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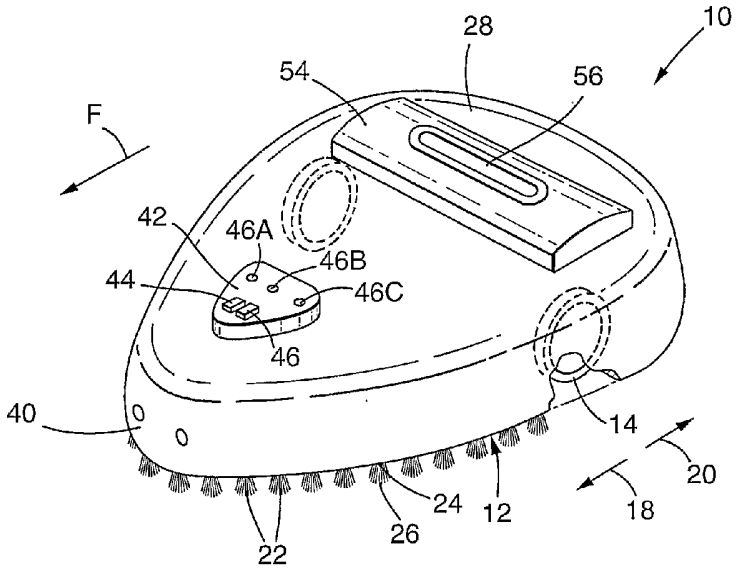

(57) Abstract: An autonomous robot (10) for cleaning of a flooring surface particularly for the mopping of a floor surface which robot comprises: a chassis (12) bearing a pair of drive wheels (14, 16) which may be independently operated said chassis having a forward portion (18) of the drive wheels and a rearward portion (20) of the two drive wheels housing (28),a power source (30),a controller interface (42) having one or more user controllable interface elements for modifying the operative characteristics of the robot, a control means (32) for controlling the operative characteristics of the robot, and a user replaceable cartridge (48)which is insertable within a portion of the robot, which cartridge comprises a fluid reservoir and a floor treatment means.

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AUTONOMOUS ROBOT FOR THE CLEANING OF A FLOORING SURFACE

The present invention relates to robotic devices. More particularly the present invention relates to improvements in robotic devices which are used in the treatment of flooring surfaces, especially those used in the cleaning of hard flooring surfaces.

In the past several years, there have been developed various forms of robots which are typically customized to accomplish a variety of specialized tasks, including, inter alia, security robots, robots used in performing one or more functions in manufacturing operations for articles of commerce, lawnmowing robots, vacuuming robots, robots useful in the cleaning of pools, as well as in cleaning of surfaces including household surfaces, including robots used to vacuum flooring surfaces.

Cleaning of flooring surfaces is a chore which is desirably avoided by a large number of consumers. The prior art is replete with various devices which have been proposed in order to alleviate this chore and to minimize the amount of time and/or effort required by persons involved in such a floor cleaning operation. Examples of such devices include, inter alia, mops, brooms, and floor cleaning articles with user removeable and replaceable pads or wipes. Also known are powered devices, such as electrically powered cleaning and/or polishing apparatus which are useful in the cleaning of hard flooring surfaces. While such devices have advantageous properties and may provide a good cleaning benefit, they nonetheless require constant control by a human operator, viz., consumer, in order to provide a cleaning function.

Relatively recently the art has provided a number of robotic devices which are adapted to the cleaning of various flooring surfaces. A number of these devices are directed to the cleaning of porous flooring surfaces particularly carpeted flooring surfaces which devices operate generally autonomously and will sweep and/or vacuum a carpeted flooring surface once their operation is initiated. A further number of such devices are directed to the cleaning of hard flooring surfaces, e.g., hardwood flooring, linoleum sheet flooring, tile flooring, ceramic tile flooring surfaces. Such devices are typically self-

contained units which comprise a drive means, a power supply source, and a cleaning means which is used in the treatment of the hard flooring surface. Also, all but the most rudimentary devices will also include a controller means which may include one or more sensors which are used to control the movement of the device across the flooring surface being cleaned.

While many such robotic devices are known to the art and are described in the patent literature, there remains a real need for further improvements in such robotic devices. It is to such a need and to such improvements that the present invention is directed.

In a first aspect of the invention there is provided an improved autonomous robot for the cleaning of a flooring surface, particularly for the mopping of a floor surface which robot comprises: a chassis bearing a pair of drive wheels which may be independently operated, said chassis having a forward portion forward of the drive wheels, and a rearward portion rearward of the two drive wheels, a plurality of brush elements depending from a forward portion of the chassis, a housing, a power source, a controller interface having one or more user controllable interface elements for modifying the operative characteristics of the robot, a control means for controlling the operative characteristics of the robot, and a user replaceable cartridge which is insertable within a portion of the robot, which cartridge comprises a fluid reservoir and a floor treatment means.

In a second aspect of the invention there is provided an improved user replaceable cartridge which is insertable within a portion of an autonomous robot for the cleaning of a flooring surface, which cartridge comprises a fluid reservoir and a floor treatment means useful in a floor cleaning robot.

In a third aspect of the invention there is provided a further embodiment of a user replaceable cartridge which is insertable within a portion of an autonomous robot for the cleaning of a flooring surface, which cartridge comprises a fluid reservoir and a floor treatment means useful in a floor cleaning robot.

In a fourth aspect of the invention there is provided a still further embodiment of a user replaceable cartridge which is insertable within a portion of an autonomous robot for

the cleaning of a flooring surface, which cartridge comprises a fluid reservoir and a floor treatment means useful in a floor cleaning robot.

In a fifth aspect of the invention there is provided a yet further embodiment of a user replaceable cartridge which is insertable within a portion of an autonomous robot for the cleaning of a flooring surface, which cartridge comprises a fluid reservoir and a floor treatment means useful in a floor cleaning robot.

According to a sixth aspect of the invention there is provided a user replaceable cartridge adapted to be removably insertable within a portion of the robot, which cartridge comprises a compressible fluid reservoir, and optionally further comprises a floor treatment means.

According to a seventh aspect of the invention there is provided a improved autonomous robot for the cleaning of a flooring surface according to the first aspect of the invention which further comprises a standoff means.

According to a further aspect of the invention there is provided a method of treating a flooring surfaces by use of the robot as described herein.

According to particularly preferred embodiments, the robot of the invention operates autonomously and requires no user input during treatment of the flooring surface.

These and other aspects of the invention are better understood with reference to the following specification and drawings, in which:

Fig. 1 is a perspective view of a preferred embodiment of a robot according to the first inventive aspect.

Figure 2 is a side view of the robot according to the first aspect of the invention.

Figure 3 is partial skeletal view of the robot according to Figs. 1 and 2.

Figure 4A is a partial skeletal, perspective view of a first embodiment of a user replaceable cartridge removably insertable within a portion of the robot, which cartridge comprises a fluid reservoir and a floor treatment means.

Figure 4B is a partial skeletal side view of an end of the cartridge of Fig. 4A.

Figure 5A is a partial skeletal end view of a second embodiment of a user replaceable cartridge removably insertable within a portion of the robot, which cartridge comprises a fluid reservoir and a floor treatment means.

Figure 5B is a partial skeletal end view of the second embodiment of the cartridge of Fig. 5A.

Figure 6A is a partial skeletal end view of a third embodiment of a user replaceable cartridge removably insertable within a portion of the robot, which cartridge comprises a fluid reservoir and a floor treatment means.

Figure 6B is a detail view of a portion of the cartridge of Fig. 6A.

Figure 7A is a partial skeletal end view of a fourth embodiment of a user replaceable cartridge removably insertable within a portion of the robot, which cartridge comprises a fluid reservoir and a floor treatment means.

Figure 7B is a detail view of a portion of the cartridge of Fig. 7A.

Figure 7C is a detail view of a portion of the cartridge of Fig. 7A.

Figure 8A is a partial skeletal view of a compressible fluid reservoir according to a preferred embodiment of the invention.

Figure 8B is a partial skeletal view of a compressible fluid reservoir according to Figure 8A.

Figure 9 is a partial skeletal view of a further compressible fluid reservoir according to a further preferred embodiment of the invention.

Figure 10 is a partial skeletal view of a yet further compressible fluid reservoir according to a further preferred embodiment of the invention.

Figure 11 is a partial skeletal view of a compressible fluid reservoir according to a yet further preferred embodiment of the invention.

Figure 12A is a view of a part of the compressible fluid reservoir generally in accordance with Fig. 11.

Figure 12B is a view of a part of the compressible fluid reservoir generally in accordance with Fig. 11.

Figure 13 is a partial skeletal view of a further compressible fluid reservoir according to a further preferred embodiment of the invention.

Figure 14 is a partial skeletal view of a robot according to Figs. 1 and 2, further comprising a first embodiment of a standoff means.

Figure 15 is a side view of a robot according to Figs. 1 and 2, further comprising a second embodiment of a standoff means.

It is believed that the present invention will be better understood from the following description of preferred embodiments, taken in conjunction with the accompanying drawings, in which like reference numerals identify identical elements and wherein:

With reference now to the figures, Fig. 1 is a perspective view of a first preferred embodiment of a robot 10 according to the present invention. The robot includes a chassis 12 bearing a pair of drive wheels 14, 16 which may be independently operated from one another. The chassis may be divided into two portions, a forward portion 18 forward of the drive wheels, particularly forward of the axle 14A, 16A of the each of the drive wheels 14, 16 and a rearward portion 20 rearward of the two drive wheels 14, 16, particularly rearward of the axle 14A, 16A of each of the drive wheels. Depending from the chassis 12 is a plurality of brush elements 22 which depend from a part of the forward portion 18 of the chassis 12. Desirably the brush elements 22 are individual tufts comprising a plurality of bristles each tuft having a tuft base 24 mounted in chassis 12, and terminating at individual bristle ends 26 which are adapted to contact and brush a flooring surface. The robot 10 further comprises a housing 28 which is configured to encase one or more of the parts or elements used to construct the robot 10. The housing may be of any configuration. The robot 10 further includes a power source 30, a controller interface 42 having one or more user controllable interface elements for modifying the operative characteristics of the robot, a control means 32 for controlling the operative characteristics of the robot, and a user replaceable cartridge 48 which is insertable within a portion of the robot, which cartridge comprises a fluid reservoir and a floor treatment means.

The power source 30 mounted within the interior of the housing 28 which provides a power source used to power the robot 10 during autonomous operation may be any of a variety of known-art devices which are used to store energy particularly electrical energy such as one or more batteries. Although the power source 30 may be composed of non-replenishable batteries, advantageously the power source 30 comprises one or more rechargeable batteries. While not shown in the figures, desirably the power source 30 may be replenished without necessitating the removal from the robot 10 and conveniently such may be accomplished by providing a receptacle or port which may be

used to supply an electrical current to the power source 30 from an outside source which electrical current is used to recharge the batteries. Alternately the power source 30 my be operated from, or replenished by one or more solar cells which generate an electrical current when exposed to a light source.

The robot 10 further comprises a control means 32 for controlling the operative characteristics of the robot. The control means 32 may be any device, assembly or circuit which is capable of receiving at least one input signal which provides information indicative of at least one environmental condition of the robot 10, and responsive thereto, is capable of transmitting at least one output control signal which capable of controlling the operation of one or both of the motors 34, 36 which are used to drive their respective wheels 14, 16. Of course the control means 32 may be capable of receiving a plurality of input signals as well as being capable of transmitting a plurality of output control signals as well; for example the control means 32 may be capable of receiving a plurality of input signals such as from an a sensor means 38, as well as the instantaneous current load upon one or both of the motors 34, 36, both of which provide information indicative of environmental conditions of the robot 10. For example, the sensor means 38 may be a sensor which detects the distance between the sensor affixed upon or within the robot 10 and the flooring surface at a point adjacent to the nose 40 of the robot 10. Such a sensor 38 can determine if there is a sudden distance differential adjacent to the nose 40 of the robot 10 and when detected provide a signal or response to the control means 32 indicative of such an environmental condition. Such a sudden distance differential adjacent to the nose 40 may occur, for example, when the nose 40 of the robot 10 sensed a vertical discontinuity in the flooring surface upon which the robot operates 10. One such form of vertical discontinuity which is termed to be a "negative vertical discontinuity" is where the nose 40 of the robot 10 reaches a point adjacent to or extending over the edge or margin of a flooring surface, e.g, such as at the margin of a downward stair or step. When such an environmental condition is sensed, a signal or response is detected by the control means 32 which may in turn modify the operation of one or both of the motors 34, 36 such as to cause the robot 10 to halt, move rearwardly or move in a different direction so to avoid the possibility of falling over the edge of the flooring surface or step and into the negative vertical discontinuity. Such a sensor 38

may be also capable of sensing the presence of other forms of vertical discontinuities such as upward vertical irregularities in the flooring surface, as well as the presence of upwardly depending elements extending from or resting upon the flooring surface. Such are termed as "positive vertical discontinuities". An example of a positive vertical discontinuity is an upward irregularity in the flooring surface such as a boundary region between a first flooring surface such as a hard flooring surface and an adjacent or adjoining second flooring surface which is higher than that of the first flooring surface, e.g, a carpeted surface, or a threshold in a doorway between adjacent rooms. When then nose 40 of the robot 10 encounters such a boundary region the nose 40 may be to forced to move or tip upwardly, away from the flooring surface, thus increasing the distance between the sensor 38 and the flooring surface. Such an environmental condition would sensed by the sensor 38 as a sudden distance differential adjacent to the nose 40 and a signal or response is detected by the control means 32 which may in turn modify the operation of one or both of the motors 34, 36 such as to cause the robot 10 to halt, move rearwardly or move in a different direction so to avoid the boundary region. Similarly when the nose 40 of the robot 10 is proximate to other upwardly depending elements extending from or resting upon the flooring surface, e.g., in the case of the former a wall or door, in the case of the latter, e.g., a piece of furniture or part thereof such as a leg resting upon a flooring surface, the sensor 38 would detect such an environmental condition and a signal or response is detected by the control means 32 which may in turn modify the operation of one or both of the motors 34, 36 such as to cause the robot 10 to halt, move rearwardly or move in a different direction so to avoid such positive vertical discontinuities.

