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(54) **Title**: A FILTER FOR A HAND DRYER

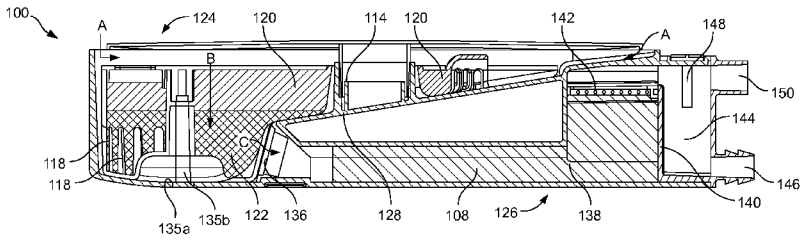


FIG. 7

(57) **Abstract**: There is provided a filter arrangement (100) for a hand dryer (10), the filter arrangement5 (100) comprising a filter housing (106) removably insertable into a hand dryer (10) and a filter (120, 122) located in the filter housing (106), the filter housing (106) defining a sump (130) having a base surface, wherein a drain aperture(135a)is formed in the base surface and a plug (135b) is removably located in the drain aperture(135a). By providing a drain aperture (135a) and a removable plug (135b), when the sump requires 10 cleaning, a user can simply flush clean water into the sump (130) to remove deposited slurry and particulates fromthe sump (130). The waste water and entrained particulates and slurry flow through the drain aperture (135a) to be captured in a suitable receptacle, such as a bucket.

A Filter for a Hand Dryer

The present invention relates to a filter arrangement. Particularly, the invention relates to a filter arrangement for a hand dryer.

It is known from, for example, US 5,459,944 to provide an arrangement for collecting and removing waste water from a hand dryer. Waste water is collected via a duct and transferred to a drip collector for subsequent manual removal. However, storage of waste water in this manner is unhygienic because the waste water is untreated. This may result in the spread of bacteria within the hand dryer if the drip collector is not regularly emptied and cleaned.

JP 11-18999 A describes the use of an anti-bacterial sheet in a water collector of a hand dryer. This reduces the problem of bacterial infestation in a water collector and correspondingly reduces the frequency at which it needs to be cleaned for hygiene reasons. However, in use, the anti-bacterial sheet is likely to become blocked with particulate matter. This will affect the performance of the sheet and is likely to increase the level of maintenance required.

WO 2007/088318 discloses a hand dryer having a waste water filtration unit which is located in a cavity formed in the hand dryer. The filtration unit comprises both a particulate filter for removing larger particles of dirt and soap, and a sterilising filter for killing bacteria in the waste water. The sterilising filter is located downstream of the particulate filter. The filtration unit is removable from the cavity for cleaning or replacement.

It is an object of the present invention to provide an improved filter arrangement for a hand dryer.

The invention provides a filter arrangement for a hand dryer, the filter arrangement comprising a filter housing removably insertable into a hand dryer and a filter located in the filter housing, the filter housing defining a sump having a base surface, wherein a drain aperture is formed in the base surface and a plug is removably located in the drain aperture.

By providing a drain aperture and a removable plug, when the sump requires cleaning, a user can simply flush clean water into the sump to remove deposited slurry and particulates from the sump. The waste water and entrained particulates and slurry flow through the drain aperture to be captured in a suitable receptacle, such as a bucket.

It is preferred that the plug is removable from the drain aperture through the sump. By providing such an arrangement, the user can remove the plug out of the sump without being exposed to the outflow of slurry and particulates through the drain aperture.

Preferably, the plug has a graspable elongate part. More preferably, the distal end of the graspable elongate part is, in use, located above a level of fluid retainable within the sump. This arrangement allows the user to remove the plug without contacting material and fluid within the sump, resulting in a more hygienic cleaning process.

It is preferred that the graspable elongate part extends through at least a part of the filter. More preferably, the filter is located in the sump. This makes the filter arrangement more compact.

The filter is, preferably, removable from the filter housing. It is also preferred that the filter is located within a cartridge which is removable from the filter housing. This makes the filter easier to access and to clean.

Preferably, the filter is a particulate filter. A particulate filter is able to filter out solid matter such as flakes of skin, cigarette ash and soap from the water in the sump.

It is preferred that the filter arrangement further comprises a further filter located downstream of the filter. More preferably, the further filter is located within the sump. This arrangement allows a second stage of filtration of the fluid in the sump, resulting in a more sanitary environment.

Preferably, the further filter is a sterilising filter comprising a material including an anti-bacterial agent. This can enable the interior of the filter arrangement to be kept substantially bacteria-free, improving the cleanliness of the hand drying apparatus. This material may be a resin. Resins release loaded agents by ion exchange, which is more convenient than conventional dosing methods and more effective than surface-acting coatings.

There is also provided hand drying apparatus comprising a main body, a cavity formed in the main body for receiving objects to be dried, an outlet disposed in the cavity and a filter arrangement as claimed in any one of the preceding claims located downstream of the outlet. Preferably, the plug is removable from the filter arrangement through the cavity. This allows the plug to be accessed and to be removed easily by a user without the need for access panels to be removed. Therefore, the sump can be cleaned without the entire filter arrangement having to be removed from the hand dryer. This makes routine cleaning more straightforward.

An embodiment of the invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a side view of a hand dryer;

Figure 2 is a perspective view of the hand dryer of Figure 1;

Figure 3 is plan view of the hand dryer of Figure 1;

Figure 4 is an exploded perspective view of a filter arrangement removed from the hand dryer of Figure 1;

Figure 5 is a perspective view of the filter arrangement of Figure 4 with the component parts fitted together;

Figure 6 is a plan view of the filter arrangement of Figure 4;

Figure 7 is a section through the filter arrangement of Figure 4 taken along the line A-A of Figure 6; and

Figure 8 is a section through the filter arrangement of Figure 4 taken along the line A-A of Figure 6 showing the filter arrangement in place in the hand dryer of Figure 1.

Figures 1 and 2 show a hand dryer 10. The hand dryer 10 includes a main body 12. A cavity 14 is formed in the main body 12. The cavity 14 is defined by opposing arcuate front and rear walls 16, 18, and has an upper end 20 and a lower end 22. The cavity 14 is open at the upper end 20 thereof, the dimensions of the opening being sufficient to allow a user's hands (not shown) to be inserted easily into the cavity 14 for drying.

A high-speed airflow is generated by a motor and fan assembly (not shown) located inside the main body 12. The high-speed airflow is expelled through two slot-like openings 24 disposed at the upper end 20 of the cavity 14 to dry the user's hands. These openings 24 are not material to the present invention. The cavity 14 is open at the sides as can be seen in Figures 1 and 2.

