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(56) Documents Cited:
**GB 2144325 A** **JP 110244192 A**

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(54) Abstract Title: **Drying apparatus with waste water filter**

(57) A drying apparatus 10 comprises an outer case 12 defining a cavity 16 in which items are dried in use, an outlet 22 for waste liquid such as water at the lower end of the cavity and a filter unit 200 downstream of the outlet, the filter comprising a particulate filter 216 and a sterilising filter 214 for removing particulates and bacteria from the waste liquid. In use, the device produces a hygienic and sanitary waste liquid output from the filter unit.

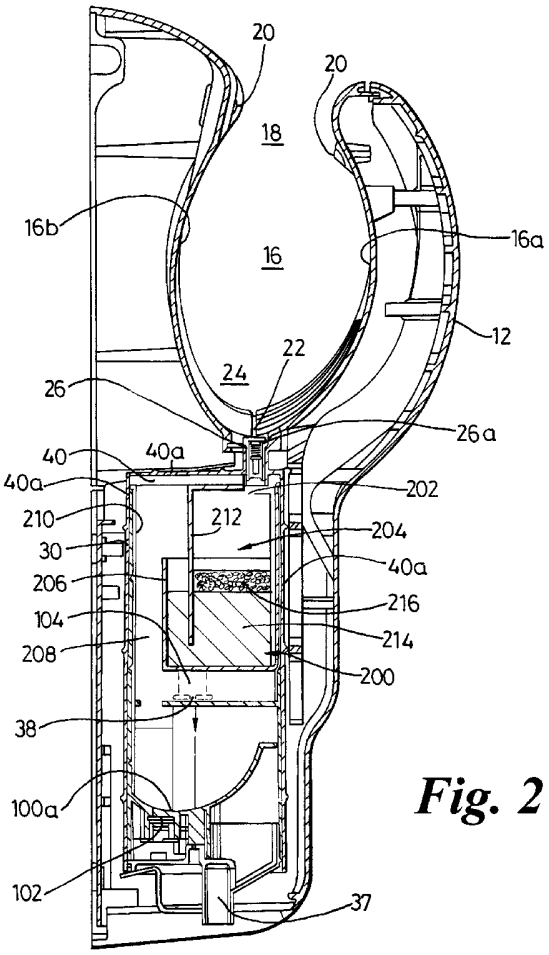


*Fig. 2*

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

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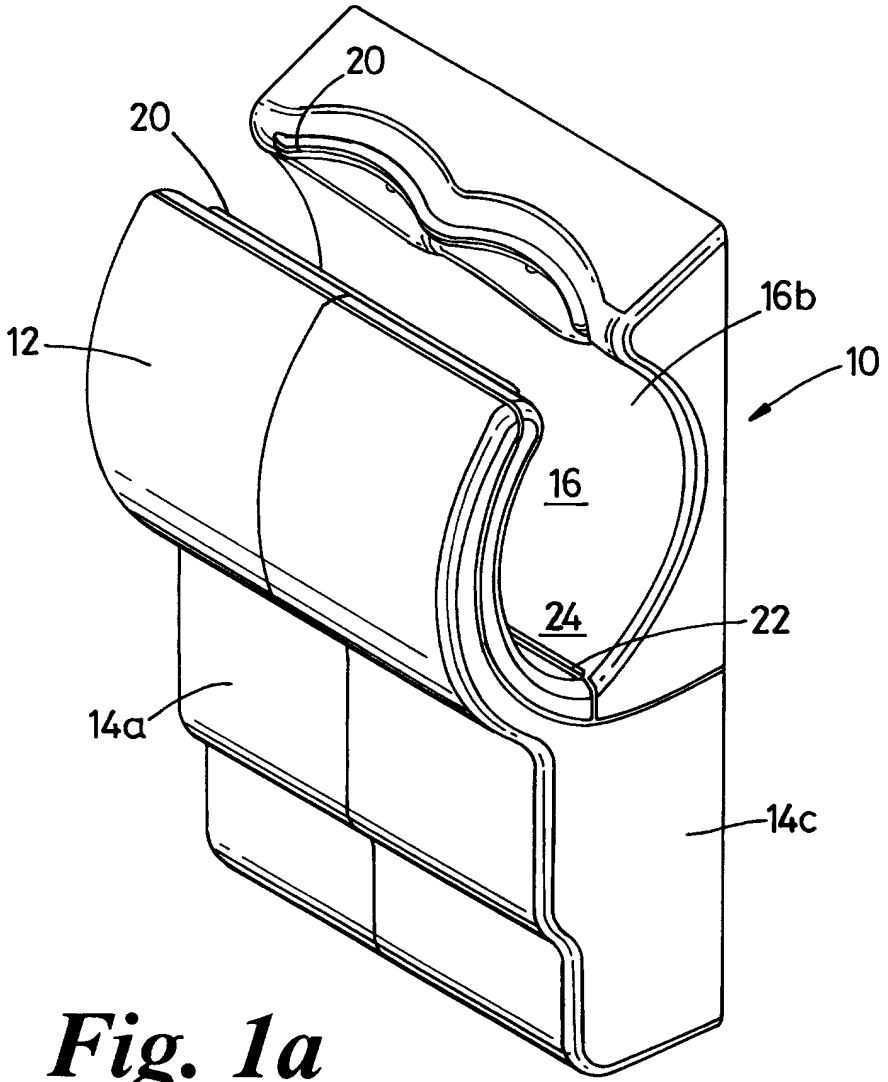