The sensor 38 may be any device, circuit or apparatus which is capable of detecting environmental conditions as described herein, and may by optical, mechanical, opto-mechanical, ultrasonic, or other sensors operating on other principles. The sensor 38 as described herein is to be understood as not only encompassing a sensor device, but to also encompass any supporting or ancillary power supply, circuitry, etc. which may be necessary in order to provide a working sensor device capable of transmitting a signal or other information indicative of an environmental condition to the control means 32, or

providing a signal or other information indicative of an environmental condition which may be read by the control means 32.

The control means 32 may also be capable of receiving other input signals such as sensing the instantaneous current load upon one or both of the motors 34, 36, which may be information indicative of environmental conditions of the robot 10. For example during the normal autonomous cleaning mode of the robot 10, the robot 10 may encounter a positive vertical displacement within the normally, generally planar flooring surface which is not sensed by one or more other sensors which may be present in the robot 10, which encounter may block or retard the motion of the robot 10, causing a sudden rise of current load of one or both of the motor 34, 36 which respond to the stoppage or drag of robot 10 by the positive vertical displacement. The control means 32, responding to such an environmental condition may cause the robot 10 to halt, move rearwardly or move in a different direction so to avoid the encountered positive vertical displacement. For example, during a turning step a portion of the robot 10 may contact or collide with a positive vertical displacement, e.g, a chair leg, a part of a furniture article, or a wall which physical contact stops the robot 10 or drags upon the robot 10 and retarding its motion. The sudden rise of current load of one or both of the motor 34, 36 may be sensed by the control means 32 which responding thereto may output one or more signals which alter the operation of the robot 10. Such a form of feedback-response permits for the production of a robot 10 which requires no external sensors such as sensor 38, but which still may be used in a robot 10 to provide a degree of object avoidance during an autonomous cleaning operation.

In preferred embodiments, the control means 32 include a central processing unit or other processing unit, and a memory means which is capable of storing information.

The robot 10 includes a controller interface 42 having one or more user controllable interface elements, e.g., switches 44, 46 for modifying the operative characteristics of the robot. In the illustrated preferred embodiment, the controller interface 42 includes a panel portion of the housing 28 having mounted therein a pair of electrical switches 44, 46 and a plurality of indicator lights 46A, 46B, and 46C. Preferably at least one switch is present on the controller interface 42 which permits the user to engage or disengage the operation of the robot 10, which any remaining switches

46 present may be used to alter or establish other operational characteristics of the robot 10. For example the presence or absence of any audible sound effects, or the presence or absence of an on-board light, or the rate of delivery of a liquid floor treatment composition during the autonomous operation of the robot 10 may be established.

Transmission of electrical signals, as well as transmission of electrical power is accomplished via conventional current conductors 'w', e.g., wires or leads as may be present within or upon a circuit board, and any means effective in transmitting such signals or power are contemplated to be useful in conjunction with the present invention.

The robot 10 also includes a user replaceable cartridge 48 which is insertable within a portion of the robot, which cartridge 48 comprises a fluid reservoir 50 and a floor treatment means 52. In the embodiment depicted, the cartridge 48 is insertable beneath a cover 54 which engages a part of the housing 28 or which alternately may be a part of the user replaceable cartridge 48. The cover 54 may include a grip portion 56 adapted to facilitate the grasping and insertion and/or removal of the cartridge 48 by a user of the robot 10. The cartridge 48 is an assembly which includes a casing 58 which contains the fluid reservoir 50 which is connected via an intermediate fluid conduit 60 to a fluid manifold 64, optionally via an intermediate pump 62 which is used to withdraw and/or meter the amount of fluid delivered to the fluid manifold 64 and ultimately to the flooring surface being treated using the robot 10. The fluid conduit 60 may be included as part of the cartridge 48 or may form a part of the robot 10 when the cartridge 48 is removed or is otherwise absent from the robot 10. The cartridge 48 also includes a floor treatment means 52 here in the form of a continuous web of a fibrous material which is used to contact the flooring surface. The fibrous material may optionally be absorbent or adsorbent. The continuous web of the fibrous material has two opposite ends, each of one end mounted upon a spool 52A, 52B to form a scroll configuration. Initially as a new cartridge 48 is installed into the robot 10 most of the web of fibrous material is wound upon one spool, but during the autonomous cleaning operation of the robot 10, the spools 52A, 52B turn or are caused to turn thereby causing transfer from the first spool to the second spool. Thereby during the autonomous cleaning operation of the robot 10 clean fibrous material is paid out and transported to the second spool at a constant rate or at periodic intervals, during which cleaning operation at least a part of the surface of the

fibrous material contacts the flooring surface being cleaned or otherwise treated. The transport of the fibrous material between the first and second spool ensures that the portion of the fibrous material is changed, and any dirt or other matter which is contacted and entrained by the fibrous material is drawn up and away from the flooring surface and is physically entrapped in the laminar layers of the fibrous material collected on the second, or take-up spool.

During the autonomous cleaning operation the robot 10 periodically or continuously dispenses a quantity of a floor treatment composition which is a liquid composition via one or more openings on the fluid manifold 64, preferably directly onto the flooring surface and in the near proximity but forward of the portion of the fibrous material which contacts the flooring surface. In such a manner a floor treatment composition, inter alia, a cleaning liquid composition, a disinfecting liquid composition, a cleaning and disinfecting liquid composition, a floor polishing composition, a floor waxing composition, a floor-wax stripping composition, may be dispensed during a floor treatment operation, preferably directly to the flooring surface beneath the fluid manifold 64 then present under the robot 10. While the fluid manifold 64 is depicted in the figures as a fluid conduit having a plurality of holes or orifices through which the floor treatment composition may be dispensed, it is to be understood that according to certain preferred embodiments that the fluid manifold 64 may comprise one or more, preferably two or more nozzles or orifices through which the floor treatment composition is dispensed. Such nozzles include spray nozzles which will provide to the dispensed floor treatment composition a circular, semi-circular, or elliptical spray pattern onto the flooring surface proximate to such spray nozzles.

The dispensing of, and the rate of dispensing of the continuous web of the fibrous material may controlled by the controller means 32 or alternately may be dispensed independently of the controller means. In the case of the latter the robot 10 may include, e.g., a mechanical drive means (not shown) which operates from an electric motor, or which my be driven via mechanical means such as being driven from a rotating shaft or axle, such as may already be present, e.g., from an axle 14A, 16A or from one or both of the motors 34, 36. Such means may be removably engageable directly with the continuous web of fibrous material, such via the spool upon which it is wound, or

alternately via a gear or other element which is engageable with a mechanical drive means which may form part of the robot, or part of a user replaceable cartridge or form parts of both. Similarly the dispensing of, and the rate of dispensing of the liquid composition may be controlled by the controller means 32 or alternately may be dispensed independently of the controller means 32. For example, where an intermediate pump 62 is present, then the controller means 32 may provide a control signal to the pump 62 to operate. Alternately, when present, the intermediate pump may operate independently of the controller means 32 and be controlled or driven via driven via mechanical means such as being driven from a rotating shaft or axle, such as may already be present, e.g., from an axle 14A, 16A or from one or both of the motors 34, 36. Where an intermediate pump is not present, and the floor treatment composition is provided in a pressurized a fluid reservoir 50, such as an aerosol container or canister, release means (not shown) may be present in order to permit the contents of the fluid reservoir 50 to be dispensed into the intermediate fluid conduit 60 to a fluid manifold 64.

The fluid reservoir 50 may take any of a variety of forms, it only being required that it be capable of containing and dispensing the floor treatment composition. In one simple form the fluid reservoir 50 is a pouch or sac which is non-pressurized, and which contains a quantity of the floor treatment composition. Such a pouch or sac may be flexible and deformable such that when it is subjected to an external, compressive force the floor treatment composition is expelled through an orifice or valve which may also be present. Alternately the non-pressurized pouch or sac need not be pressurized in order to dispense its contents but rather, gravity or the use of a pump associated with the intermediate fluid conduit 60 or fluid manifold 64 may be used to withdraw the floor treatment composition from within the fluid reservoir 50. The fluid reservoir 50 may also take the form of a rigid walled container, such as tank, canister or vessel, which contains a quantity of the floor treatment composition. The fluid reservoir 50 may also be a rigid walled container which contains within its interior a non-pressurized pouch or sac containing a quantity of the floor treatment composition. In such an embodiment, the walls of the container may be deformable or compressible which in turn causes the non-pressurized pouch or sac to compress the quantity of the floor treatment composition which can be dispensed under pressure from the compressed rigid walled container. In

another embodiment of a rigid walled container which contains within its interior a non-pressurized pouch or sac containing a quantity of the floor treatment composition there is also included a member or element of the rigid walled container which, when moved relative to the rigid-walled container causes the pressurization of the non-pressurized pouch or sac. Still alternately the fluid reservoir 50 may be a pressurized container, such as an aerosol container which contains a quantity of the floor treatment composition and a conventional propellant. Each of the foregoing embodiments of the fluid reservoir 50 may also include an appropriate orifice, or dispensing valve as may be appropriate to the type of the fluid reservoir 50. It is also to be understood that yet other embodiments and formats of a fluid reservoir 50 may also be used in the robot 10, although not specifically elucidated herein.

In use, the user replaceable cartridge 48 is removably insertable within a portion of the robot, and may be used either a single time for a single cleaning operation, or it may be used for a plurality of cleaning operation before requiring replacement by the user. The cartridge 48 may be a single-use device, or it may be refilled with a new continuous web or with a further quantity of a floor treatment composition, or both, as may be necessary or desirable.

Figure 2 is a side view of the robot according to the first aspect of the invention. As therein depicted the robot 10 is seen to rest upon the wheel 14, and the bristle ends 26 of the plurality of brush elements 22 depending from part of the forward portion 18 of the chassis 12.

Figure 3 is partial skeletal view of the robot according to Figs. 1 and 2, showing more details of the interior of the robot and a preferred arrangement of the various components described previously.

Turning now to Figure 4A therein is depicted a partial skeletal, perspective view of a first embodiment of a user replaceable cartridge 48A removably insertable within a portion of the robot 10 which cartridge comprises a fluid reservoir 50 and a floor treatment means 52. The housing 28 includes two endwalls 11A, 110B, two sidewalls therebetween 112A, 112B and optionally but desirably a topwall 114 depending from the endwalls and sidewalls. Opposite from the topwall 114, the cartridge 48A is at least partially open in at least one or more regions 116 beneath the manifold 64 so as not to

obscure the dispensing of the floor treatment composition exiting the manifold 64 via one or more valves or orifices 65; here three spray orifices 65 are depicted providing a spray onto the flooring surface. The cartridge 48A is also at least partially open in a further region 118 wherein a portion of the floor treatment means 52 is exposed and is intended to come into contact with the flooring surface 124 being treated. Also provided in the cartridge 48A is a guide plate 120 which includes at least one, but preferably a plurality of guide ribs 122 which are dependent from the guide plate 120 and extend downwardly therefrom. In the embodiment depicted, there are provided a plurality of guide ribs 122. The guide ribs 122 to contact a portion of the face of the floor treatment means 52 opposite to the part of the floor treatment means 52 which contacts the flooring surface 124 being treated. While not essential, the guide ribs 122 are however preferably formed of a deformable resilient material such that when the robot 10 passes over any irregularity in the flooring surface 124 being treated, pressure from the guide ribs 122 will improve the contact of the floor treatment means 52 with the locus of the flooring surface 124 being treated. While not depicted, the guide plate 120 may exclude protruding elements such as the guide ribs 122 instead be formed of a resilient material which is deformable, such as any of a number of known elastomeric materials including particularly open-celled as well as closed-celled sponges at the like. Also, while not depicted the guide plate 120 and all elements thereof may be formed of a rigid, non-deformable material of construction. Such may be preferred in certain embodiments. Preferably however when the guide plate 120 and all elements thereof may be formed of a rigid, non-deformable material a degree of resilient behavior may nonetheless be provided by using a resilient member, such as a resilient compressible material, or spring member in any mounting arrangement between the guide plate 120 and one or more parts of the cartridge 48A.