Referring to Figure 3, an outlet 26 is located at the lower end 22 of the cavity 14. The outlet 26 is arranged to receive fluid removed from a user's hands by the high-speed airflow expelled through the slot-like openings 24. In this embodiment, the outlet 26 forms a part of a filter arrangement 100.

Figure 4 shows an exploded view of the filter arrangement 100 in more detail. In this figure, the filter arrangement 100 has been removed from the remainder of the hand dryer 10 for clarity. The filter arrangement 100 is designed to filter particulates and impurities from, and to kill bacteria in, waste water which has passed through the outlet 26. The filter arrangement 100 includes a barrier member 102, a particulate filter unit 104, a filter housing 106 and a sterilising filter 108.

The barrier member 102 takes the form of a flat plate which, when placed in the hand dryer 10, is surrounded by the outlet 26 and prevents relatively large objects, for example cigarette butts or coins, from entering the filter arrangement 100 via the outlet 26.

The particulate filter unit 104 is in the form of a cartridge and has an outer case 110 which is substantially wedge-shaped. The outer case 110 has a flat upper surface 112. A cut-out 114 is formed in the upper surface 112. The cut-out 114 enables the particulate filter unit 104 to be located in the filter housing 106. The upper surface 112 also includes a number of through-holes in the form of a plurality of elongate slots 116. The slots 116 provide access for fluid and entrained particulates to the interior of the particulate filter unit 104. A plurality of outlet openings 118 are provided at a lower end of the outer case 110 to enable fluid to leave the particulate filter unit 104.

Referring to Figure 7, the particulate filter unit 104 includes first and second particulate filters 120, 122. The first particulate filter 120 is located within the upper part of the particulate filter unit 104 and comprises copper wool. The copper wool provides a physical filtration effect (i.e. preventing larger particles from passing through into the second particulate filter 122 and the sterilising filter 108). However, the copper wool also has a bacteria-limiting effect in that it is able to prevent uncontrolled growth of bacteria in a stagnant environment. This helps to control odour.

By providing the first particulate filter 120 within the upper, elongated part of the wedge-shaped particulate filter unit 104, the area of the bed of the first particulate filter

120 is maximised. A large bed area reduces the pressure drop across the first particulate filter 120 and increases the resistance of the particulate filter unit 104 to fouling and becoming blocked. The large bed area also improves the water collection efficiency of the filter arrangement 100.

Additionally, by locating the first particulate filter 120 at the upper part of the particulate filter unit 104, the copper wool is able to limit the growth of bacteria on the slurry of separated particulates which will form on the surface of the water, providing the maximum odour-reducing effect.

The second particulate filter 122 is located immediately below the first particulate filter 120 with no separating structure. The second particulate filter 122 comprises glass beads having a diameter of 4 mm. The glass beads are packed together within the lower part of the particulate filter unit 104 and serve as a further particulate filter stage, preventing larger particles of solid matter (in particular soap, dirt or loose skin) from entering parts of the filter arrangement 100 downstream of the second particulate filter 122.

Referring back to Figure 4, the filter housing 106 has first and second sections 124, 126. The first and second sections 124, 126 are divided by a partition wall 128. The first section 124 forms an open-ended cavity 130 into which the particulate filter unit 104 and barrier member 102 are received (this is best shown in Figure 5). A locating portion 132 projects upwardly from the partition wall 128 and is arranged to secure the particulate filter unit 104 in the cavity 130 by engagement with the cut-out 114.

The cavity 130 has an outer wall 134. The upper end of the outer wall 134 delimits a part of the outlet 26. Therefore, the outlet 26 from the cavity 14 of the hand dryer 10 is defined by the barrier member 102 and the upper end of the outer wall 134. As can be seen in Figure 3, when located in the hand dryer 10, the uppermost end of the outer wall 134 lies adjacent, and flush with, the front and rear walls 16, 18.

The lower end of the cavity 130 is arranged, in use, to function as a sump and to retain a level of water therein. This is so that the second particulate filter 122 of the particulate filter unit 104 and the sterilising filter 108 remain wetted during normal use of the hand dryer 10. The retained water comprises water received by the outlet 26 – no external water supply is required.

At the base of the cavity is located a drain 135a. A sump plug 135b is located in the drain 135a. The sump plug 135b is removable from through the cavity 130 of the filter arrangement 100 to allow any water remaining in the cavity 130 to drain out during cleaning. The sump plug 135b has an elongate upper part so that a user can grasp the sump plug 135b without having to touch any water or particulates within the cavity 130.

The second section 126 is located downstream of the first section 124, below the water line of the filter arrangement 100 in normal use. The second section 126 contains the sterilising filter 108 and includes connections to parts of the hand dryer 10 downstream of the sterilising filter 108. When the filter arrangement 100 is installed in the hand dryer 10, the whole of the second section 126 is located inside the main body 12.

An inlet 136 is located at a lower end of the cavity 130 and provides a communication path between the cavity 130 and the interior of the second section 126. The inlet 135 is covered by a mesh (not shown). The sterilising filter 108 is located downstream of the inlet 136.

The sterilising filter 108 is located within an L-shaped cavity 138 and is bounded by a weir wall 140 and a mesh 142. The sterilising filter 108 comprises particles of an iodine-loaded resin which is loaded at a concentration of 500 g/l. The iodine-loaded resin acts as a sterilising compound to kill any bacteria present in the water. The particles of the sterilising filter 108 are substantially spherical and have dimensions around 0.9 mm. However, particles having dimensions in the range of 0.1 to 2 mm could also be used.

The filter arrangement 100 is arranged such that, when the water level in the sterilising filter 108 has reached its natural level in normal use, the iodine-loaded resin of the sterilising filter 108 is completely submerged in water. This is beneficial because the sterilising filter 108 is prone to cracking and forming air pockets if it is permitted to dry out once it has become wetted. By keeping the sterilising filter 108 continuously wetted, this problem is avoided. In addition, this configuration ensures that the water flow is well distributed. Due to the cavity 138 being in communication with the cavity 130 through the inlet 136, the water levels in the cavity 138 and the cavity 130 will, in use, equalise.

A collector 144 is located downstream of the sterilising filter 108. The collector 144 is separated from the sterilising filter 108 by the weir wall 140. The height of the weir wall 140 determines the maximum level of liquid that can be contained within the collector 144. The collector 144 is arranged to collect filtered and sterilised water which has passed through the particulate filter unit 104 and the sterilising filter 108. The collector 144 has an outlet 146 located at the lower end of the collector 144 through which water can be leave the collector 144.

