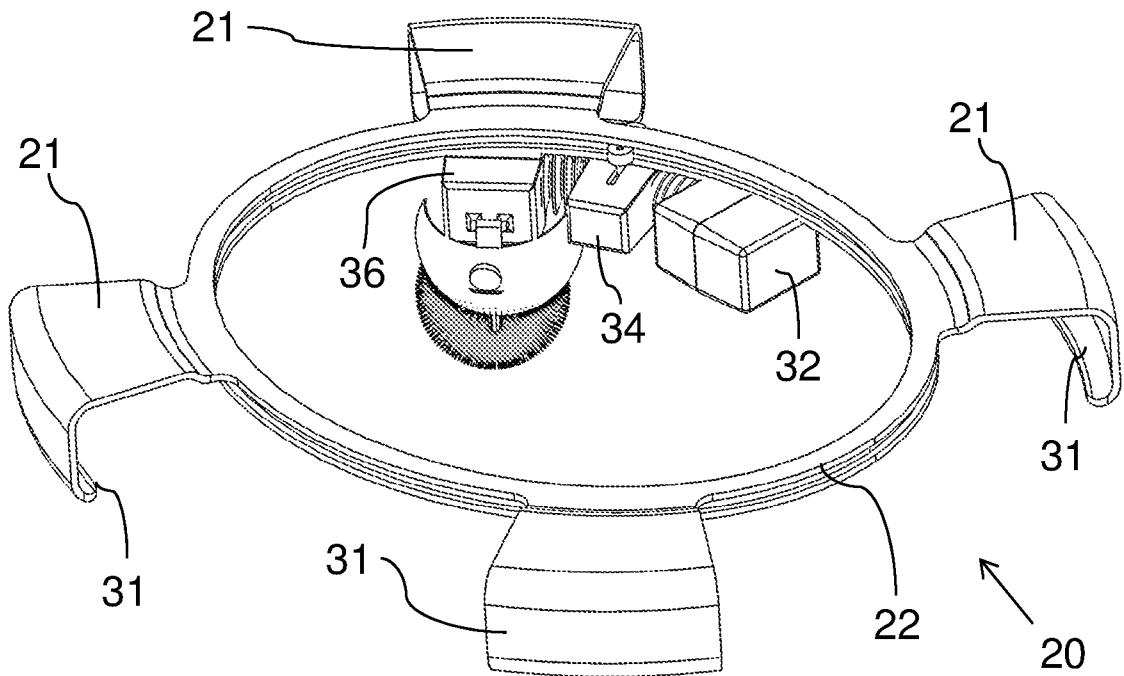


Fig. 3B

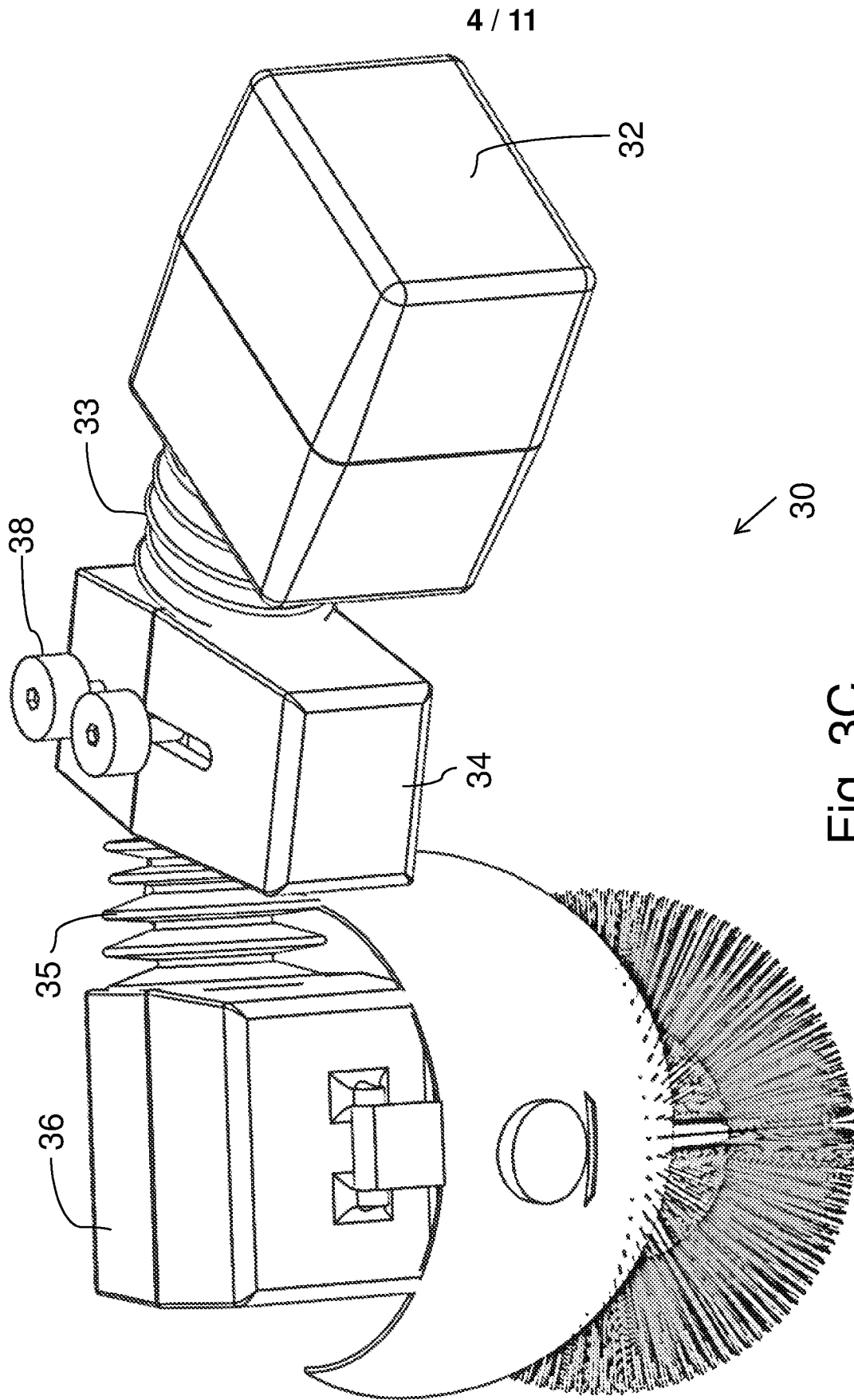