The fluid reservoir 50 depicted in Fig. 4A is a pressurized container which is connected to the manifold 64 by an intermediate fluid conduit 60 which is an integral part of the manifold 64, both of which are included as elements of the cartridge 48A. It is to be understood however that the manifold 64 by an intermediate fluid conduit 60 need not necessarily form a part of the cartridge 48A, but may be permanent parts of the robot 10. It is to be understood that the fluid reservoir 50 may be other than the depicted

pressurized container, including one or more of the alternative embodiments discussed above.

Figure 4B is a partial skeletal side view of one end of the cartridge of Fig. 4A. As is visible from the figure, the cartridge 48A is at least partially open in a region 118 wherein a portion of the floor treatment means 52 is exposed and comes into contact with the flooring surface 124 being treated. The guide plate 120 includes a plurality of downwardly depending guide ribs 122 which contact a portion of the face of the floor treatment means 52 opposite to the part of the floor treatment means 52 which contacts the flooring surface 124 being treated.

Preferably the floor treatment means 52 is a continuous web of a material, especially a fibrous material but it is also contemplated that the floor treatment means 52 may be a pad or wipe. Exemplary useful materials useful for the floor treatment means 52 include fabric substrates which may include nonwoven or woven fabric substrates. Such fabrics are known commercially in this field, and can be resin bonded, hydroentanged, thermally bonded, meltblown, needlepunched or any combination of the former. Such fabric substrates may be a combination of wood pulp fibers and textile length synthetic fibers formed by well known dry-form or wet-lay processes. Synthetic fibers such as rayon, nylon, orlon and polyester as well as blends thereof can be employed. The wood pulp fibers advantageously comprise about 30 to about 60 percent by weight of the nonwoven fabric, preferably about 55 to about 60 percent by weight, the remainder being synthetic fibers. The wood pulp fibers provide for absorbency, abrasion and soil retention whereas the synthetic fibers provide for substrate strength and resiliency. Optionally the floor treatment means 52 may be preimpreganted with a floor treatment composition.

The floor treatment means 52 may also be a film forming material such as a water soluble polymer. Such self-supporting film substrates may be sandwiched between layers of fabric substrates and heat sealed to form a useful substrate. The free standing films can be extruded utilizing standard equipment to devolatilize the blend. Casting technology can be used to form and dry films, or optionally a liquid blend can be saturated into a carrier and then dried in a variety of known methods.

Figure 5A is a partial skeletal end view of a second embodiment of a user replaceable cartridge 48B removably insertable within a portion of the robot 10, which cartridge 48B comprises a fluid reservoir 50 and a floor treatment means 52. As is visible in the figure, the continuous web of the floor treatment means 52 passes in a scroll like manner during the autonomous cleaning operation of the robot 10 transferring the floor treatment means 52 from the first spool 52B to the second spool 52A caused by rotation of the spools 52A, 52B. Further visible are a pair of winged guide rollers 126, 128 which guide the floor treatment means 52. The winged guide rollers 126, 128 are illustrated in a first position in Fig. 5A, and are illustrated in a second position in Fig.5B. Each of the winged guide rollers 126 have at least one rib extending from the roller in a direction perpendicular to the central axis of their respective winged guide rollers 126; in the present figure, each of the winged guide rollers 126, 128 having a pair of ribs respectively 126A, 126B and 128A, 128B offset from one another by 180 degrees. Of course the particular configuration of the winged guide rollers 126, 128, placement, size and configuration of the ribs may be different than that depicted and still fall within the present inventive teaching. By way of non-limiting example each of the winged guide rollers 126, 128 may include elements of different shapes and configurations under than generally linear extending ribs as depicted such as wave-form ribs, a series of generally linear extending ribs which are interrupted in one or more places between the two ends of each of the winged guide rollers 126, 128, as well as one or more generally linear extending ribs which are generally rectangular or triangular in cross section but which are placed in a helical configuration about the periphery of the winged guide rollers 126, 128. During operation the winged guide rollers 126, 128 rotate, preferably at a uniform rotational speed about their respective axes either periodically during the operation of the robot 10, or continuously during the operation of the robot 10. As the winged guide rollers 126, 128 rotate, the portions of the continuous web of the floor treatment means 52 contacting each of the winged guide rollers 126, 128 is periodically contacted with the flooring surface 124 and subsequently drawn away from contact with the flooring surface. Such is for example more apparent from a comparison in Figures 5A, and 5B of the positioning of the continuous web of the floor treatment means 52 contacting winged guide roller 126 further in respect to the flooring surface 124. Due to such periodic

contact with the flooring surface, none of the portions of the continuous web of the floor treatment means 52 is in continuous contact with the flooring surface thereby avoiding a squeegeing effect, namely as portions of the continuous web of the floor treatment means 52 are periodically lifted off the flooring surface 124 while being transported to the first second spool 52A any stains or dirt loosened by the floor treatment composition applied forward of the floor treatment means 52 may be absorbed or adsorbed onto or into the floor treatment means 52 and not pushed or dragged over the flooring surface 124.

Figure 5B is a partial skeletal end view of the second embodiment of the cartridge of Fig. 5A wherein the winged guide rollers 126, 128 have rotated in a counterclockwise direction by 90 degrees from their prior position as depicted on Fig. 5A, illustrating that the portion of the floor treatment means 52 in the region of the first winged guide roller 126 is lifted off the flooring surface 124, while the portion of the floor treatment means 52 in the region of the second winged guide roller 126 contacts the flooring surface 124. While not depicted, it is readily foreseeable to a skilled artisan that when each of the winged guide rollers 126, 128 rotate a further 45 degrees in a counterclockwise direction from their positions depicted on Fig. 5B, that none of the floor treatment means 52 will be in contact with the flooring surface.

With reference to the embodiment of Figs. 5A, 5B it is to be understood that a three or more winged guide rollers may be included in the cartridge 48B. It is further to be understood that the rotational speed and rotational direction of each of the winged guide rollers 126, 128 may be independent of one another, although it is preferred that both rotate in the same direction, either clockwise or counterclockwise at the same rotational speed.

Figure 6A is a partial skeletal end view of a third embodiment of a user replaceable cartridge 48C adapted to be removably insertable within a portion of the robot, which cartridge comprises a fluid reservoir 50 and a floor treatment means 52. The cartridge includes a forward guide roller 130 and rear guide roller 132 positioned transverse to the floor treatment means 52. The forward guide roller 130 includes a resilient guide roller sidewall 131 which covers at least part of, but most preferably all of the exterior surface of the forward guide roller 130 which contacts the floor treatment means 52. The guide roller sidewall 131 is advantageously formed of a deformable

resilient material such that during a cleaning operation, when the robot 10 passes over any irregularity in the flooring surface 124 being treated, pressure from the resilient guide roller sidewall 131 will improve the contact of the floor treatment means 52 passing beneath guide roller sidewall 131 the with the locus of the flooring surface 124 being treated. Such provides improved cleaning efficacy of the flooring surface 124.

Figure 6B is a detail view of a portion of the cartridge of Fig. 6A, particularly the section of Figure 6A which is indicated by the region indicated as "E". As is clearly visible in Fig. 6B, the locus of the flooring surface 124 being treated by the floor treatment means 52 at that moment in time passing the forward guide roller 130 includes a small negative vertical discontinuity, specifically a trough 125 formed by the chamfered upper edges of adjacent planks of a wood flooring surface. As the robot 10 passes over this trough 125, the forward guide roller 130 and particularly its resilient guide roller sidewall 131 causes the floor treatment means 52, here a continuous web of a material to deflect downwardly into the trough 125 and thereby provide an improved cleaning effect thereto.

Figure 7A is a partial skeletal end view of a fourth embodiment of a user replaceable cartridge 48D removably insertable within a portion of the robot, which cartridge comprises a fluid reservoir 50 and a floor treatment means 52 in the form of a continuous web 52 passing from a first spool 52B to a second spool 52A. The cartridge 48D a forward guide roller 130 and rear guide roller 132 both positioned transverse to the floor treatment means 52. The forward guide roller 130 includes a multi-lobed resilient guide roller sidewall 133 which covers at least part of, but most preferably all of the exterior surface of the forward guide roller 130. As is seen in this end view, the resilient guide roller sidewall 133 includes a number of lobes, here depicted as resilient ribs extending outwardly and radially from the central axis of the forward guide roller 130. The resilient guide roller sidewall 133 is advantageously formed of a deformable resilient material such that during a cleaning operation, when the robot 10 passes over any irregularity in the flooring surface 124 being treated, pressure from the resilient guide roller sidewall 133 will improve the contact of the floor treatment means 52 passing beneath the resilient guide roller sidewall 133 and the locus of the flooring surface 124 being treated. Such provides improved cleaning efficacy of the flooring surface 124.

Figure 7B is a detail view of a portion of the cartridge of Fig. 7A, illustrating in more particular detail deformation of lobes 133B of the resilient guide roller sidewall 133 which improves the contact of the floor treatment means 52 passing beneath the forward guide roller 130 and the locus of the flooring surface 124 being treated.

Figure 7C is a detail view of a portion of the cartridge of Fig. 7A illustrating the in particular detail the deformation of several lobes 133B of the resilient guide roller sidewall 133 which improves the contact of the floor treatment means 52 passing beneath the forward guide roller 130 and the locus of the flooring surface 124 being treated. As is illustrated as the floor treatment means 52 passing beneath the forward guide roller 130 encounters a small vertical discontinuity, here a gap 125 containing a ceramic grout between two adjacent ceramic floor tiles forming a section of a flooring surface 124, several lobes 133B deform to approximate the opposite contour of the of the gap 125 and the section of the flooring surface 124, forcing the floor treatment means 52 into the gap 125. Such provides improved cleaning efficacy of the flooring surface 124.

The configuration of the resilient guide roller sidewall 133 according to the embodiment depicted in Figures 7A, 7B and 7C may be of a different shape and a different configuration than that disclosed, which illustrates a preferred embodiment. Preferably parts of, or lobes of a resilient guide roller sidewall 133 should be deformable both in a compressive manner, that is to say should be compressible towards the central axis of the forward guide roller 130 as well as in one or more directions radially about the central axis of the forward guide roller 130. Such properties are provided by the embodiment depicted in Figures 7A, 7B and 7C.

As noted above, most preferably the fluid reservoir 50 used in the robot, or forming part of a user replaceable cartridge 48 according to the invention is a compressible fluid reservoir 180.

Fig. 8A is a partial skeletal view of a compressible fluid reservoir 180 according to a preferred embodiment of the invention. The compressible fluid reservoir comprises a housing 182 which is preferably generally cylindrical in cross-section which includes an internal cavity 184 which includes at least one, here two are depicted, helical slots 182 passing through the housing wall 186. The housing 182 further contains a compressible sac 188 containing a quantity of a floor treatment composition, and a moveable base 190

having extending tabs 192 extending through the helical slots 182 and engaging guide channels 194 which are dimensioned to receive a portion of the extending tabs 192. The housing wall 186 also contains on a part of its outer surface a gear track 196 here depicted to be adjacent to the base of the housing wall 186 although the location of the gear track may be at another section of the housing wall 186 such as at the upper end thereof. Part of the gear track 196 is enmeshed with a drive gear 198 which may be driven by a motor 200 or alternately may be driven by other drive means available in the robot. The floor treatment composition contained in the sac 188 is dispensed from the compressible fluid reservoir 180 by causing the drive gear to rotate 198 which in turn drives the enmeshed gear track 196 and imparts rotation of the housing wall 186 of the housing 182; due to this rotation, the moveable base 190 is braked from rotation due to the extending tabs 192 engaged in the guide channels 194 and rather the moveable base 190 is forced upward within the housing 182 along the helical slots 182 thereby compressing the compressible sac 188 and causing the floor treatment composition out via the intermediate fluid conduit 60 to a fluid manifold 64 which may form part of the robot, or may form part of the cartridge.

Figure 8B is a partial skeletal view of a compressible fluid reservoir according to Fig. 7A, illustrating the moveable base 190 in a position displaced from that depicted on Fig. 7A, and with the sac 188 partially compressed.