A level sensor 148 is provided in the collector 144 in order to determine the level of the water in the collector 144 and, therefore, to determine when the collector 144 requires emptying. The actual form of the level sensor 148 is not material to the invention. Any suitable means could be used; for example, a magnetic float, or a suitable thermistor may be used.

An air outlet 150 is located at the upper end of the collector 144 adjacent the level sensor 148. When the filter arrangement 100 is located in the hand dryer 10, the air outlet 150 is arranged to supply atmospheric air to the interior of the collector 144. This ensures that the fluid levels within the interior of the second section 126 equalise with the fluid levels in the cavity 130 of the first section 124.

Referring now to Figure 8, when the filter arrangement 100 is located within the hand dryer 10, the outlet 146 is in communication with parts of the hand dryer 10 downstream of the filter arrangement 100. A pipe 152 forming part of the hand dryer 10 is connected to the outlet 146. A pump 154 is located in the flowpath along the pipe 152 and is arranged to pump water from the collector 144 for disposal. An example of a disposal method may include, for example, evaporation by a high frequency agitator as shown and described in WO 2007/080364. However, the actual method of disposal of water from the hand dryer 10 is not material to the present invention and will not be discussed any further here.

A breather pipe 156 is connected to the air outlet 150 and provides a communication path between the atmospheric air outside the hand dryer 10 and the collector 144. The breather pipe 156 leads to an air hole 158 located in the cavity 14 of the hand dryer 10. The air hole 158 is selectively closeable by means of a solenoid valve 160. The solenoid valve 160 is located within the hand dryer 10 adjacent the air hole 158. The solenoid valve 160 is arranged to be in a normally open state. When the filter arrangement is in normal use and the pump 154 is not operating, the air hole 158 remains in an open state so that the pressure inside and outside the filter arrangement 100 can equalise.

However, when the pump 154 is operating, the air hole 158 must be closed such that the pump 154 does not draw air into the collector 144 through the air hole 158. By closing the air hole 158 through energisation of the solenoid valve 160, the pressure created by operation of the pump 154 can be used to draw water through the sterilising filter 108 into the collector 144. This enables the filter arrangement 100 to be flatter in shape, because gravity feeding of water is not essential to draw water through the filter arrangement 100.

In use, the water removed from a user's hands during the drying process flows down the front wall 16 and the rear wall 18 of the cavity 14 and into the outlet 26 disposed at the lower end 22 of the cavity 14. Larger items of dirt and debris (for example, cigarette butts or coins) will be prevented from entering the outlet by the barrier member 102 and

will remain at the lower end 22 of the cavity 14 where they can be removed easily by a user.

Referring to Figure 7, upon entering the outlet 26 (arrows A), the water passes into the filter arrangement 100. The water passes through the plurality of elongate slots 116 in the flat upper surface 112 of the particulate filter unit 104. Upon entering the interior of the particulate filter unit 104, the water spreads evenly across the surface of the first particulate filter 120 comprising copper wool. The water moves down through the copper wool (arrow B) of the first particulate filter 120 under the influence of gravity. During this process, bacteria in the water are suppressed and larger particulates in the water are removed, the particulates remaining trapped in the copper wool.

The water then passes through the plurality of glass beads (arrow B) that form the second particulate filter 122. This process removes further particles of dirt and debris from the water. By the time that the water reaches the sterilising filter 108, the majority of the solid particulates in the water will have been removed by the particulate filter unit 104.

The pre-treated and filtered water then exits the particulate filter unit 104 through the outlet openings 118 and passes through the inlet 136 into the sterilising filter 108 (arrow C). The sterilising filter 108 sterilises the water by deactivating bacteria in the water. The sterilising filter 108 comprises iodine-loaded resin releases iodine into the water at a rate of 1 to 5 parts per million (ppm). Iodine is a strong oxidant and hence acts as broad spectrum antimicrobial.

The water flows through the sterilising filter 108, is sterilised and then remains in the bottom thereof. This process continues as more water enters the outlet 26 and flows down through the particulate filter unit 104 to be collected at the bottom of the sterilising filter 108. The level of the water collected in the sterilising filter 108 (and lower end of the particulate filter unit 104) will continue to rise until it reaches the maximum level permitted by the weir wall 140. At this point, if more water is

introduced through the outlet 26, a net movement of water over the weir wall 140 will occur in the direction shown by the arrow D.

At this point, the water flows over the weir wall 140 and is deposited in the collector 144 for disposal. Therefore, the weir wall 140 forces the water to follow a convoluted path from the inlet 136, through the L-shaped cavity 138 and over the weir wall 140. If the weir wall 140 were not present, then the iodinated resin forming the sterilising filter 108 would not be kept submerged, and water entering the sterilising filter 108 would be less reliably directed through the sterilising filter 108, reducing the effectiveness of the sterilisation process.

The water level in the collector 144 will gradually rise towards the top of the weir wall 140. However, if the level in the collector 144 is allowed to rise beyond the top of the weir wall 140, the whole filter arrangement 100 would eventually overflow out of the outlet 26. In order to avoid this problem, the water is removed from the collector 144 at regular intervals.

The level detector 158 detects when the level of water in the collector 144 rises above a pre-determined maximum allowable level. At this point, the pump 154 is started and the solenoid valve 160 is energised to close the air hole 158. The pump 154 operates for a pre-determined period, for example 5 seconds, in order to remove a volume of fluid. By way of an example, a volume of 2 cc may be pumped from the collector 144 during a typical 5 second pumping operation. The pumped water is then passed to a suitable disposal unit (not shown). The actual method of disposal of the water is not material to the present invention.

When the air hole 158 is closed by the solenoid valve 160, the collector 144 effectively becomes a sealed system. Therefore, when the pump 154 operates and water is pumped therethrough, a pressure difference between the collector 144 and the cavity 130 will result. This pressure difference will draw fluid from the lower end of the cavity 130 into

the sterilising filter 108, and cause additional water to flow over the weir wall 140 and into the collector 144 for subsequent disposal.

When the pump 154 has pumped sufficient water from the collector 144 such that the level detector 158 is no longer triggered, the pump 154 is switched off. The solenoid valve 160 is then de-energised, so that the air hole 158 again opens. This allows the pressures inside and outside the filter arrangement 100 to equalise, permitting gravity feeding of water into the sterilising filter 108 whilst the pump 154 is switched off.