Fig. 1a

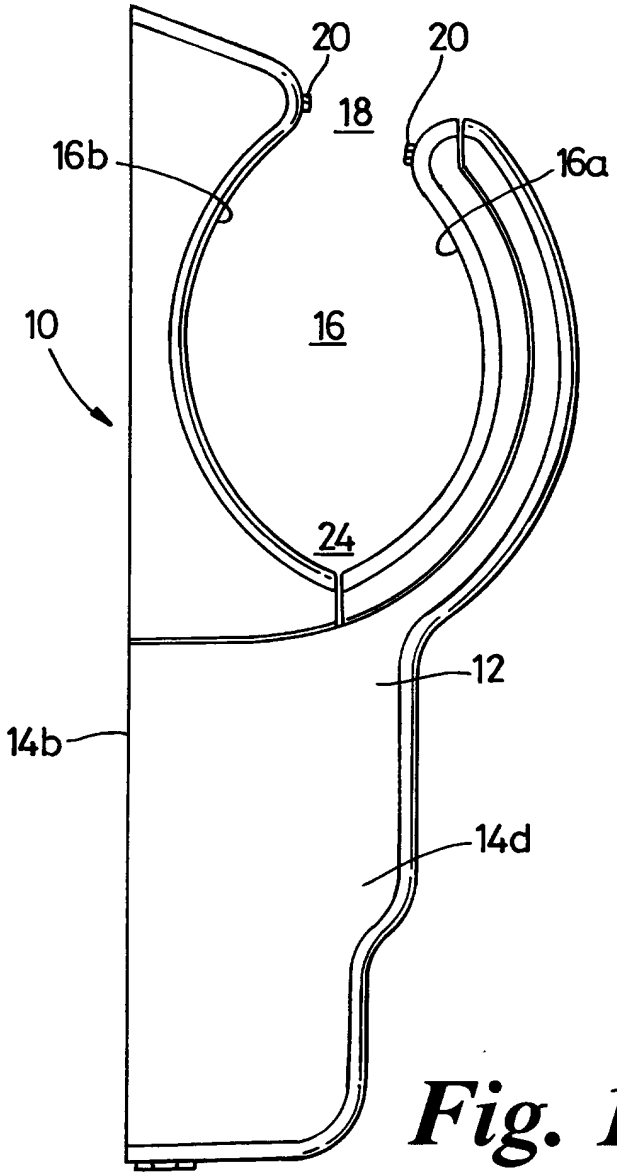


Fig. 1b

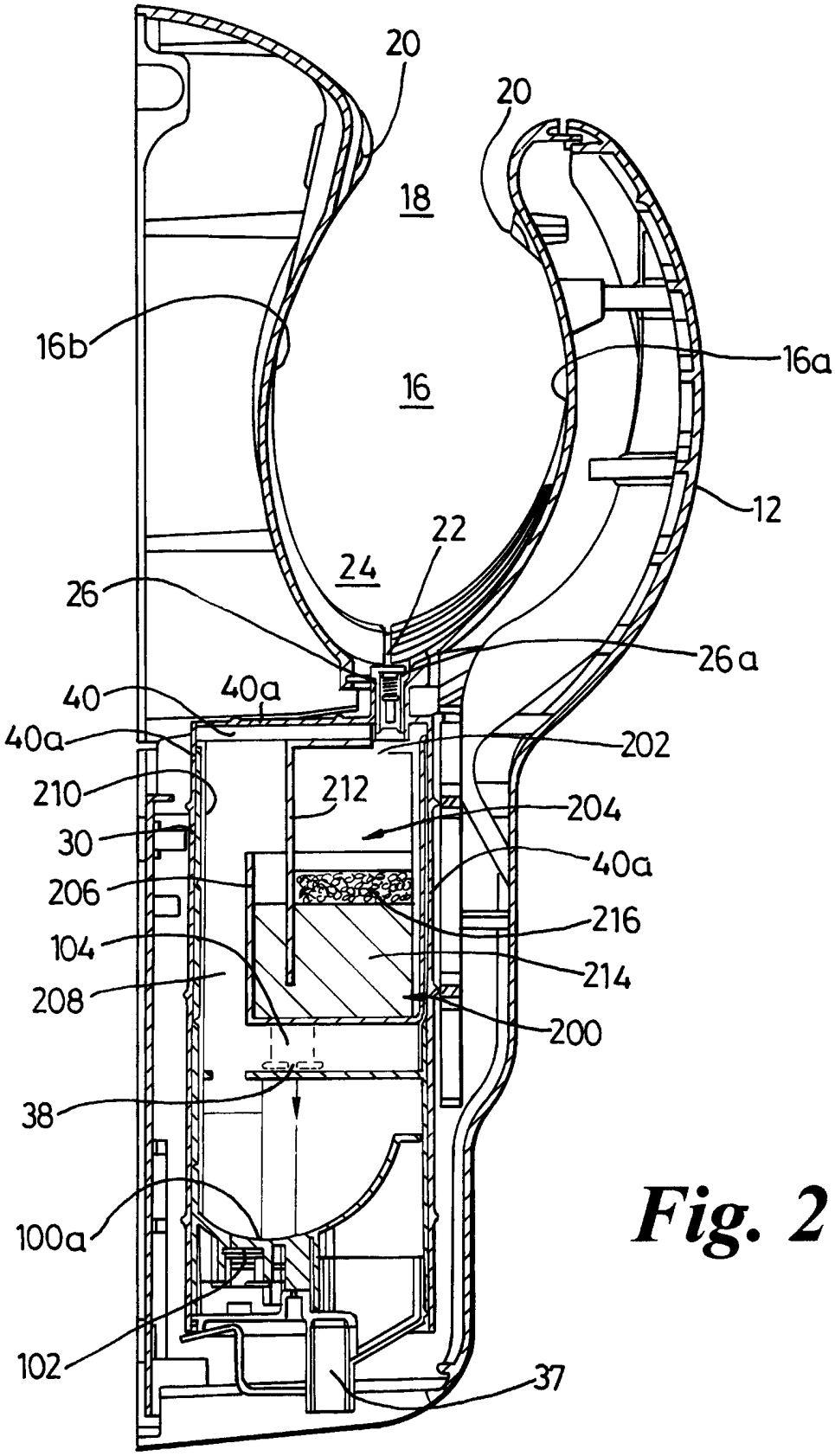
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*Fig. 2*