Fig. 9 is a partial skeletal view of a further compressible fluid reservoir 210 according to a yet further preferred embodiment of the invention suitable for use in a cartridge 48. The compressible fluid reservoir 210 includes a pair of concentric generally cylindrical housings an outer housing 212 and an inner housing 214 which are rotatable with respect to one another. The inner housing 214 has a sidewall 216 comprising at least one helical slot 218 passing therethrough and defining a helical path between the base 220 and the top 222 of the inner housing 214. The inner housing further comprises a moveable base 190 having extending from a part therefrom at least one tab 192 extending therethrough. The inner housing also comprises a compressible sac 188 containing a quantity of a floor treatment composition. The inner housing 214 is affixed to, or incorporates a gear track 196, here at the base 220 which is enmeshed with a drive gear 198 which may be driven by a motor or by other drive means available in the robot. The

outer housing 212 encases at least a part of the inner housing 214 and includes at least one engaging guide channel 194 which is dimensioned to receive a portion of the tab 192. In the embodiment depicted the engaging guide channel 194 is depicted as passing through the sidewall 224 of the outer housing 212, although it is equally likely that the engaging guide channel 194 be present as a passage or channel within the outer housing 212 and not pass through the sidewall 224 as depicted in the following Figure 9. In the embodiment depicted in the present figure, the portion of the tab 192 extending from the moveable base 190 engages both the helical slot 218 and the engaging guide channel 194 and is thus visible to a user as an approximate indicator of the remaining quantity of the floor treatment composition still remaining in the compressible sac 188. In use, when the outer housing 212 is retained in a stationary position and the drive gear 198 is driven, the enmeshed gear track 196 causes the inner housing 214 to rotate with respect to the outer housing 212 which in turn causes the moveable base 190 to move in a direction which the compresses the compressible sac 188 and thereby causing the floor treatment composition out via the intermediate fluid conduit 60 to a fluid manifold 64 which may form part of the robot, or may form part of the cartridge. To facilitate such an operation the outer housing 212 may include parts or elements such as lobes 226 extending therefrom which may be used to engage the compressible fluid reservoir 210 in a device, such as a robot 10 or a cartridge 48 and retain it in a stationary position with respect to the 10 or cartridge 48.

Figure 10 is a partial skeletal view of a yet further compressible fluid reservoir 230 according a further preferred embodiment of the invention suitable for use in a cartridge 48. The compressible fluid reservoir 210 includes a pair of concentric generally cylindrical housings, an outer housing 212 and an inner housing 214 which are rotatable with respect to one another. The inner housing 214 has a sidewall 216 comprising at least one engaging guide channel 194 passing through the sidewall 216. The inner housing further comprises a moveable base 190 having extending therefrom at least one tab 192 extending through the engaging guide channel 194 and which also engages a part of channel 218. The inner housing also comprises a compressible sac 188 containing a quantity of a floor treatment composition. The outer housing 212 has a sidewall 216 comprising at least one helical channel 218 defining a helical path between the base 228

and the top 232 of the outer housing 212. Optionally but desirably the at least one helical channel 218 includes at or near the top 232 of the outer housing 212 a ring section 219; the ring section is not helical but rather defines a channel which is circular into which an end of the helical channel 218 extends. The outer housing 212 is affixed to, or incorporates a gear track 196, here near the top 232 thereof which is enmeshed with a drive gear 198 which may be driven by a motor or by other drive means available in the robot. In use, when the inner housing 214 is retained in a stationary position and the drive gear 198 is driven, the enmeshed gear track 196 causes the outer housing 212 to rotate with respect to the inner housing 214 which in turn causes the moveable base 190 to move in a direction which compresses the compressible sac 188 and thereby causes the floor treatment composition out via the intermediate fluid conduit 60 to a fluid manifold 64 which may form part of the robot, or may form part of the cartridge. When the moveable base 190 has substantially compressed the compressible sac 188 the tab 192 extending through the engaging guide channel 194 comes passes beyond the end of the helical section of the channel 218 and enters into the ring section 219 of the channel 218which terminates the forward movement of the moveable base 190. When the tab 192, engaged through the engaging guide channel 194 is engaged in the ring section 219 of the channel 218 the outer housing 212 may continue to rotate without risk of stoppage or damage to the motor or other drive means which is used to drive the drive gear 198.

To facilitate such an operation the inner housing 214 may include parts or elements such as lobes 226 extending therefrom which may be used to engage the compressible fluid reservoir 230 in a device, such as a robot 10 or in a cartridge 48 and retain it in a stationary position.

Fig. 11 is a partial skeletal view of a further compressible fluid reservoir 240 according to a further preferred embodiment of the invention also suitable for use in a cartridge 48. The compressible fluid reservoir 240 comprises a housing 242 having a sidewall 248, a top 250, optionally but preferably a stationary base 252 defining an internal cavity 244 therebetween. According to the preferred embodiment illustrated, the housing 242 is generally cylindrical in cross-section and contains a compressible sac 246 containing a quantity of a floor treatment composition, located between a moveable base 248 and an outlet 254 which passes through or forms part of the top 250. A pair of

threaded shafts 256A, 256B are also present within the interior of the housing 242 and pass through parts of the moveable base 248 which advantageously includes threaded passages 248A, 248B engaging portions of the threaded shafts 256A, 256B. When a stationary base 252 is present, as is depicted on Fig. 11, a portion of the threaded shafts 256A, 256B also pass through portions of the stationary base 252. The threaded shafts include at one end shaft heads 256C, which are extended at least beyond the moveable base 248 and if present beyond the stationary base 252 as well such that the shaft heads 256C are accessible from the exterior of the housing 242. Preferably, as shown, portions of the threaded shafts 256A, 256B included non-threaded regions, a head region 256D which may be present in the portion of the threaded shafts 256A, 256B which pass through the stationary base 252 and/or an end region 256E opposite that of the shaft heads 256C. Advantageously the length of the non-threaded end region 256E is a length equal to at least the thickness of the moveable base 248. Desirably a portion of the tips of 256F of each of the threaded shafts 256A, 256B rotates within a cup 258 or other suitably dimensioned recess formed within the interior of the top 250 the distance between the cups 258 being equal to or approximately equal to the distance between the threaded passages 248A, 248B of the moveable base 248. In such an arrangement illustrated, during their rotation the threaded shafts 256A, 256B are retained in parallel to one another. Retention of the threaded shafts 256A, 256B is further improved when a stationary base 252 is present.

The floor treatment composition contained in the compressible sac 246 may be dispensed from the compressible fluid reservoir 240 in the following manner. The compressible fluid reservoir 240 is inserted into a robot or is provided as part of a removeable cartridge 48 into a robot such that both of the shaft heads 256C engage a drive means 260, here depicted as a pair of electrical motors each having a drive coupling, namely a shaped shaft section 262 which couples with a correspondingly shaped coupling portion 256K of the shaft heads 256C, here depicted to be recesses within the shaft heads 256C. When the electrical motors are engaged to rotate at a common rotational speed, the threaded shafts 256A, 256B are caused to rotate via the coupling between the coupling portion 256K and the shaft heads 256C which in turn urges the moveable base 248 toward the outlet 254 which functions to compress the

compressible sac 246 containing a quantity of a floor treatment composition and expelling it through the outlet 254, and into the manifold 64 via the fluid coupling 60.

The specific configuration of the compressible fluid reservoir 240 provides certain specific advantages. The inclusion of a stationary base 252 in addition to the sidewall 248, and top 250 defines a sealed internal cavity 244 which denies a consumer access to the interior of the cavity and to the compressible sac 246 containing the floor treatment composition contained therein. This provides not only a safety aspect to the compressible fluid reservoir 240 but an anti-tampering benefit as well. The inclusion of a stationary base 252 as depicted herein having passages therethrough having a distance therebetween being equal to or approximately equal to the distance between the threaded passages 248A, 248B of the moveable base 248 as well as the distance between the cups 258 lessens the likelihood that the threaded shafts 256A, 256B would twist or be displaced as might occur in the absence of a stationary base 252. The inclusion of a non-threaded head region 256D forming part of the threaded shafts 256A, 256B passing through the stationary base 252 provide a slideable surface within which the respective portion of the threaded shafts 256A, 256B may freely rotate without displacing the stationary base 252. The inclusion of a non-threaded head region 256D forming part of the threaded shafts end region 256E of the threaded shafts 256A, 256B provides a limiting function with respect to the travel distance of the moveable base 248. When an unused compressible fluid reservoir 240 is provided to the robot, the compressible sac 246 contains sufficient floor treatment composition at or near its maximum fluid capacity. As the drive means 260 are engaged, rotating the threaded shafts 256A, 256B impelling the moveable base 248 in the direction of the outlet 254, the sac 246 is compressed emptying its contents. When the contents of the sac 246 have been emptied or are nearly emptied the moveable base 248 passes beyond the threads of the threaded shafts 256A, 256B and into end region 256E in which the threads of the threaded shafts 256A, 256B no longer engage corresponding threads of the moveable base 248 thereby ceasing further movement of the moveable base 248 and likewise ceasing further compression of the sac 246. This feature provides a further anti-tampering benefit as well as making the sac 246 particularly difficult to refill as the moveable base 248 would be difficult to retract permitting the compressible sac 246 to expand.

While certain specific elements are disclosed in conjunction with the preferred embodiment of Fig. 11 it is nonetheless to be understood that alternative elements and alternative configurations are foreseeable and are specifically considered to fall within the scope of preferred embodiments. For example: a greater or lesser number of threaded shafts may be provided, the placement of the one or more threaded shafts may be arranged differently than that depicted. In one preferred alternative arrangement the sidewall may include one or more extended channels which extend laterally along the sidewall and are open to the interior cavity but closed to the exterior, which extended channels contain a threaded shaft. In such an arrangement the threaded shafts are spaced away from the compressible sac which decreases the likelihood that contact between parts of the threaded shafts and the compressible sac would cause binding or the threaded shafts or rupture of the sac itself due to such contact. The drive means, depicted as a pair of electrical motors each having a drive coupling may be any other drive means which can be removably coupled to part of one or may be coupled to a plurality of the threaded shafts which may be present. Two or more of the plurality of the threaded shafts present may be mechanically coupled so that rotation of one of the threaded drive shaft simultaneously drives the other coupled drive shaft, thus reducing the number of couplings required between the compressible fluid reservoir and drive means. The drive means may be one or more separate motors or other elements which are responsive to the control means, or may operate without regard to the control means. The drive means may be provided from other parts or elements of the robot either directly or indirectly such as through a gear train, or other power transmission system.

Figure 12A depicts an alternative embodiment to a portion of the compressible fluid reservoir 240 depicted on Fig. 11. Depicted is a plan view of the under surface of either the stationary base 252 illustrating an anti-retraction mechanism for the threaded shafts. The shaft heads 256C comprise a series of gear teeth 256G located at the periphery thereof which engage a pawl 264 which is affixed to the stationary base 252. The shaft heads 256C also include a shaped coupling portion 256K which is configured to couple with drive means (not shown.) The pawl 264 is arranged such that each of the shaft heads 256C, and hence their associated threaded shafts, may rotate in only one direction and cannot reverse direction. The inclusion of such an arrangement to at least

one of the threaded shafts provides an anti-retraction feature to the compressible fluid reservoir in that retraction of the moveable base 248 is denied. While the arrangement of the pawl 264 and shaft heads 256C having peripheral gear teeth 256G are depicted in a position which may be exposed to a user or consumer, particularly when the compressible fluid reservoir is not provided as part of a cartridge 48, other arrangements are foreseen and may be used. For example, with reference to Fig. 11, an appropriate gear may be located upon part of the threaded shafts 256A, 256B such in or near non-threaded regions, e.g., the head region 256D between the stationary base 252 and the moveable base 248. When the pawl 264 is mounted on the stationary base 252 below the moveable base 248 and engages a gear mounted on an adjacent threaded shaft, the anti-retraction benefits described with reference to Fig. 12A, with the added benefit that the pawl 264 and the corresponding gear is positioned between the stationary base 252 and the moveable base 248 which is not visible to or accessible by the user of the compressible fluid reservoir 240.

Figure 12B illustrates an alternative embodiment of a portion of the compressible fluid reservoir 240 depicted on Fig. 11. Depicted is a plan view of the under surface of either the stationary base 252, the upper surface of the stationary base between the stationary base 252 and the moveable base 248. Depicted thereon is a central drive gear 257 having a shaped coupling portion 256K which is configured to couple with drive means (not shown) having peripheral gear teeth which are engaged with corresponding gear teeth on the periphery of shaft heads 256C. In operation, the drive means are coupled into the shaped coupling portion 256K of the central drive gear 257 which causes it to rotate, as well as simultaneously rotating the peripheral gear teeth of shaft heads 256C and the corresponding threaded shafts. In such an arrangement a single drive means and a single coupling are sufficient to operate the compressible fluid reservoir 240. While not illustrated completely in Fig. 12B, but with additional reference to Fig. 11 it is also contemplated that the central drive gear 257 may be positioned on the stationary base 252 between it and the moveable base 248 so that it is not visible to or accessible by the user of the compressible fluid reservoir 240. An appropriate gear may be located upon part of the threaded shafts 256A, 256B such in or near non-threaded regions, e.g., the head region 256D between the stationary base 252 and the moveable base 248 enmeshed

with the central drive gear 257, such that as the central drive gear 257 is rotated by means of a drive means and coupling which passes through an suitable orifice or passage through part of the stationary base 252 engaging the shaped coupling portion 256K, the central drive gear 257, gears located on threaded shafts 256A, 256B and the threaded shafts 256A, 256B are caused to rotate themselves.