After a period of use, the filter arrangement 100 will require maintenance. In normal use, the particulate filter unit 104 will become clogged or blocked with particulates before the sterilising filter 108 requires replacement. The particulate filter unit 104 is, therefore, arranged to be removable from the filter housing 106 separately from the sterilising filter 108.

The barrier member 102 and the particulate filter unit 104 are removable from the main body 12 of the hand dryer 10 through the cavity 14. This provides easy and quick access for a user. The user removes the barrier member 102 first, lifting it upward to expose the particulate filter unit 104. The particulate filter unit 104 can then be removed in the fashion of a cartridge from the remainder of the filter arrangement 100 through the cavity 14.

The particulate filter unit 104 can be cleaned by running clean water through it. The nature of the copper wool and the glass beads (forming the first and second particulate filters 120, 122 respectively) mean that a vigorous water flow through these media will cause them to move around and to release the captured dirt, soap and skin particles. If required, the copper wool and the glass beads can be replaced. Occasionally, after a long period of use, the entire particulate filter unit 104 may require replacement.

When the particulate filter unit 104 is removed from cavity 130, a quantity of water and particulate slurry will remain in the lower end of the cavity 130. In order to remove this

material easily and without undue inconvenience to the user, the sump plug 135b can be grasped and pulled from the drain 135a located in the base of the cavity 130. The sump plug 135b can be removed through the cavity of the hand dryer, making maintenance and cleaning straightforward.

Once the sump plug 135b is removed from the drain 135a, the waste water and particulate slurry will then pass through the drain 135a and out of the hand dryer 10 at a lower end thereof. A bucket or other suitable receptacle can be used to collect the waste water and particulate slurry. The cavity 130 and first section 124 can then be rinsed with clean water in order to clean it. The clean water will flow out through the drain 135a and can be collected in the bucket or other suitable receptacle. The sump plug 135b can then be replaced in the drain 135a to seal therein.

When cleaning or replacement is complete, the particulate filter unit 104 can be replaced, cartridge-like, in the cavity 130 formed in the first section 124 of the filter housing 106 by aligning the cut-out 114 with the locating portion 132. The barrier member 102 can then be replaced on top of the particulate filter unit 104. The filter arrangement 100, now clean, can be returned to use quickly and efficiently, with the minimum of effort required by the user.

Eventually, the sterilising filter 108 and parts of the filter arrangement 100 downstream thereof will require cleaning and maintenance. In order to do this, the filter arrangement 100 is removed downwardly through the interior of the main body 12 of the hand dryer 10. The entire filter arrangement 100 can then be replaced, or individual parts thereof replaced or cleaned as required.

Removal of the entire filter arrangement 100 is less straightforward and more time consuming than removal of just the particulate filter unit 104 as described above. However, the entire filter arrangement 100 will need to be removed far less frequently than the particulate filter unit 104, reducing the number of man hours required to maintain the filter arrangement 100 in a fully operational state.

It will be understood that the invention is not to be limited to the precise details described above. Other variations and modifications will be apparent to the skilled reader.

The particulate filter unit need not be removable through the cavity. Other arrangements may be used; for example, the particulate filter unit may be removed by sliding from the side, front or rear of the main body of the hand dryer.

There need not be a filter housing in which both the particulate filter and the sterilising filter can be located. The particulate filter unit and the sterilising filter may be located separately within the main body, and connected by a conduit such as a pipe.

Additionally, the outlet need not be formed by the filter arrangement. A separate outlet may be located remote from the filter arrangement and connected by a suitable conduit, such as a length of pipe.

Further, there need not be two particulate filters. Any number of particulate filters may be provided. For example, a single particulate filter may be used. The particulate filters may also be located, in use, out of the water in the filter arrangement.

Alternatively, the positions of the first and second particulate filters may be reversed, with the wool located beneath the plurality of beads.

Any suitable material may be used for the particulate filter; it does not need to be metallic wool and/or beads. Other types of particulate filter media could be used; for example, glass-fibre brushes, plastic brushes, porous ceramics, plastic beads or small stones, preferably formed from an inert material with a density greater than 1 g/l.

If a metal is used, it need not be in the form of a wool. Further, other metals may be used; for example, aluminium or silver wool may be used. Further, if beads are to be used, they need not be made from glass. Plastic or metal may be equally suitable.

Additionally, the dimensions of the beads need not be 4 mm. They may be varied in size from 1 mm to 6 mm.

As a further variation, the size of the particulate filter may be varied and may be any size suitable to ensure that the majority of the particulates are filtered and removed from the water to prevent the sterilising filter from clogging and becoming blocked.

The sterilising filter need not be formed of a resin with substantially spherical particles with dimensions in the range of 0.1 to 2 mm. Other particle shapes or sizes could be used, for example by grinding. Alternatively, a single, porous block of resin could be used.

As a further variation, the sterilising filter need not be formed from a resin. Other inorganic host media could be used; for example, inorganic polymers, metal chelates, metal complexes or crystal structures.

The loading of iodine need not be 500 g/l and may be within a preferred range of 300 g/l to 600 g/l. Further, the concentration of iodine released into the water may also be outside the range of 1 to 5 ppm. What is important is that the concentration is high enough to kill the bacteria in the water whilst low enough to avoid discolouring the water. A high iodine concentration may be harmful and may discolour surfaces. Further, the volume of the sterilising filter can be varied, provided it is sufficient to sterilise the water.

Additionally, the anti-bacterial agent in the sterilising filter need not be iodine and could include alternative bacteria-killing media; for example, a halogen-containing material or a precursor to a halogen-containing material. Typical, non-exhaustive, examples of these are materials including: Chlorine, Bromine, Iodine, Hypochlorite or Hypobromide. Alternatively, other methods of sterilising bacteria may be implemented; for example, Titanium dioxide or UV-radiation activated silver nanoparticles.

Further, the particulate filter and sterilising filter need not be located, in use, submerged in water in a sump. They could be located out of the water, or both could be partially submerged in the water. Alternatively, no sump may be provided.

As a further variation, the filter arrangement need not be removable from the hand drying apparatus. The filter arrangement could remain inside the casing of the drying apparatus with only the particulate filter being removable.

Additionally, there need not be a barrier member. If there is a barrier member, it need not be located directly above the particulate filter unit and may, for example, be located at the side or spaced therefrom.

Additionally, other types of hand drying apparatus could be used other than that shown in the figures. The invention may be applied to conventional hot air hand dryers, or hand drying apparatus having different structural configurations.

CLAIMS

1. A filter arrangement for a hand dryer, the filter arrangement comprising a filter housing removably insertable into a hand dryer and a filter located in the filter housing, the filter housing defining a sump having a base surface, wherein a drain aperture is formed in the base surface and a plug is removably located in the drain aperture.