Fig. 3C

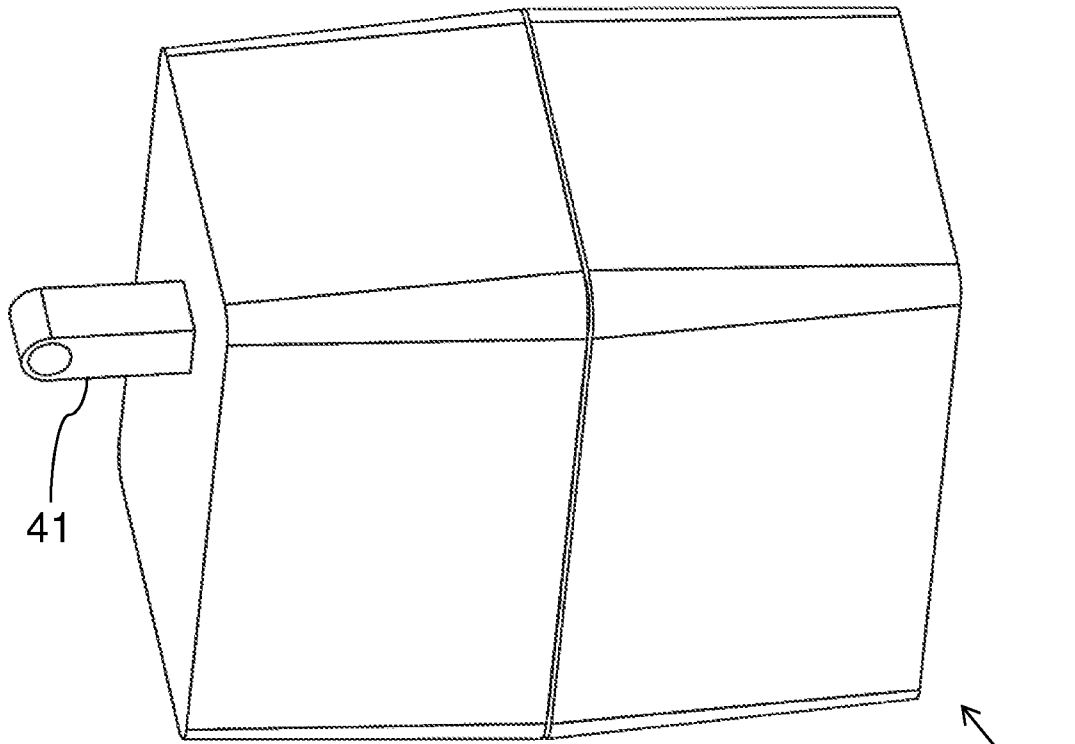