Figure 13 is a partial skeletal view of a compressible fluid reservoir 270 according a further preferred embodiment of the invention suitable for use in a cartridge 48. The compressible fluid reservoir 270 comprises a housing 242 having a sidewall 248, a top 250, and a moveable base 248 defining an internal cavity 244 therebetween. According to the preferred embodiment illustrated, the housing 242 is generally cylindrical in cross-section and contains a compressible sac 246 containing a quantity of a floor treatment composition, located between the moveable base 248 and an outlet 254 which passes through or forms part of the top 250. The sidewall 248 includes two slots 268 passing therethrough through which extend tabs 249 extending from the moveable base 248 and in engagement with a pair of threaded shafts 256A, 256B present exterior to the housing 242. These threaded shafts 256A, 256B may form part of a robot, or cartridge 48, but are not an element of the compressible fluid reservoir 270. Desirably the two slots 268 are linear in configuration and on opposite sides of the sidewall 248. While not visible, the threaded shafts 256A, 256B are attached to drive means which are used to rotate the threaded shafts 256A, 256B and due to the presence of the tabs 249 in engagement with the spiral recesses of the threaded shafts 256A, 256B, the moveable base 248 is driven in the direction of the outlet 254 compressing the sac 246. The floor treatment composition expelled from the sac 246 is expelled via the outlet, optionally past a valve or pump through a connecting fluid conduit 60 to the manifold 64, which comprises a plurality of outlets or nozzles 65.

With particular attention to Figure 13, according to the embodiment depicted the threaded shafts 256A, 256B include broad flights in the form of helical ribbon shape which broad flights are not the conventionally encountered V-shaped flights as found on conventionally threaded shafts or threaded rods. The broad flights in the form of helical ribbon shape define a continuous U-shaped or rectangular channel within which the tabs 249 are engaged. This configuration of broad flights of the threaded shafts 256A, 256B

permit for easier insertion and placement of the compressible fluid reservoir 270 within a robot, or within a removeable cartridge 48, as the alignment of the tabs 249 between the flights of the threaded shafts 256A, 256B is greatly simplified.

Further, advantageously the threaded shafts 256A, 256B include non-threaded end region 256E having a length equal to at least the thickness of the moveable base 248. As noted with reference to Fig. 11 such a non-threaded end region 256E provides a limiting function with respect to the travel distance of the moveable base 248 limiting the movement of the moveable base 248 and ceasing further compression of the sac 246 when it is empty or nearly empty.

It is to be understood that the compressible fluid reservoirs described herein may be used within a robot directly or may be used as an element of a user replaceable cartridge which is insertable within a portion of the robot, which cartridge comprises a compressible fluid reservoir and optionally but in certain cases desirably also includes a floor treatment means. Exemplary cartridges include those depicted with reference to prior Figures.

Figure 14 is a partial skeletal view of a robot according to Figs. 1 and 2, further comprising a first embodiment of a standoff means. Figure 14 is partial skeletal view of the robot according to Figs. 1 and 2, showing more details of the interior of the robot and a preferred arrangement of the various components described previously. In the depicted embodiment the standoff means is provided by a standoff drive means 320 here an electrical dual shaft motor in electrical communication with the control means 32. At the ends of each of the shafts 322 are provided lobed cams 324 which are caused to slowly turn when the standoff drive mans 320 is actuated. The lobed cams 324 may engage a portion of the cartridge 48. When the user replaceable cartridge 48 is first installed the lobed cams 324 are positioned in such a manner that the user replaceable cartridge 48 may be fully installed permitting contact between the floor treatment means and the flooring surface to be treated. When the standoff means is actuated, the standoff drive means 320 is actuated, causing the lobed cams 324 to sufficiently rotate to cause the user replaceable cartridge 48 to lift sufficiently, or to be retracted sufficiently such that the contact between the floor treatment means and the flooring surface to be treated is removed. The user replaceable cartridge 48 may be conveniently removed by the user of

the robot 10, and a new user replaceable cartridge 48 may be installed at the beginning of the next floor treatment operation utilizing the robot 10.

While not depicted in Fig. 14, it is also contemplated that means or elements other than the lobed cams 324 engageable with a portion of the cartridge 48 means may be present. For example other device such as levers or solenoids may be used for causing the user replaceable cartridge 48 to lift sufficiently, or to be retracted sufficiently such that the contact between the floor treatment means and the flooring surface to be treated is removed.

While not depicted in Fig. 14, it is also contemplated that the standoff means may, instead of causing the user replaceable cartridge 48 to lift sufficiently, or to be retracted sufficiently such that the contact between the floor treatment means and the flooring surface to be treated is removed, may instead cause only a portion of the user replaceable cartridge 48 to operate such that contact between the floor treatment means and the flooring surface to be treated is removed. For example wherein the user replaceable cartridge 48 includes an element such as roller or sharp-edged element which is used to ensure contact between the floor treatment means and the floor the positioning or orientation of such an element may be modified, e.g., rotated, partially rotated, retracted or displaced so that the floor cleaning means is withdrawn away from the flooring surface. In such an embodiment the user replaceable cartridge 48 itself does not otherwise change its position within the robot 10.

Figure 15 is a side view of a robot according to Figs. 1 and 2, further comprising a second embodiment of a standoff means. Figure 15 depicts in a side view a yet further embodiment of a standoff means according to the invention which comprises a rotatable support 240 preferably having an arcuate face 242 at the exterior thereof which depends from the chassis, here via a support bracket 244. While not visible in the figure, the robot 10 includes a latching mechanism which may be actuated by the control means 32 either directly such as by means of a motor or solenoid, or indirectly such as by means of a gear or set of gears, which when actuated cause the rotatable support 240 to rotate such that the arcuate face 242 engages the flooring surface F which causes lifting or raising the floor treatment means 88 out of contact with the flooring surface F. In a preferred mode of operation used in conjunction with the specific embodiment of Fig. 15, the robot 10 is

controlled by the control means 32 such that the conclusion of a floor cleaning method, the robot 10 is caused to move in a rearwards direction and also actuating the rotatable support 240 to engage the flooring surface F, lifting the floor treatment means 88 out of contact with the flooring surface F.

Of course it is also contemplated that instead of providing a standoff means which modifies the position of the user replaceable cartridge 48 as discussed above, the standoff means may instead comprise one or more elements or members of the robot which act to lift the robot or at least a portion of the robot whereby the floor treatment means is removed from further contact with the flooring surface, e.g.; a plunger-type solenoid may be actuated by an appropriate control signal from the control means 32 which extends the plunger of the solenoid and latches it into its extended position, at the same time lifting or raising the floor treatment means out of contact with the flooring surface. The robot may then enter into a "standby" or "off" mode, and as preferably, the latch mechanism of the plunger-type solenoid does not require a continuous supply of current in order to retain it in its extended position.

According to particularly preferred embodiments of the invention the robot is supported on a flooring surface by the two wheels, and by one or more of the plurality of brush elements present on the forward part of the chassis; further supporting wheels or elements are not required. This is surprising in that typically at least a third wheel such as a further wheels directed to a steering mechanism, or a driving mechanism, or even a non-powered, non-controlled idler wheel is commonly encountered in the art. The favorable operating characteristics of the robot of the present invention without such a third or further wheels is beneficial in avoiding the potential for staining or scratching a flooring surface due to the presence of such a third or further wheels.

The robot according to the present invention is particularly adapted to clean flooring surfaces, particularly hard flooring surfaces. By way of non-limiting example hard flooring surfaces include composed of refractory materials such as: glazed and unglazed tile, brick, porcelain, and ceramics; stone surfaces including marble surfaces, granite surfaces as well as other stone surfaces; glass; metals; wood flooring surfaces including those made from hardwood, softwood, solid wood planking, tile or parquet, laminated flooring surfaces comprising a plurality of laminated layers in the form of

planking, tile or parquet of which only the uppermost surface may be a wood laminate layer or may be a synthetic material optionally pattered to appear to be a wood surface; synthetic flooring including in sheet, and tile form such as is commonly referred to a "linoleum" flooring which however may be made of any non-porous material which is rigid, semi-rigid or flexible. Such hard flooring surfaces do not include carpeted surfaces such as continuous or broadloom carpets such as are commonly used in "wall-to-wall" installations, or rugs or carpets which cover only a portion of a flooring surface.

In operation the robot of the invention is provided with a quantity of a floor treatment composition and a floor treatment means and it placed upon a flooring surface. Typically such flooring surfaces are generally substantially planar surfaces. The robot is energized or otherwise actuated, and the robot may move forward and randomly move about the flooring surface, or if provided with suitable program for governing its mode of travel (such as may be provided by means of a suitable program which may be programmed into the control means 32). Suitable techniques are known in the art. The robot is operated in a suitable cleaning method until a desired degree of cleaning or other treatment is imparted to the flooring surface.

Still other cleaning techniques, although not specifically elucidated herein may be practiced in accordance with the present invention, particularly with the robots of the present invention.

The preferred embodiments of the present invention have been illustrated and described herein. However, it is to be understood that the present invention is not limited to the preferred embodiments described here, and someone skilled in the art can modify the present invention without distorting the point of the present invention claimed in the following claims.

Claims:

1. An autonomous robot for the cleaning of a flooring surface, particularly for the mopping of a floor surface which robot comprises: a chassis bearing a pair of drive wheels which may be independently operated, said chassis having a forward portion forward of the drive wheels, and a rearward portion rearward of the two drive wheels, a housing, a power source, a controller interface having one or more user controllable interface elements for modifying the operative characteristics of the robot, a control means for controlling the operative characteristics of the robot, and a user replaceable cartridge which is insertable within a portion of the robot, which cartridge comprises a fluid reservoir and a floor treatment means.

2. An autonomous robot for the cleaning of a flooring surface according to any preceding claim which further comprises a plurality of brush elements which depend from a part of the forward portion of the chassis.

3. An autonomous robot for the cleaning of a flooring surface according to any preceding claim which further comprises a control means for controlling the operative characteristics of the robot capable of receiving at least one input signal which provides information indicative of at least one environmental condition of the robot and responsive thereto is capable of transmitting at least one output control signal which capable of controlling the operation of one or both of the motors used to drive their respective drive wheels.

4. An autonomous robot according to claim 3 wherein the control means is capable of monitoring the instantaneous current load upon one or both of the motors used to drive their respective drive wheels.

5. An autonomous robot according to claim 3 wherein the robot includes a sensor adapted to detect the distance between the robot and the flooring surface at a point

adjacent to the nose of the robot, and the control means is capable of determining a vertical discontinuity adjacent to the nose of the robot.

6. An autonomous robot according to claim 1 wherein the fluid reservoir is a non-pressurized pouch, optionally contained within a rigid walled container.

7. An autonomous robot according to claim 1 wherein the user replaceable cartridge which is insertable within a portion of the robot, which cartridge comprises a fluid reservoir and as a floor treatment means a continuous web of a fibrous material.

8. An autonomous robot according to any preceding claim wherein the fluid reservoir is a compressible fluid reservoir.

9. An autonomous robot according to claim 8 wherein the compressible fluid reservoir comprises a housing which is preferably generally cylindrical in cross-section which includes an internal cavity which includes at least one, preferably two helical slots passing through the housing wall, the housing further contains a compressible sac and a moveable base having one or more extending tabs extending through the one or more helical slots and engaging guide channels dimensioned to receive a portion of the extending tabs.

10. An autonomous robot according to claim 8 wherein the compressible fluid reservoir comprises a pair of concentric generally cylindrical outer housing rotatable with respect to a generally cylindrical inner housing , the inner housing having a sidewall comprising at least one helical slot passing therethrough and defining a helical path between a base and a top of the inner housing 214, a moveable base having extending from a part therefrom at least one tab extending therethrough, and a compressible sac, the outer housing encases at least a part of the inner housing and includes at least one engaging guide channel dimensioned to receive a portion of the tab.

11. A user replaceable cartridge adapted to be removably insertable within a portion of the robot, which cartridge comprises a compressible fluid reservoir described in claim 9 or 10.

12. An autonomous robot according to any preceding claim wherein the cartridge comprises a housing which is generally cylindrical in cross-section and contains: a compressible sac located between a moveable base including threaded passages and an outlet, a pair of threaded shafts which engage the threaded passages of the moveable base, and optionally a stationary base.

13. An autonomous robot according to any preceding claim wherein the cartridge comprises a housing having a sidewall, a top, and a moveable base defining an internal cavity therebetween, a compressible sac located between the moveable base and an outlet which passes through or forms part of the top, the sidewall includes two slots passing therethrough through which extend tabs extending from the moveable base and in engagement with a pair of rotatable threaded shafts present either within the cartridge or within the robot and exterior to the housing.