2. A filter arrangement as claimed in claim 1, wherein the plug is removable from the drain aperture through the sump.

3. A filter arrangement as claimed in claim 2, wherein the plug has a graspable elongate part.

4. A filter arrangement as claimed in claim 3, wherein the distal end of the graspable elongate part is, in use, located above a level of fluid retainable within the sump.

5. A filter arrangement as claimed in claim 3 or 4, wherein the graspable elongate part extends through at least a part of the filter.

6. A filter arrangement as claimed in any one of the preceding claims, wherein the filter is located in the sump.

7. A filter arrangement as claimed in any one of the preceding claims, wherein the filter is removable from the filter housing.

8. A filter arrangement as claimed in any one of the preceding claims, wherein the filter is located within a cartridge which is removable from the filter housing.

9. A filter arrangement as claimed in any one of the preceding claims, wherein the filter is a particulate filter.

10. A filter arrangement as claimed in any one of the preceding claims, further comprising a further filter located downstream of the filter.

11. A filter arrangement as claimed in claim 10, wherein the further filter is located within the sump.

12. A filter arrangement as claimed in claim 10 or 11, wherein the further filter is a sterilising filter comprising a material including an anti-bacterial agent.

13. A filter arrangement substantially as hereinbefore described with reference to the accompanying drawings.

14. Hand drying apparatus comprising a main body, a cavity formed in the main body for receiving objects to be dried, an outlet disposed in the cavity and a filter arrangement as claimed in any one of the preceding claims located downstream of the outlet.

15. Hand drying apparatus as claimed in claim 14, wherein the plug is removable from the filter arrangement through the cavity.