Fig. 4A

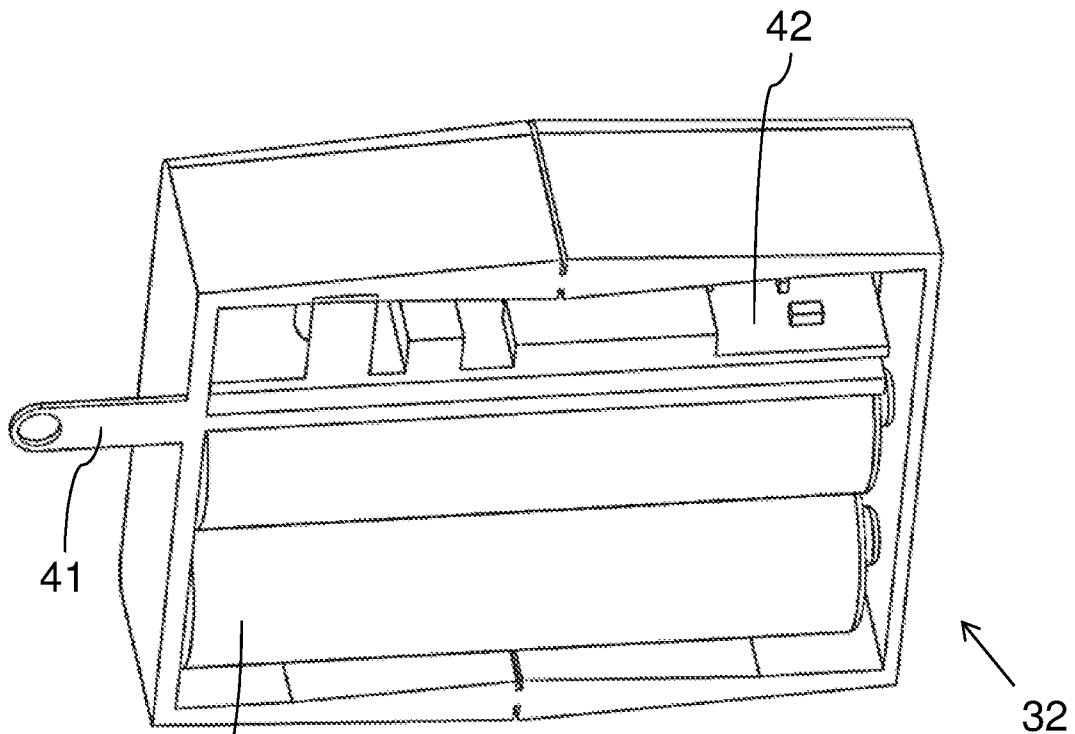


Fig. 4B