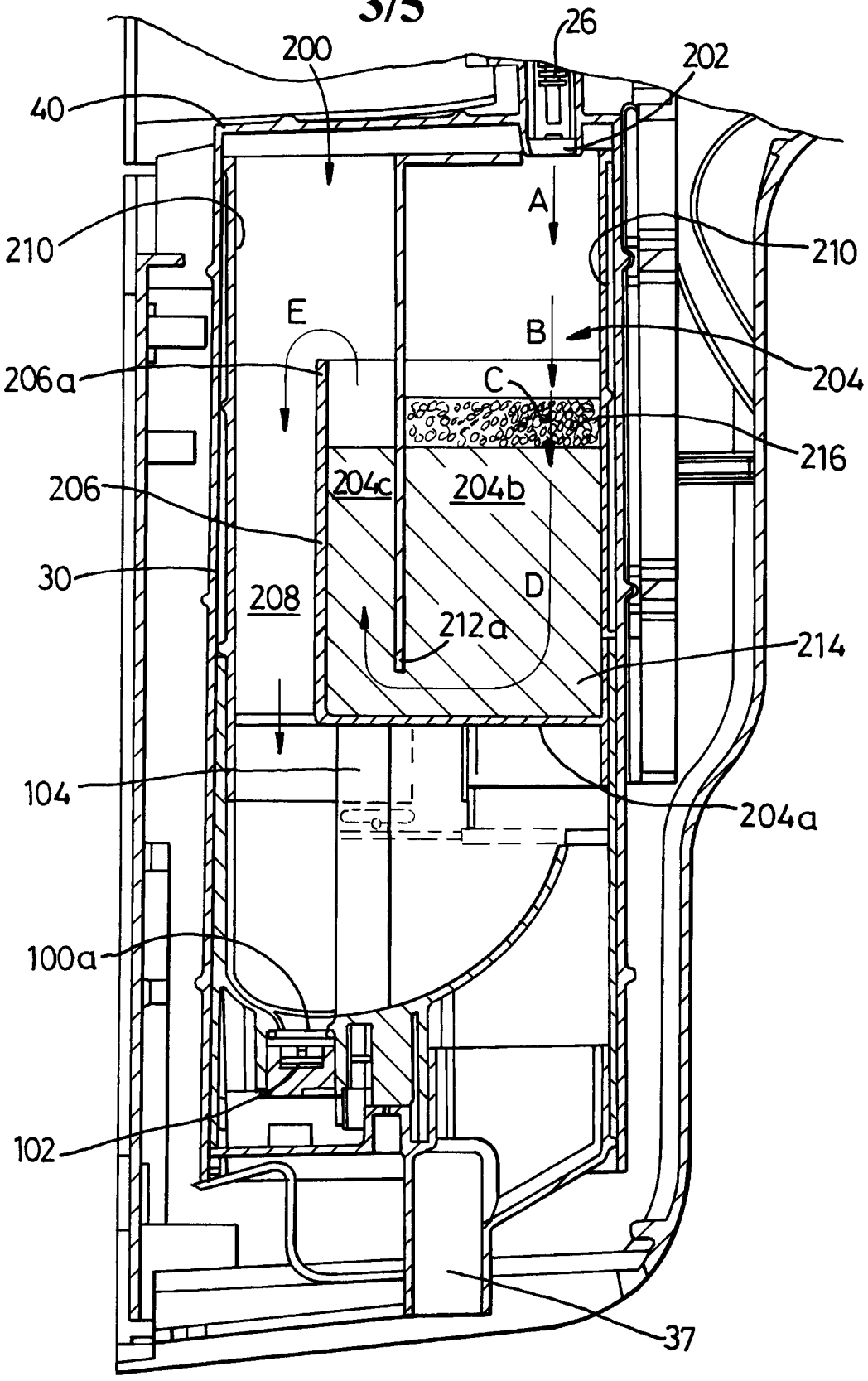
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*Fig. 3*