16. Hand drying apparatus substantially as hereinbefore described with reference to the accompanying drawings.

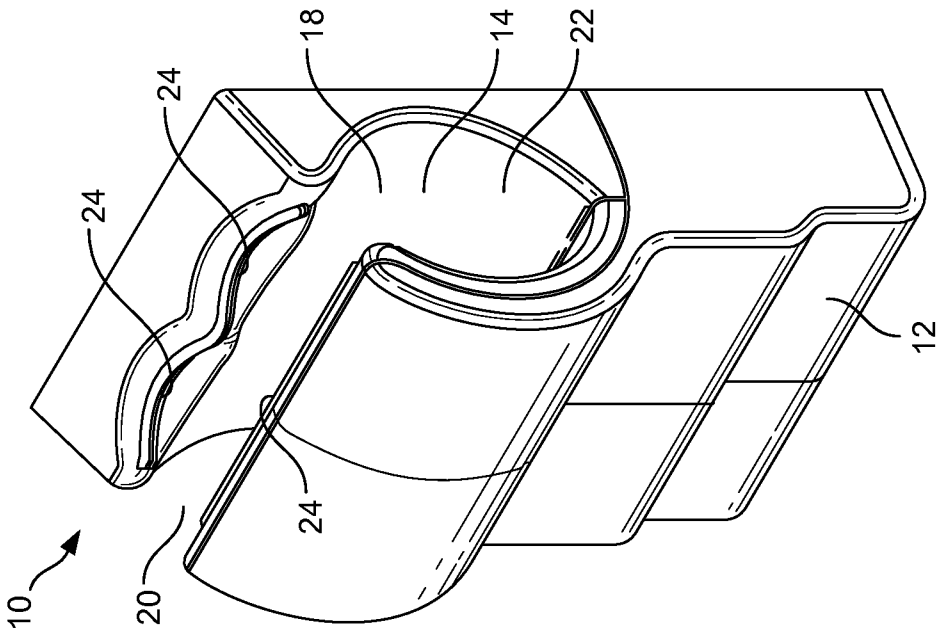


FIG. 2

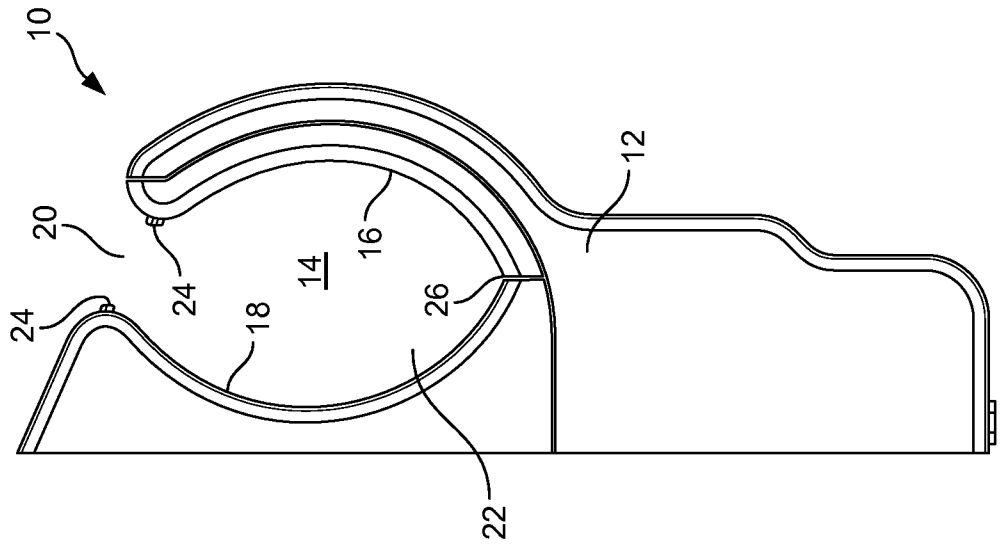


FIG. 1

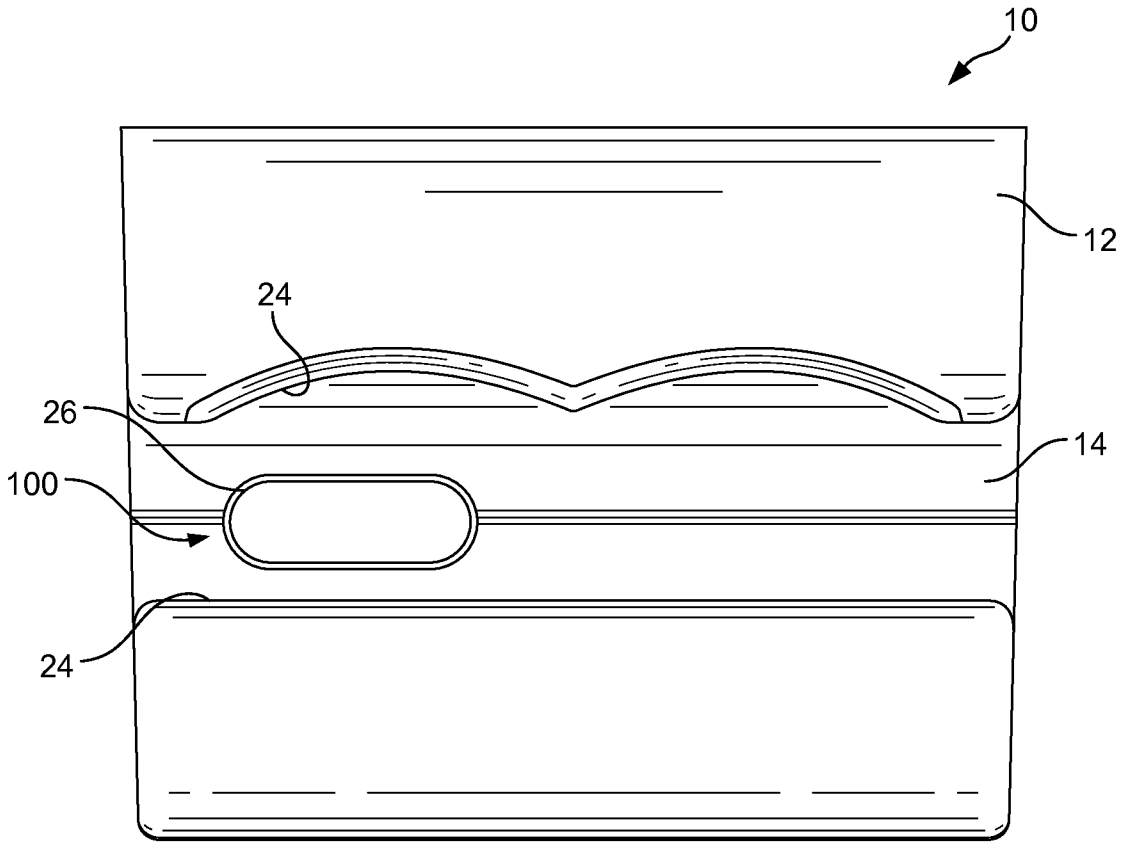


FIG. 3

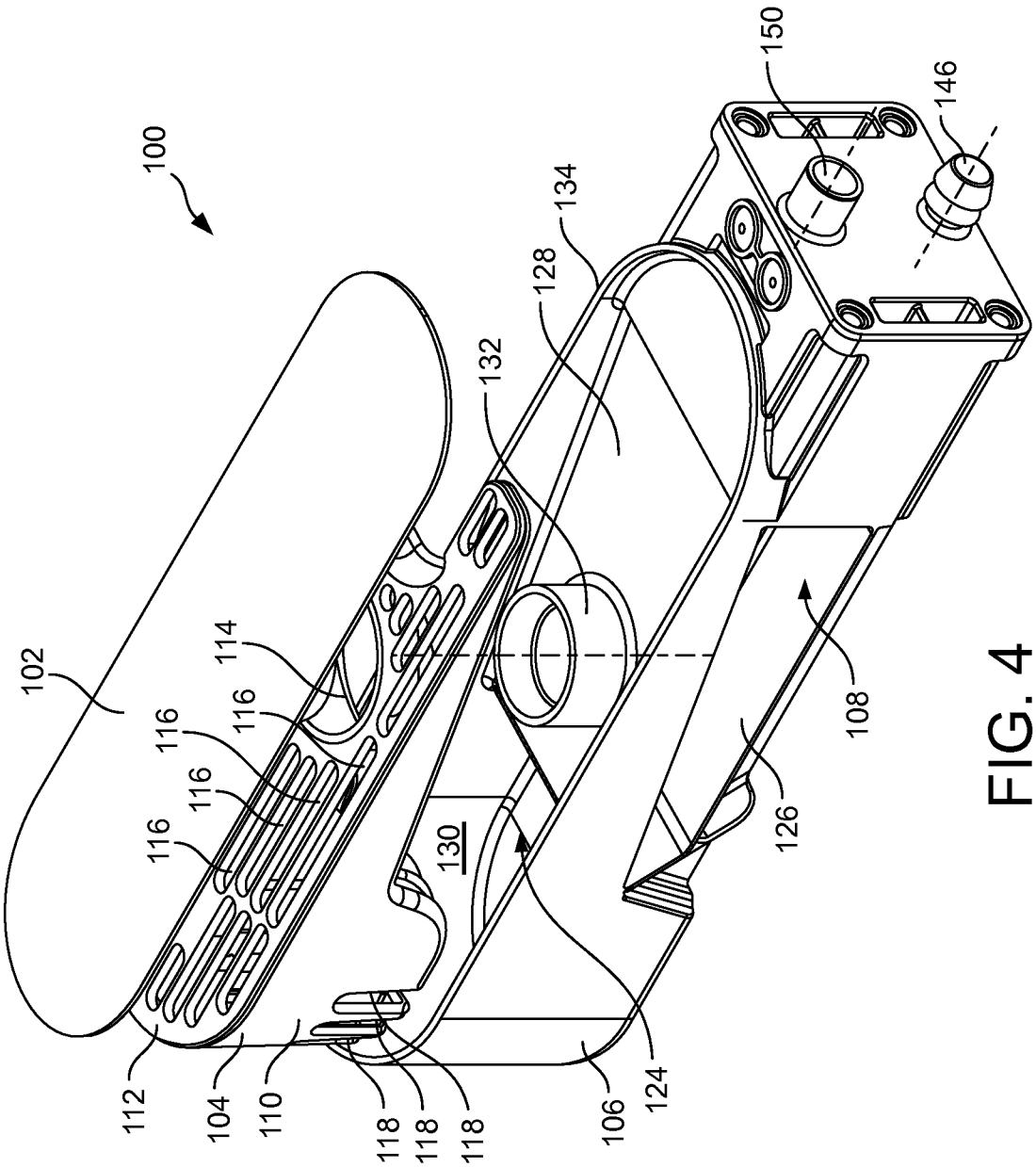

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FIG. 4

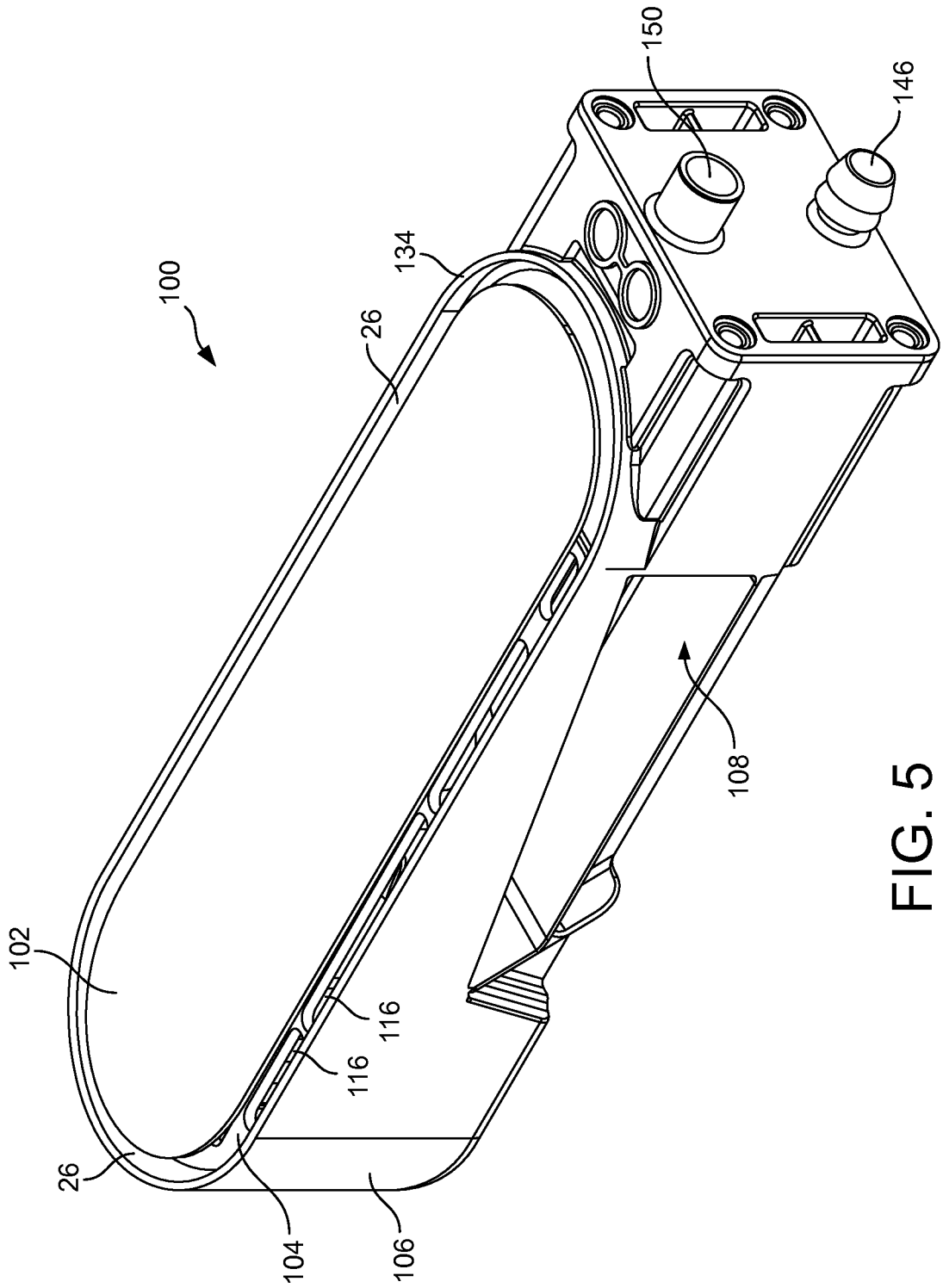


FIG. 5

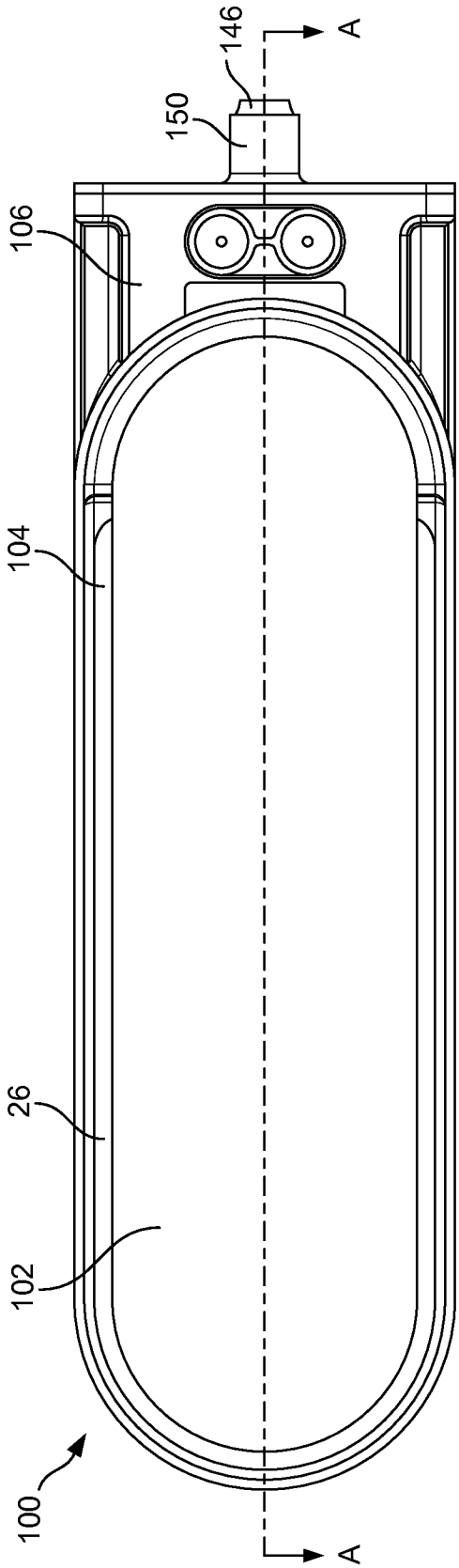

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FIG. 6

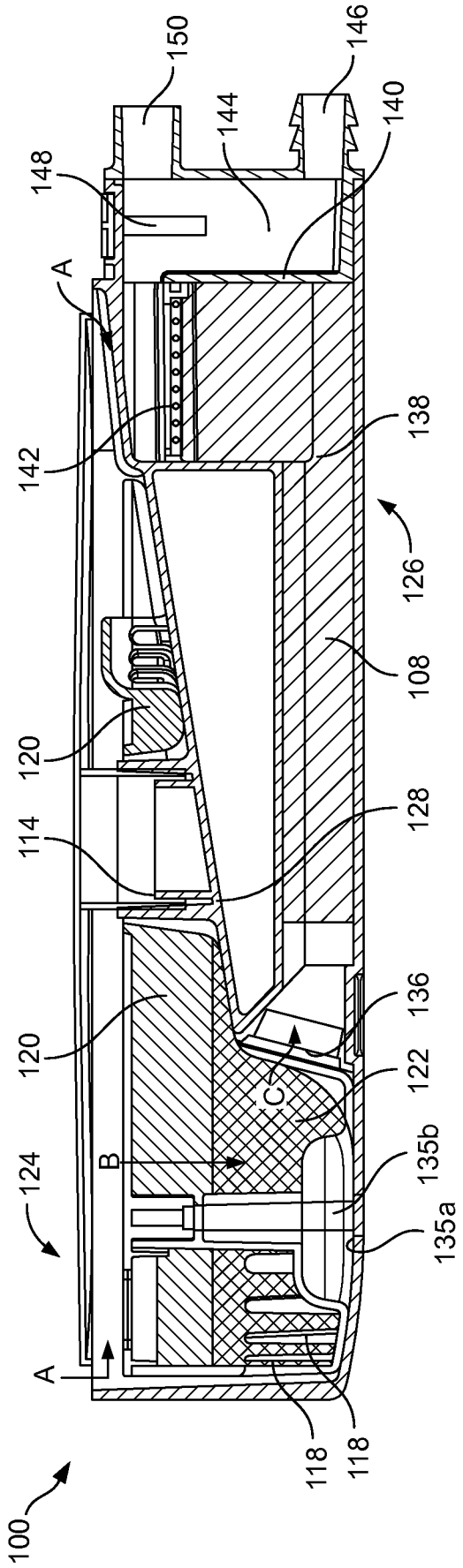

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FIG. 7

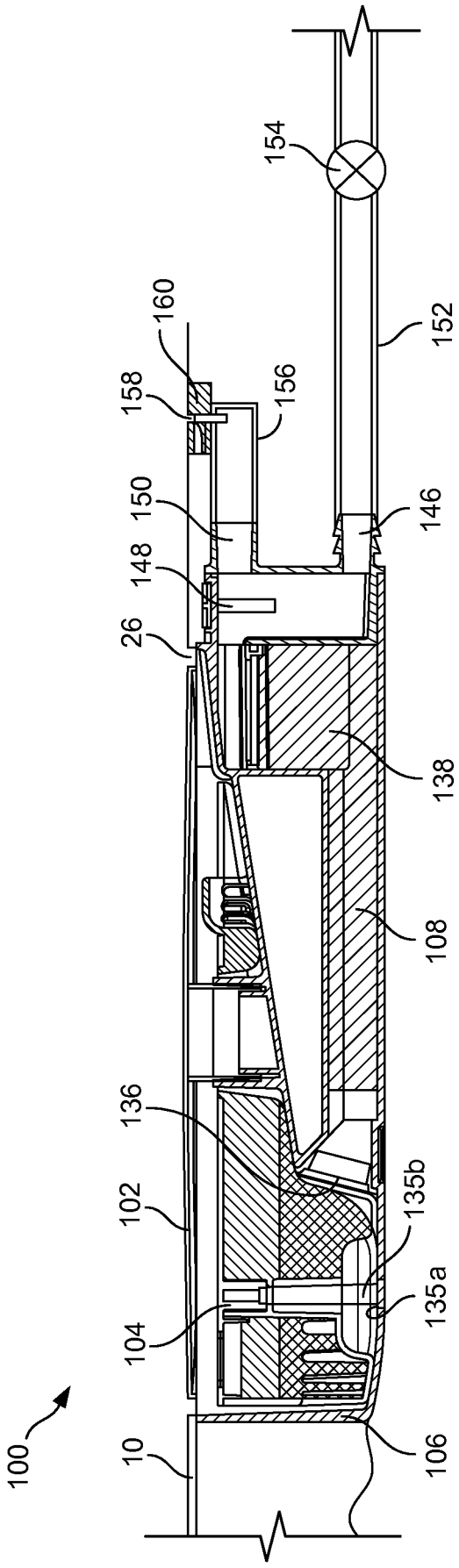

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FIG. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2009/050707

A. CLASSIFICATION OF SUBJECT MATTER
INV. A47K10/48

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)
A47K B01D

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2007/088318 A (DYSON TECHNOLOGY LTD [GB]; BROWN NATHAN CHARLES [GB]; SAVILLE TOBY JAM) 9 August 2007 (2007-08-09) cited in the application page 3, line 1 - page 7, line 7 page 10, lines 4,5; figures 1a,1b,2,3	1,6, 9-12,14