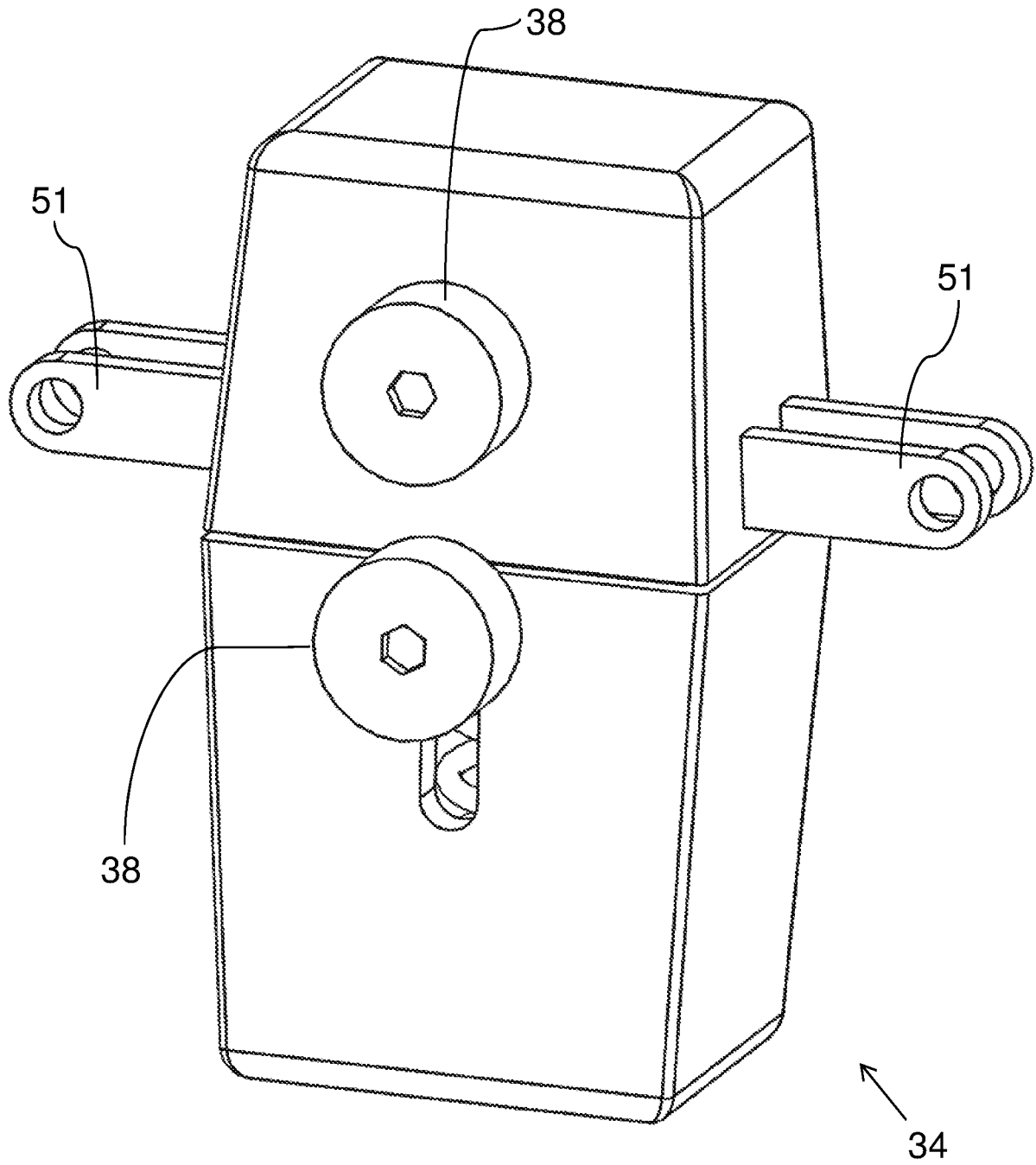
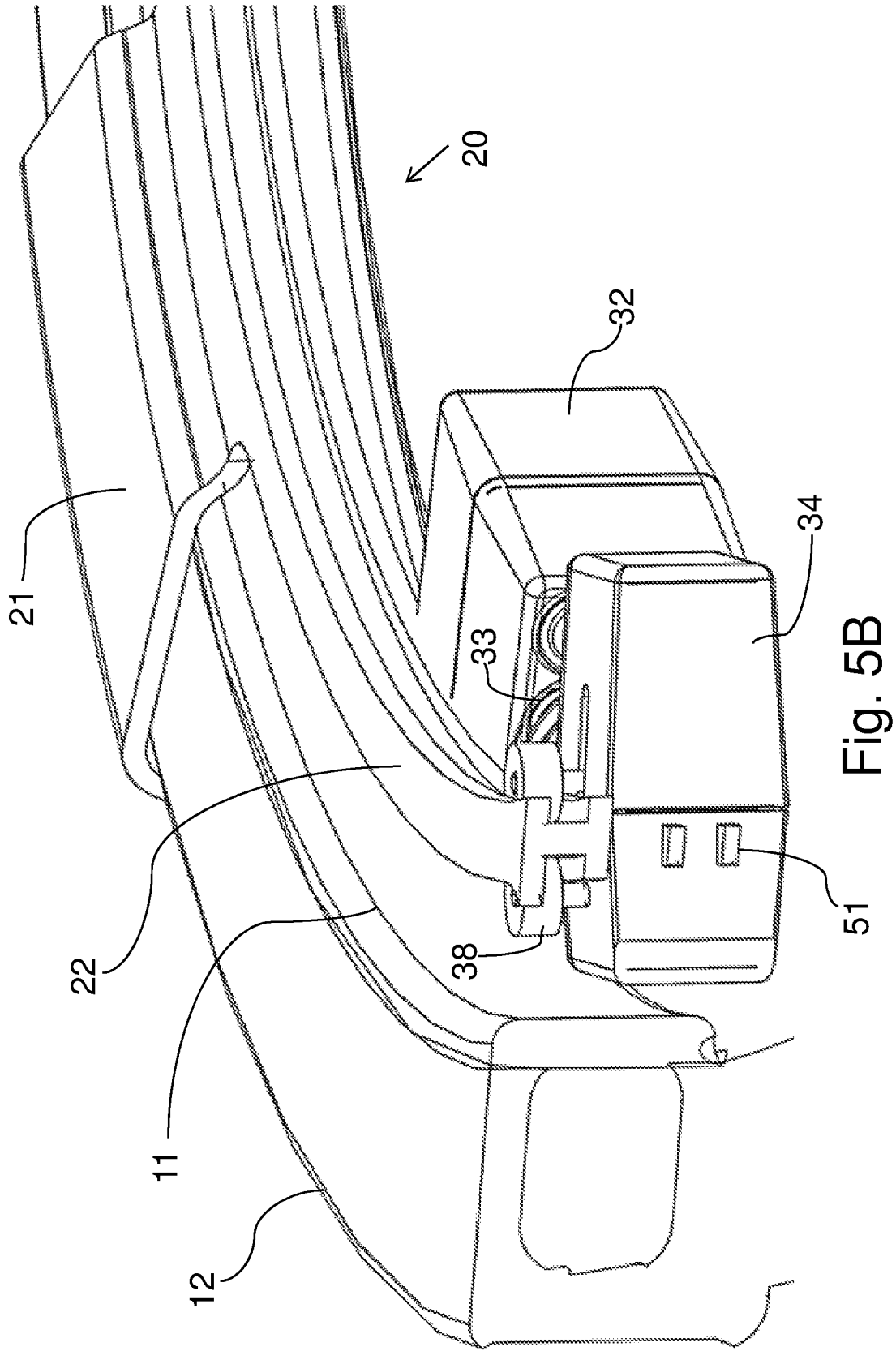