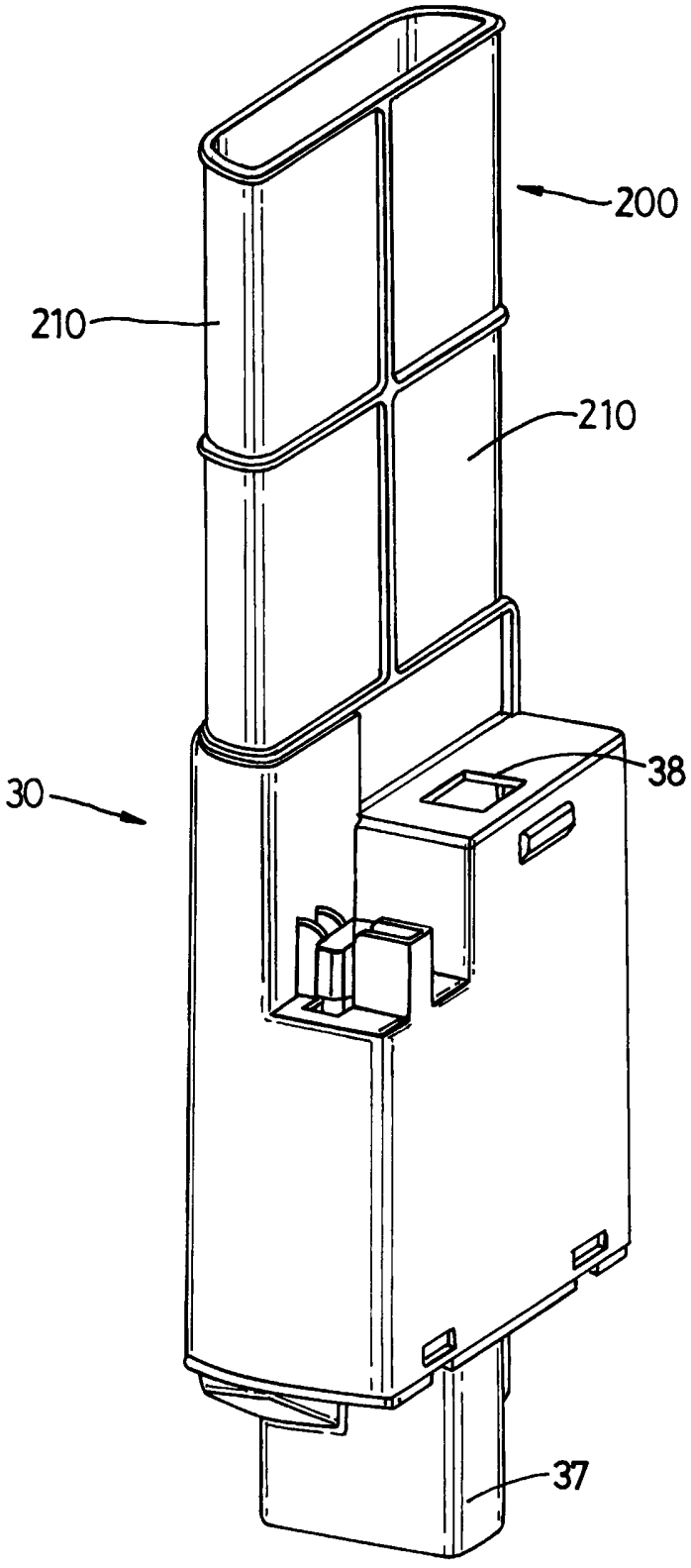


*Fig. 4*

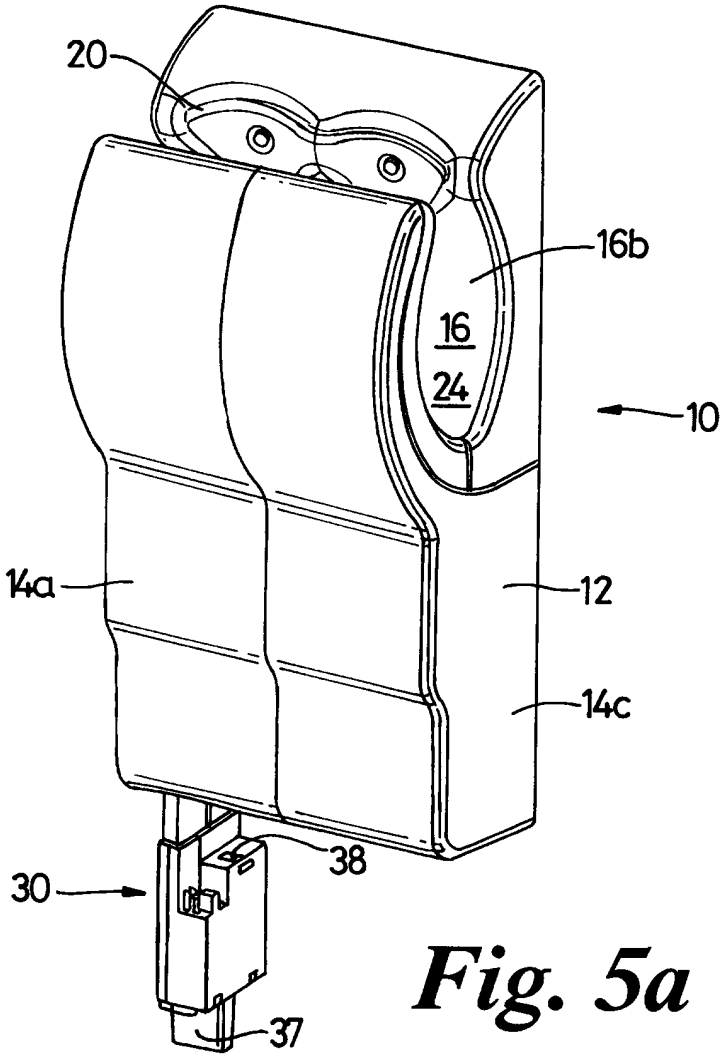


Fig. 5a

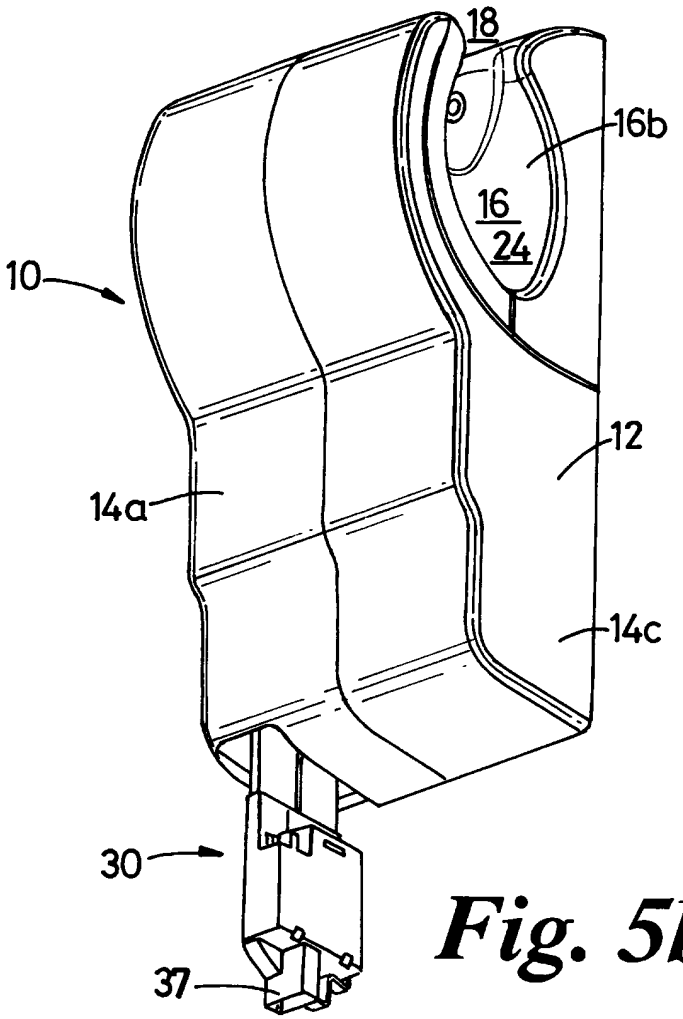


Fig. 5b

# A filter

The present invention relates to drying apparatus. Particularly, the invention relates to drying apparatus including a filter unit for removing particulates and bacteria from a waste liquid such as water.

Conventional arrangements for collecting and removing waste water from drying apparatus such as hand dryers are well known from, for example, US 5,459,944. Waste water is collected via a duct or similar and transferred to a drip collector for subsequent manual removal. Such storage of waste water is unhygienic, may lead to the spread of bacteria and requires regular maintenance to empty the drip collector and maintain a sanitary environment.

The addition of an antibacterial water absorption sheet with a large surface area to encourage evaporation is known from JP 11-18999 A. This counters some of the problems of bacterial infestation and results in less frequent emptying of a water collector. However, particulate matter will be deposited on the sheet, and this will affect the performance of the machine over time and require frequent cleaning.