14. An autonomous robot according to any preceding claim which further comprises a standoff means.

15. A method of treating a flooring surface by use of the robot according to any preceding claim.

Fig.1.

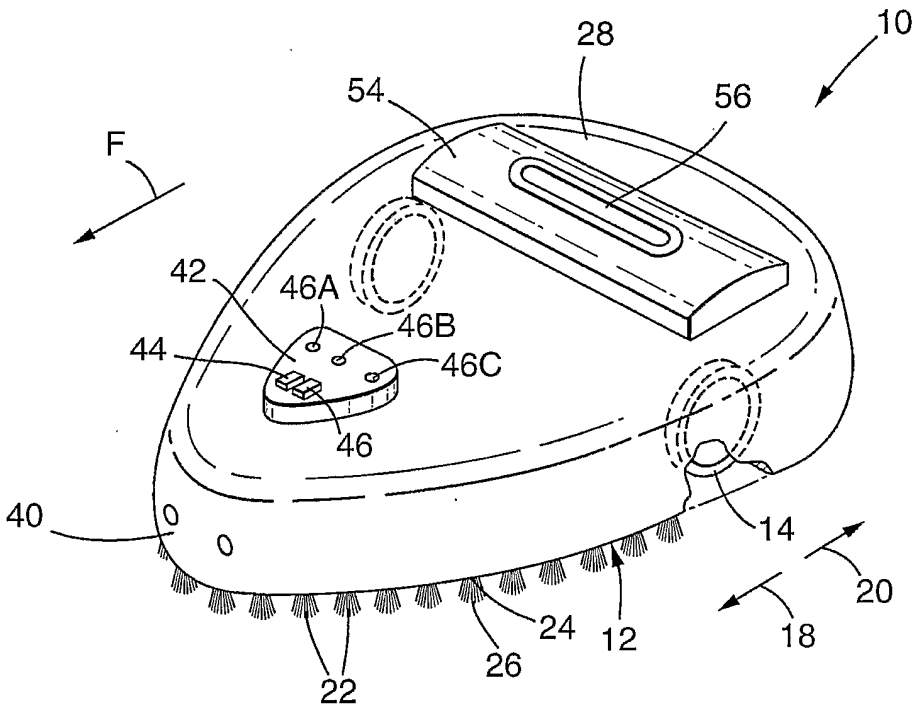

Fig.2.

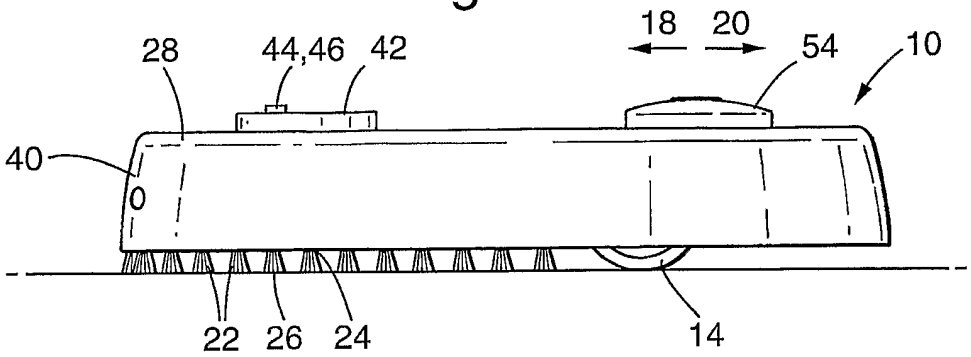
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Fig.3.

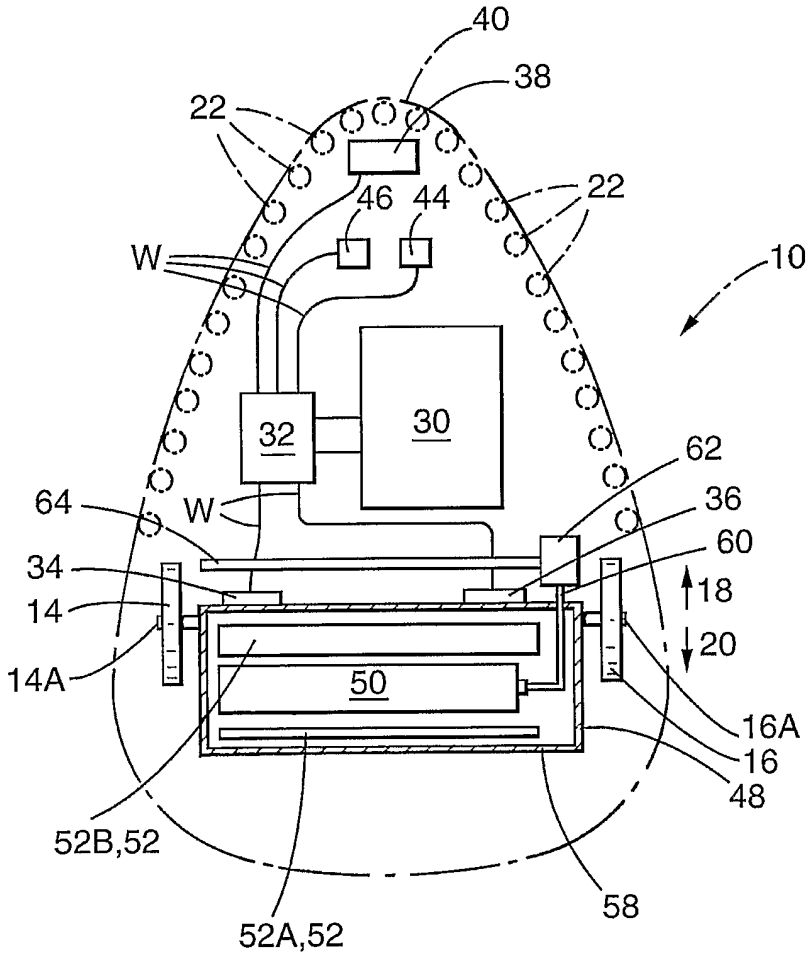
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Fig.4A.

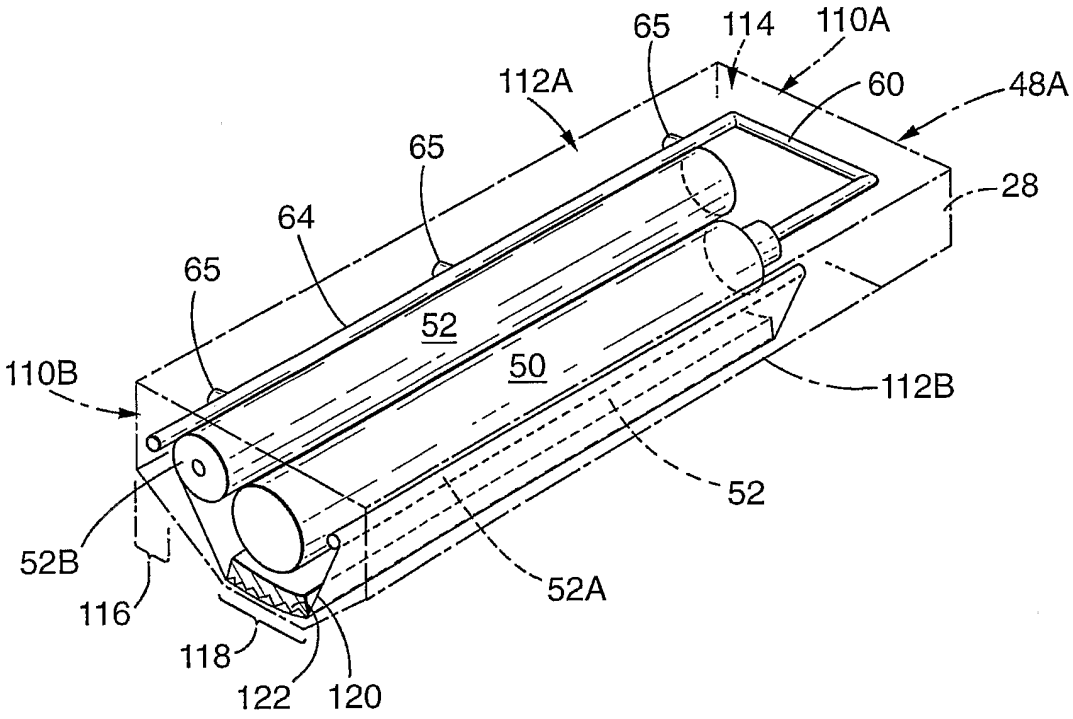
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Fig.4B.

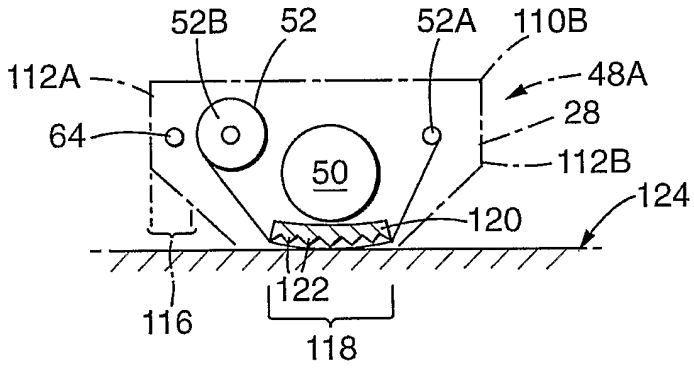
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Fig.5A.

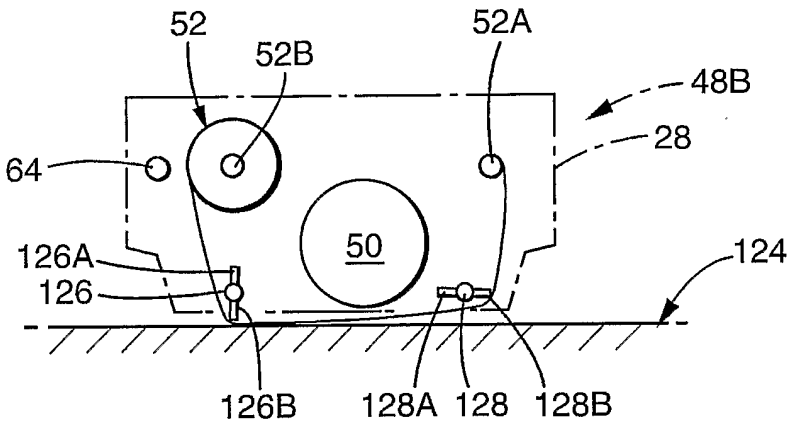
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Fig.5B.

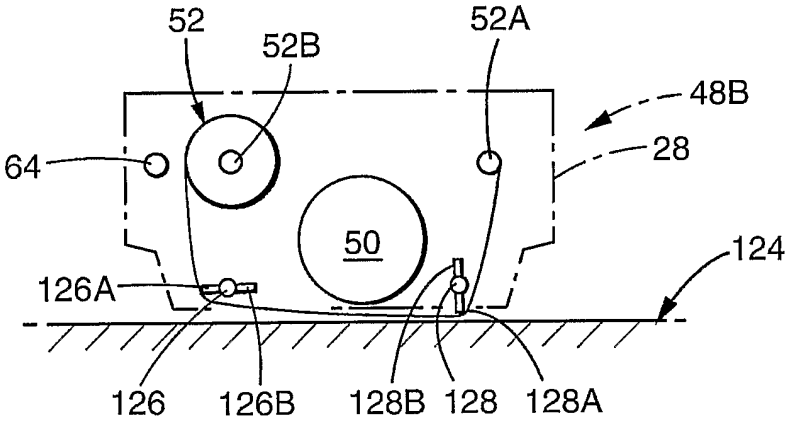
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Fig.6A.

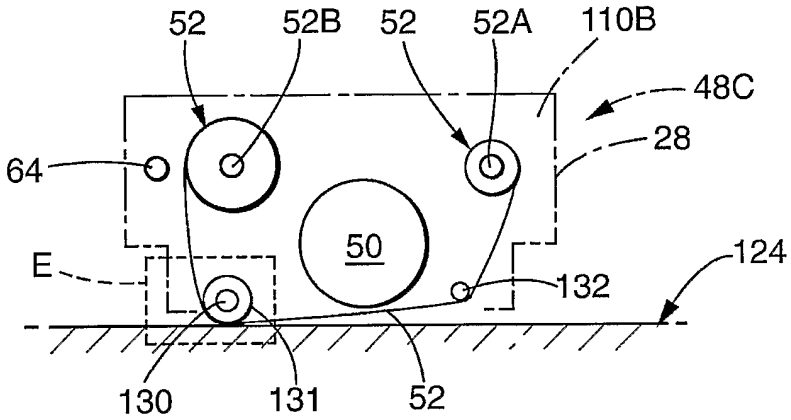
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Fig.6B.