Fig. 5A



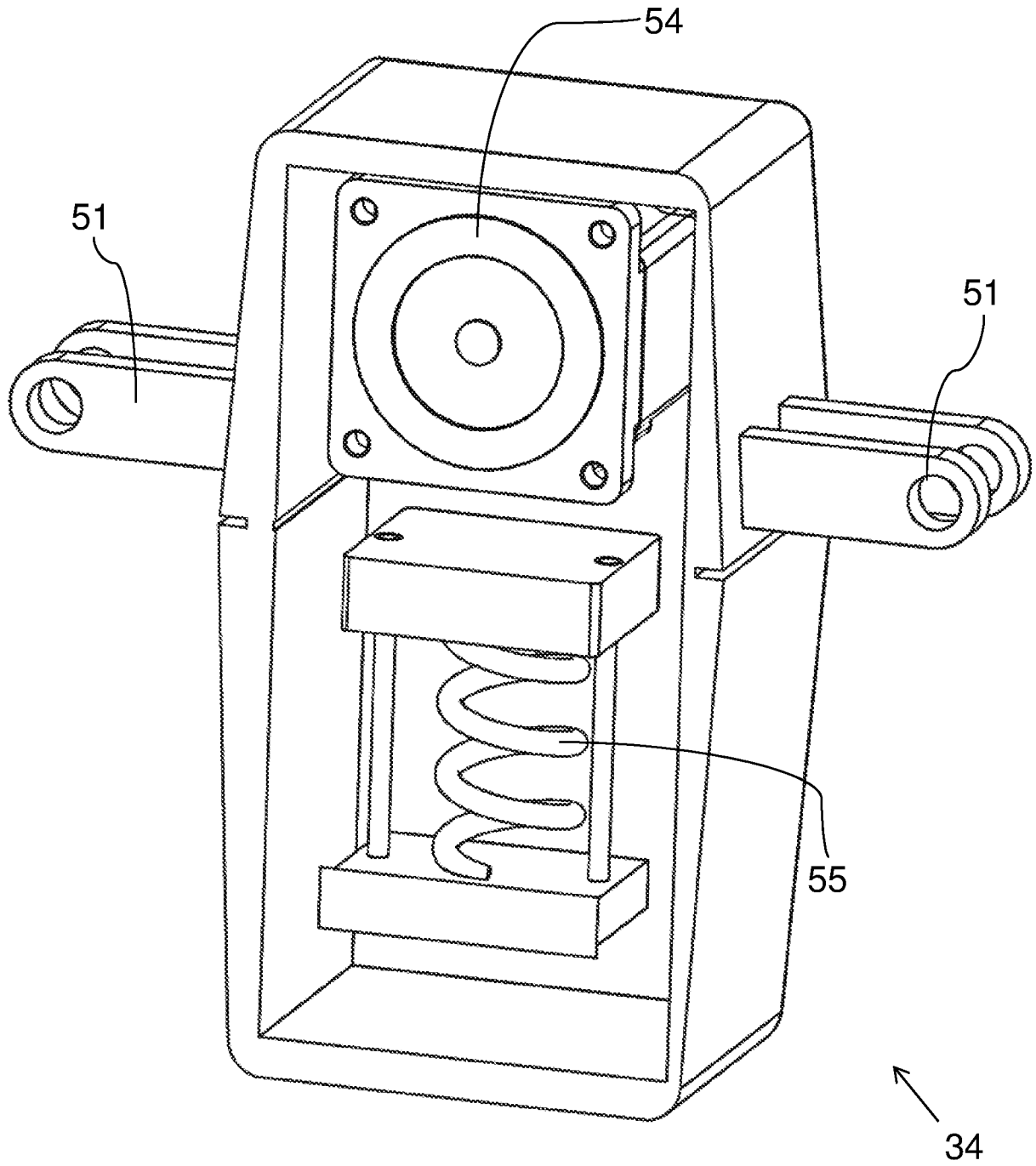


Fig. 5C

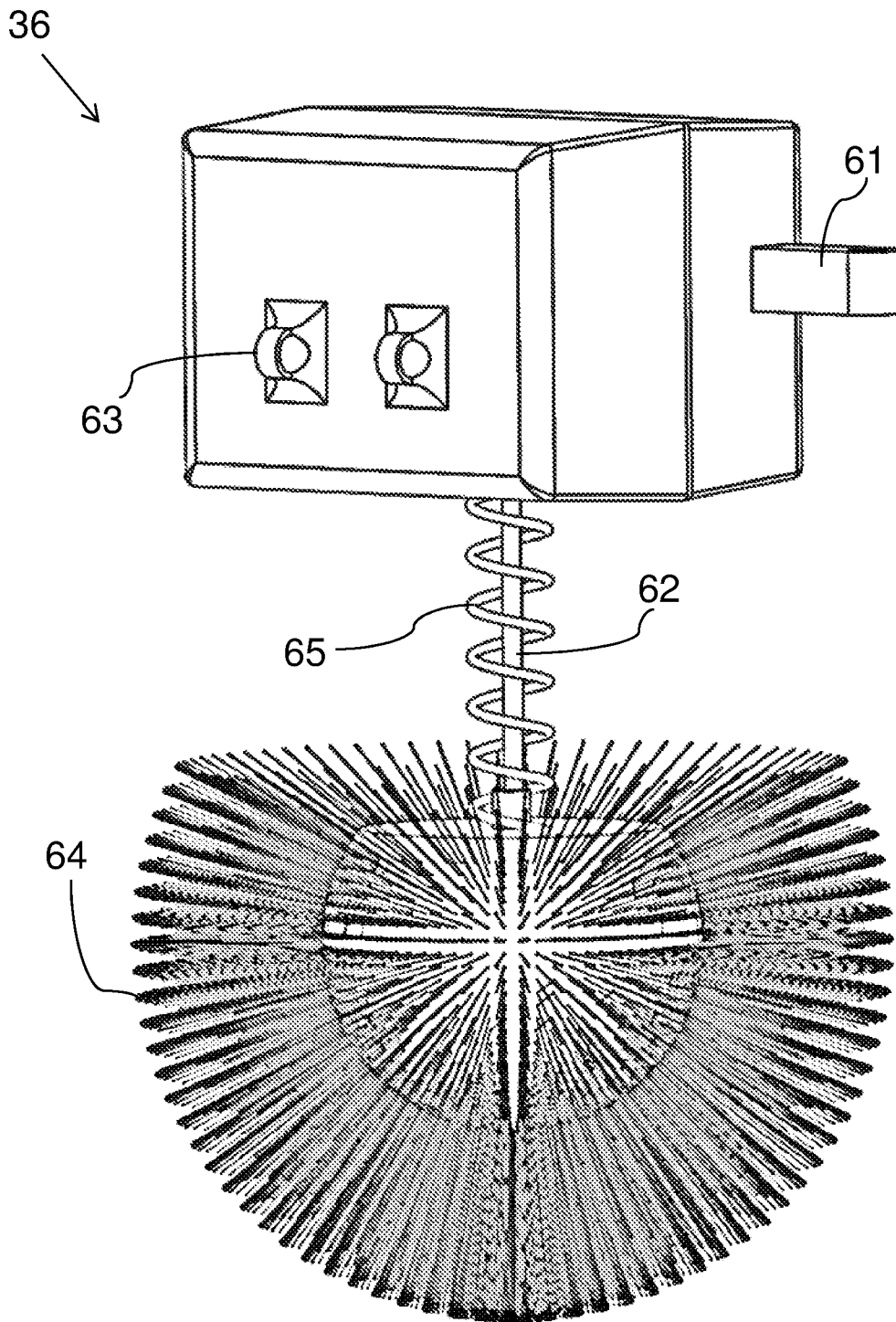


Fig. 6A

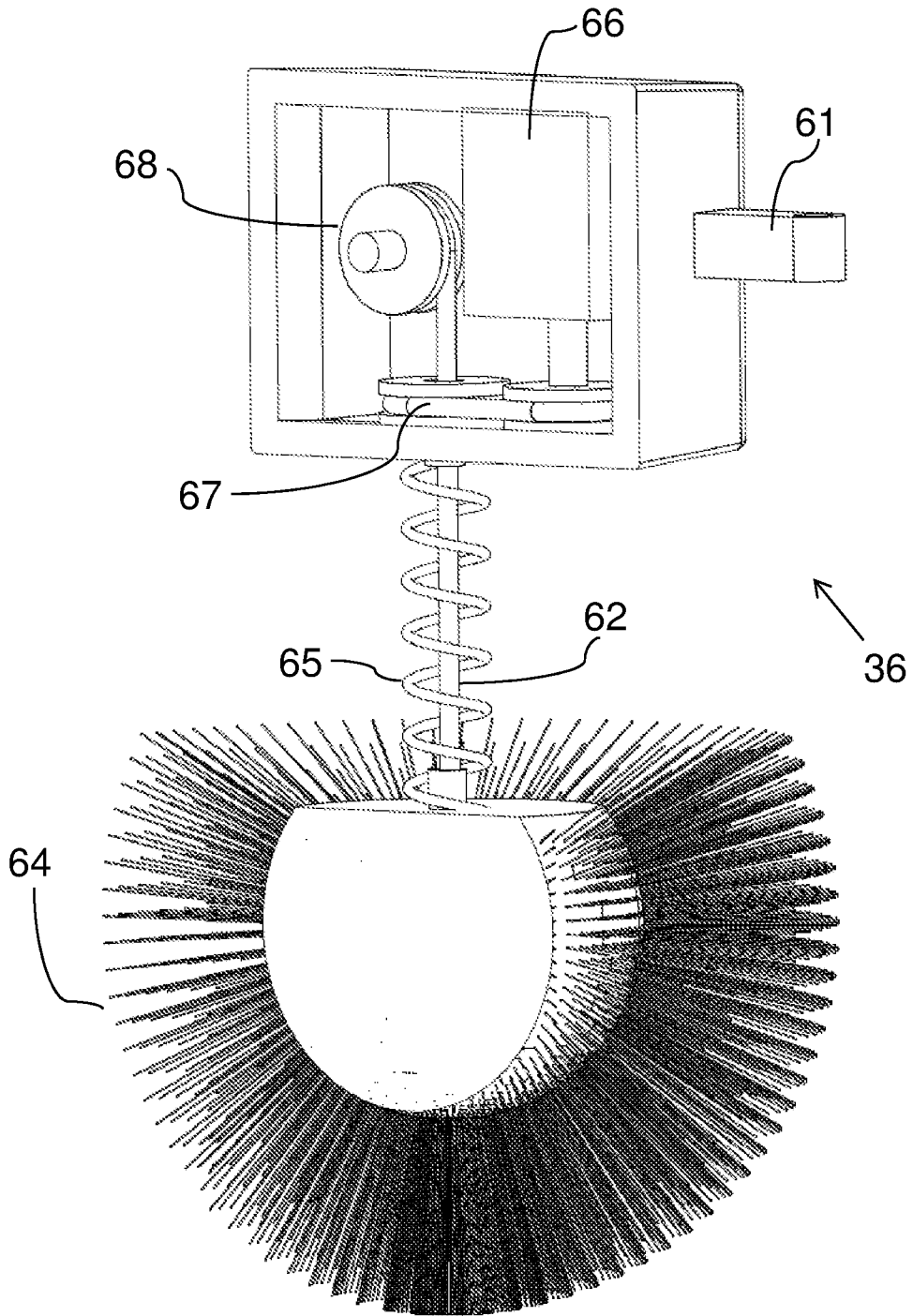


Fig. 6B

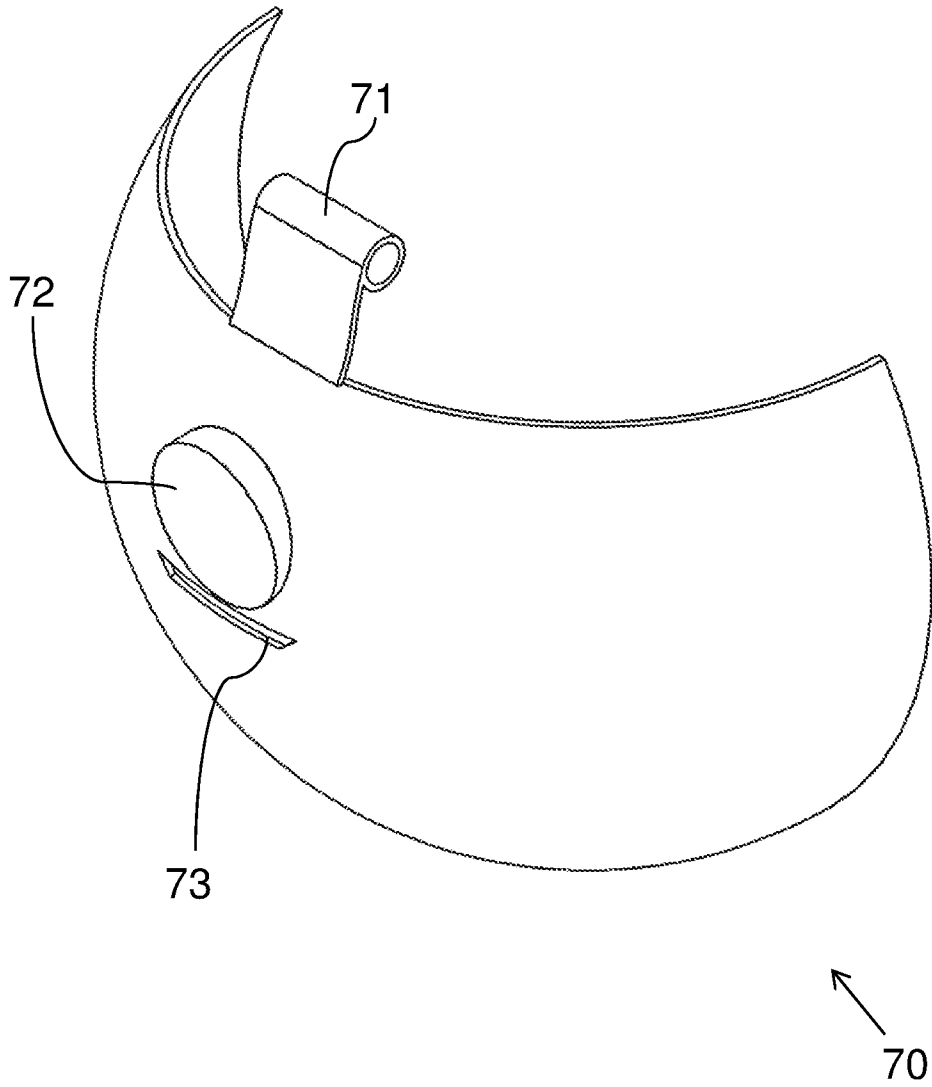


Fig. 7

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/IL2016/050636

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC(8) - E03D 9/00; A46B 13/02; E03D 9/02 (2016.01) CPC - E03D 9/002; A46B 13/02; A46B 2200/304; A47K 13/302 (2016.08) According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) IPC - A46B 13/02; E03D 9/00; E03D 9/02 CPC - A46B 13/02; A46B 2200/304; A47K 13/302; E03D 9/002 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched USPC - 4/223; 15/56; 15/246 (keyword delimited) Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) Patbase, Google Patents, Google, YouTube Search terms used: toilet, commode, water closet, bowl, rim, clip, grip, hook, hang, roller, wheel		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 4,978,447 A (HALL) 18 December 1990 (18.12.1990) entire document	1, 3, 4 --- 2, 5, 17, 18
X --- Y	US 2014/0246052 A1 (QUALLS) 04 September 2014 (04.09.2014) entire document	19, 20 --- 5, 17, 18, 21
Y	US 2006/0137081 A1 (FERRARA et al) 29 June 2006 (29.06.2006) entire document	2
Y	US 3,837,018 A (HABERLE) 24 September 1974 (24.09.1974) entire document	21
A	US 2010/0257662 A1 (HUANG) 14 October 2010 (14.10.2010) entire document	1-5, 17-21
A	US 2014/0137357 A1 (RALEA) 22 May 2014 (22.05.2014) entire document	1-5, 17-21
A	US 2009/0044322 A1 (NUNEZ et al.) 19 February 2009 (19.02.2009) entire document	1-5, 17-21
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "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 27 September 2016		Date of mailing of the international search report <b>28 OCT 2016</b>
Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300		Authorized officer Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

**INTERNATIONAL SEARCH REPORT**

International application No.

PCT/IL2016/050636

**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
3.  Claims Nos.: 6-16, 22, 23  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2.  As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
  
4.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.