A	GB 2 434 160 A (DYSON TECHNOLOGY LTD [GB]) 18 July 2007 (2007-07-18) page 3, line 20 - page 8, line 12; figures 1a,1b,2,3	1,9,10, 12,14
A	JP 11 018999 A (DUSKIN CO LTD) 26 January 1999 (1999-01-26) cited in the application abstract; figure	

☐ Further documents are listed in the continuation of Box C.

☒ 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 document 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	Date of mailing of the international search report
21 October 2009	29/10/2009

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Fajarnés Jessen, A

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2009/050707

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.: 13, 16
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:
see FURTHER INFORMATION sheet PCT/ISA/210

3. ☐ Claims Nos.:
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 allsearchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an 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 reportcovers 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.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 13, 16

Claims 13 and 16 do not contain any clear technical features defining a subject-matter but only refer to the description and drawings. Thus a reasonable search concerning these claims is not possible. (Rule 6.2(a) PCT)

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.2), should the problems which led to the Article 17(2)PCT declaration be overcome.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2009/050707

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2007088318 A	09-08-2007	AU 2006337428 A1	09-08-2007
		CA 2641182 A1	09-08-2007
		CN 101336086 A	31-12-2008
		EP 1978857 A1	15-10-2008
		GB 2434745 A	08-08-2007
		JP 2009525105 T	09-07-2009
		KR 20080080225 A	02-09-2008
		US 2008317448 A1	25-12-2008
GB 2434160 A	18-07-2007	AT 419776 T	15-01-2009
		AU 2006334532 A1	19-07-2007
		CA 2635029 A1	19-07-2007
		CN 101360441 A	04-02-2009
		EP 1971248 A1	24-09-2008
		ES 2318798 T3	01-05-2009
		WO 2007080363 A1	19-07-2007
		JP 2009523224 T	18-06-2009
		KR 20080077022 A	20-08-2008
		US 2008313919 A1	25-12-2008
JP 11018999 A	26-01-1999	NONE	