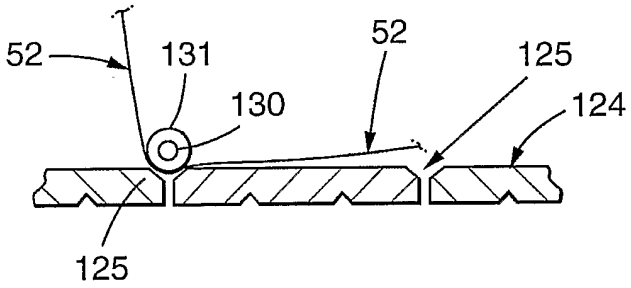
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Fig.7A.

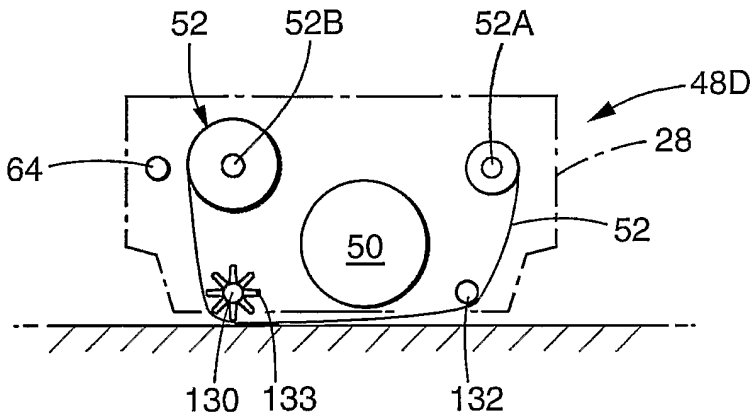

Fig.7B.

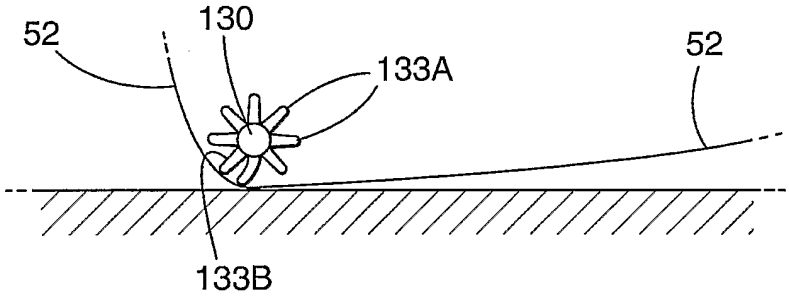

Fig.7C.

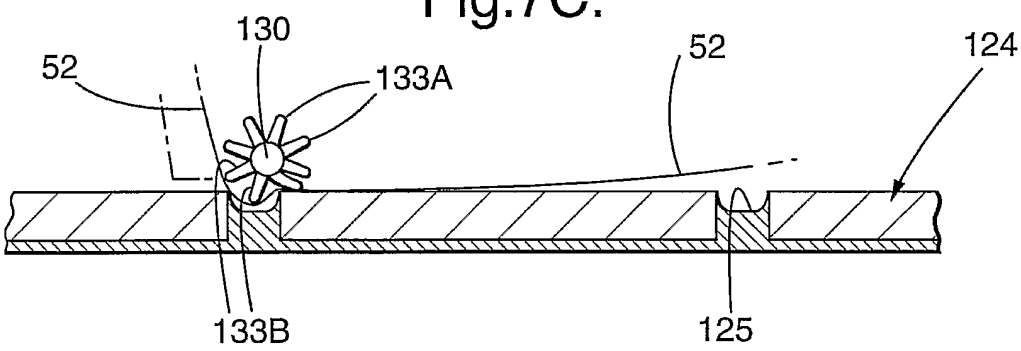

Fig.8A.

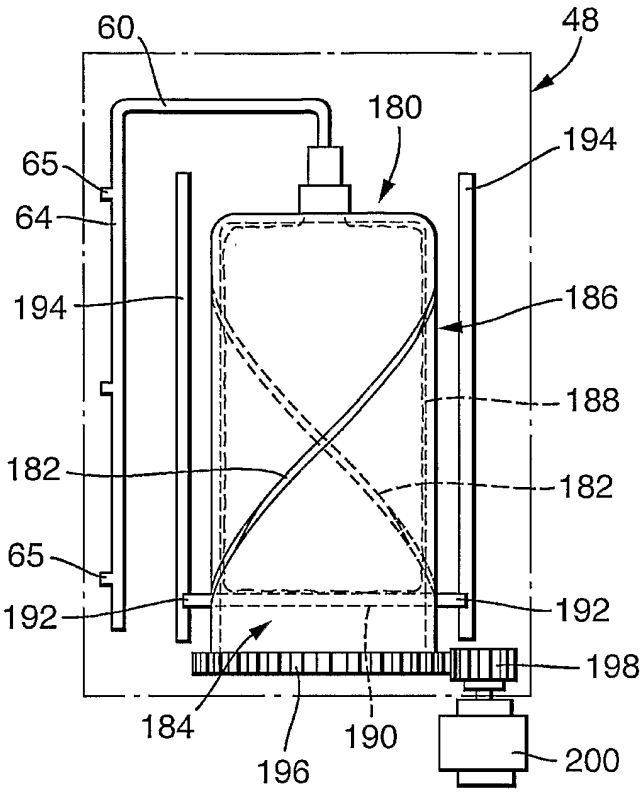
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Fig.8B.

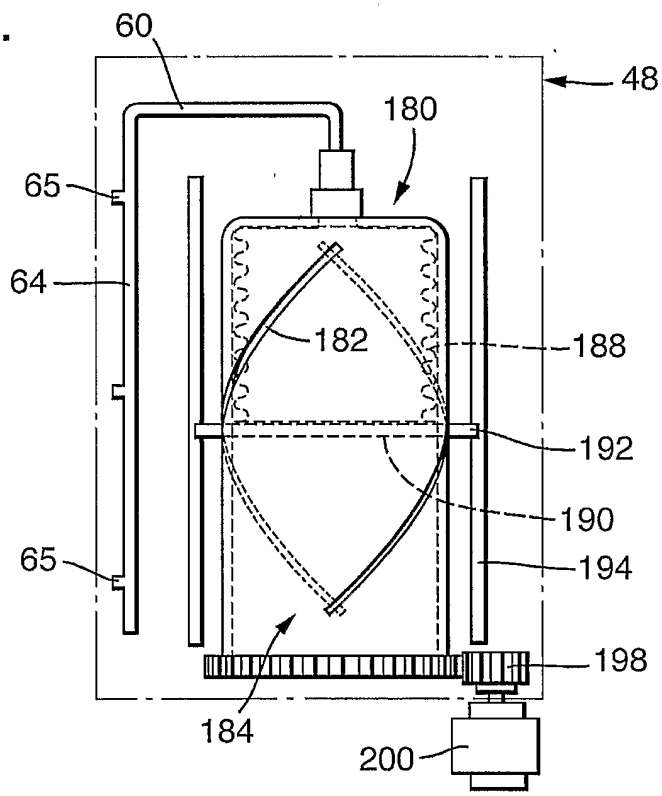
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Fig.9.

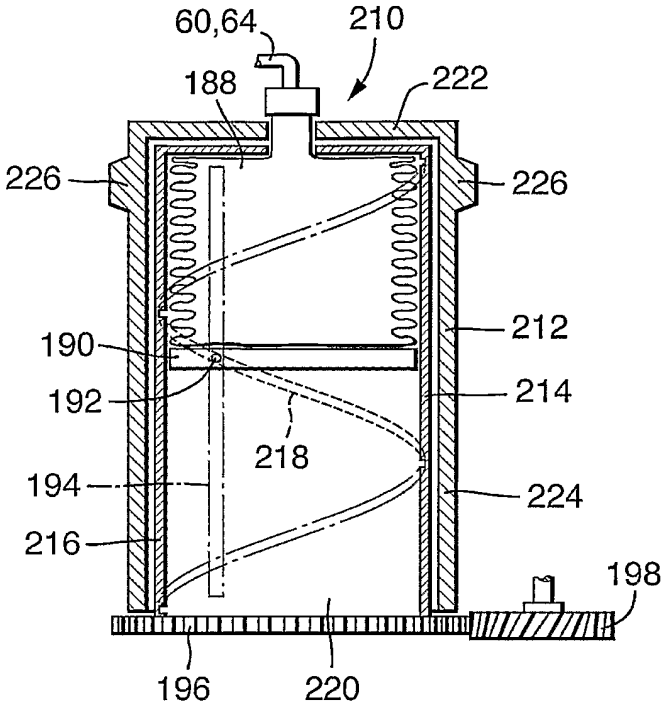
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Fig.10.

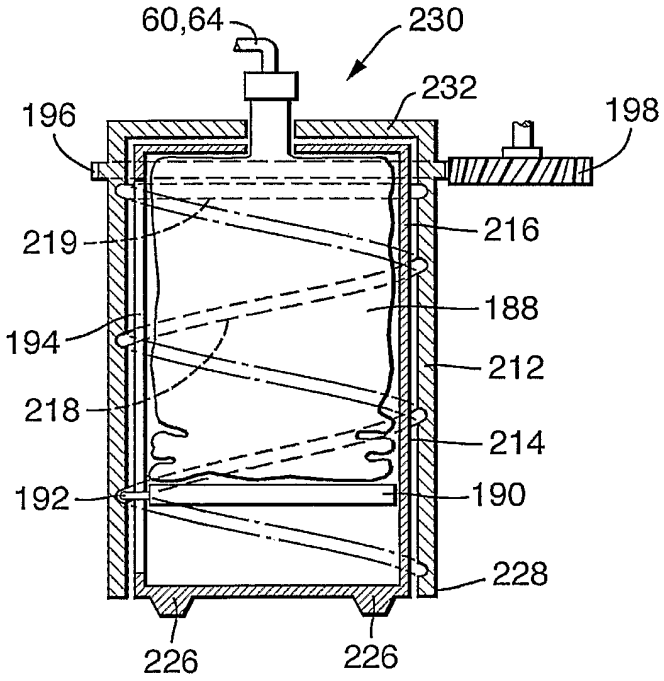
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Fig.11.

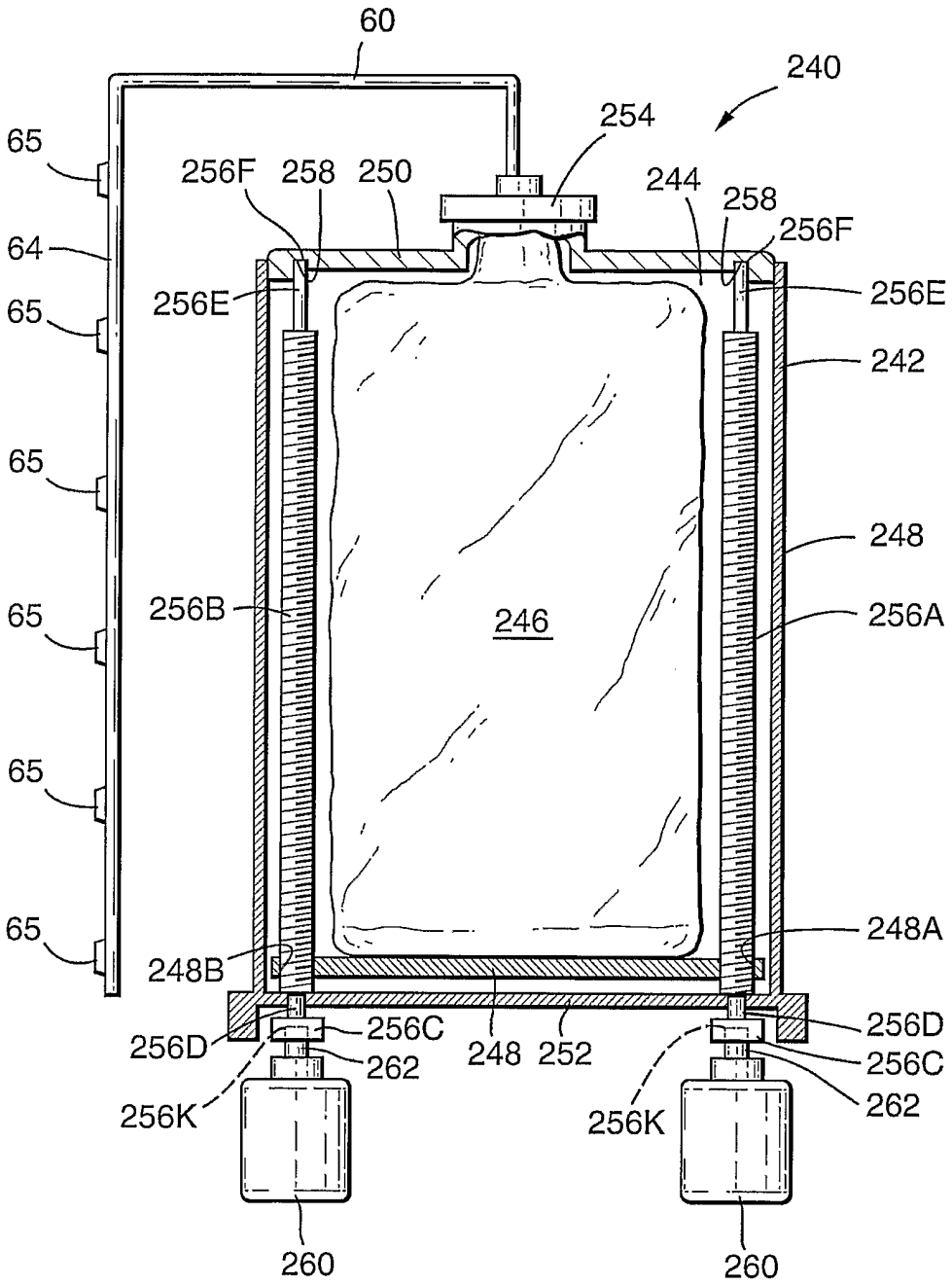
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Fig.12A.

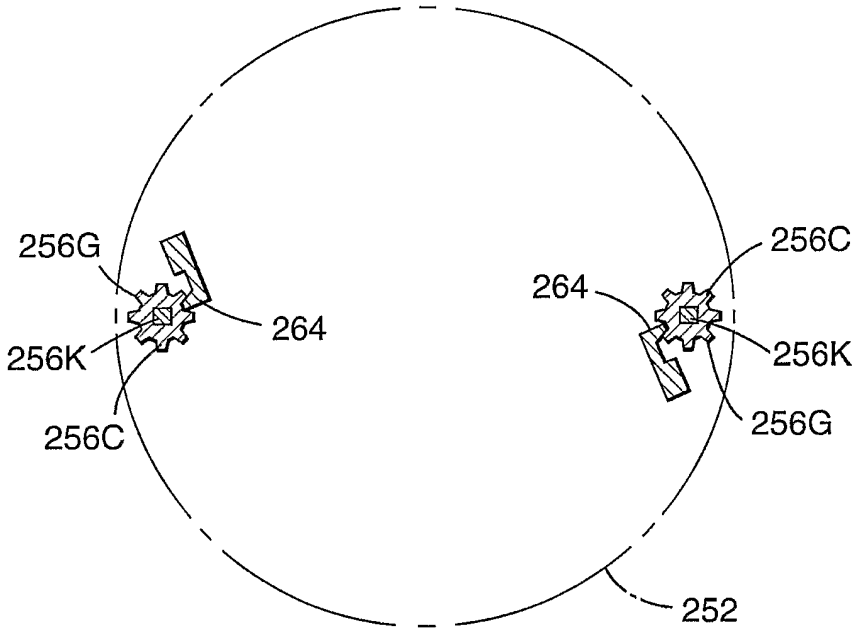

Fig.12B.

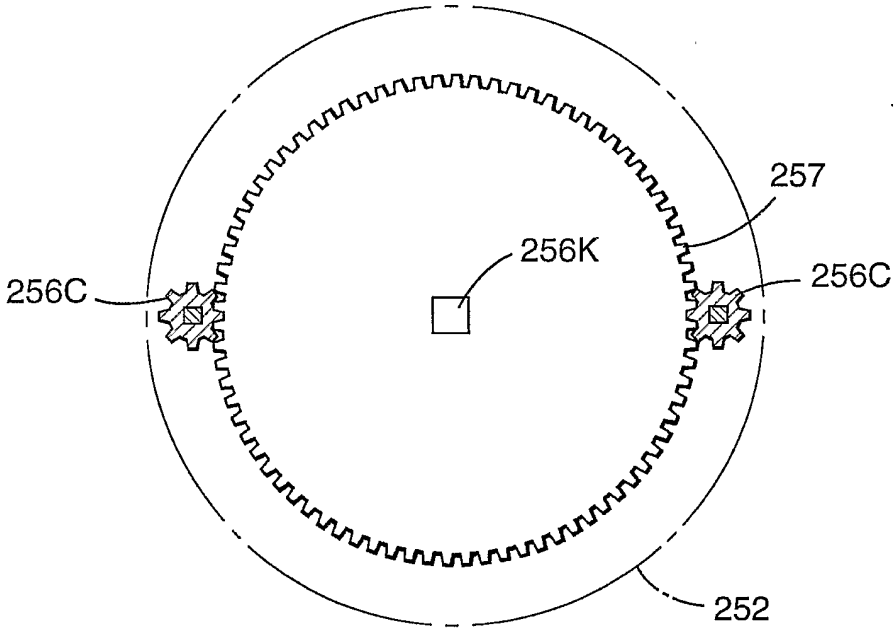

Fig.13.

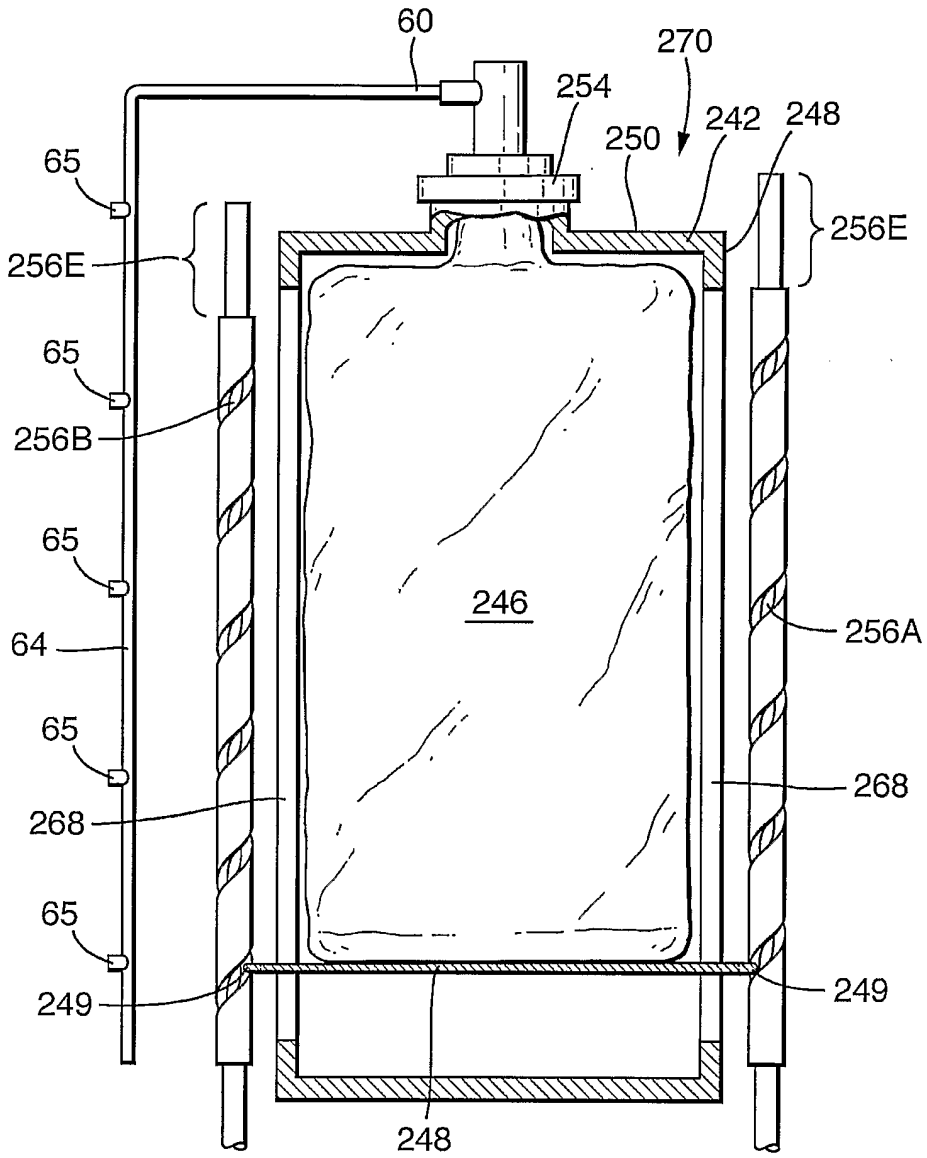
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Fig.14.

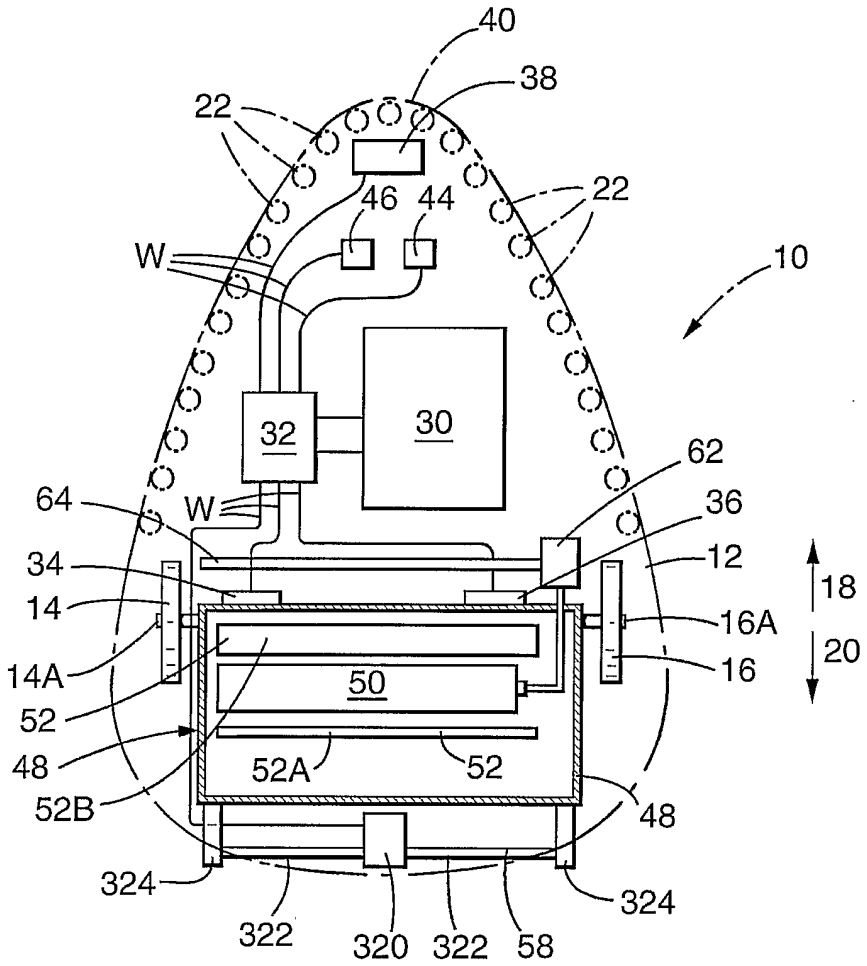
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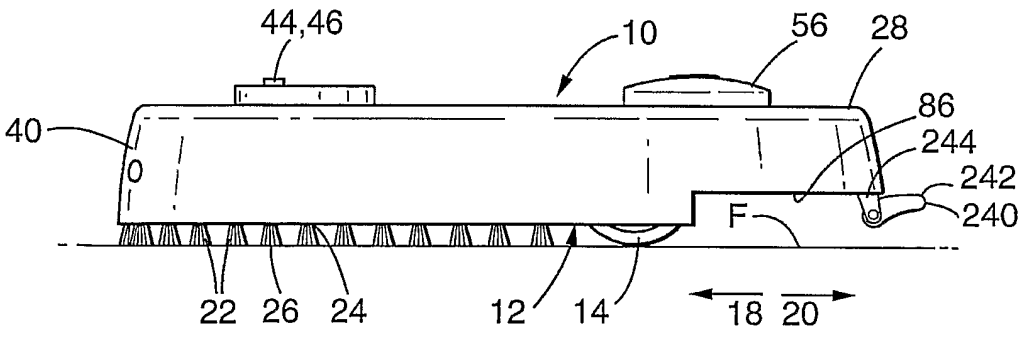
Fig.15.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INTERNATIONAL SEARCH REPORT

ational application No
/GB2005/004155

A. CLASSIFICATION OF SUBJECT MATTER
A47L11/40 A47L11/284 B65D83/00

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)
A47L B05C B65D

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	WO 2005/077244 A (S. C. JOHNSON & SON INC) 25 August 2005 (2005-08-25) abstract paragraphs '0009!, '0010!, '0031! page 9, line 25 - page 10, line 13 figures 1-9	1,7,15
X	US 6 481 515 B1 (KIRKPATRICK JAMES F ET AL) 19 November 2002 (2002-11-19) abstract column 7, line 59 - line 65 column 8, line 64 - column 9, line 9 column 13, line 37 - line 42 column 14, line 14 - line 18 column 15, line 45 - column 16, line 12 column 17, line 43 - column 19, line 8 figures 3-6a,13-15,17	1-4,6,8,15
Y		5

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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"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
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 January 2006	10/02/2006
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Authorized officer Cabral Matos, A

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INTERNATIONAL SEARCH REPORT

International application No
GB2005/004155

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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2

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