It is an object of the present invention to provide drying apparatus which is capable of filtering and sterilising liquid more efficiently and reliably than prior art apparatus.

The invention provides drying apparatus comprising an outer case, a portion of the outer case defining a cavity in which articles can be dried, an outlet disposed at the lower end of the cavity and a filter unit arranged downstream of the outlet, wherein the filter unit comprises a particulate filter and a sterilising filter. By providing a filter unit comprising a particulate filter and a sterilising filter, solid matter and bacteria can be removed from the waste liquid. This results in a hygienic and sanitary waste liquid output from the filter unit.

Preferably, the sterilising filter is located downstream of the particulate filter. By this arrangement, the particulate filter can remove some solid material and larger particulates from the waste liquid to prevent the sterilising filter from clogging.

Preferably, the filter unit further comprises flow directing means for guiding liquid through the filter unit. By providing flow directing means, the liquid can be directed to flow through the sterilising filter. The flow directing means allow efficient use of the sterilising filter ensuring that the water leaving the filter unit has been sufficiently treated.

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

Figure 1a is a perspective view of a hand dryer according to the present invention;

Figure 1b is a side view of the hand dryer of Figure 1a;

Figure 2 is a section through the hand dryer of Figure 1a showing a filter unit;

Figure 3 is an enlarged version of part of Figure 2 showing the internal workings of the hand dryer and the filter unit in greater detail;

Figure 4 is a perspective view of a liquid treatment module including the filter unit removed from the hand dryer of Figure 1a;

Figure 5a is perspective view from above of the hand dryer of Figure 1a showing the liquid treatment module partially removed from the hand dryer; and

Figure 5b is a perspective view from below of the hand dryer of Figure 1a showing the liquid treatment module partially removed from the hand dryer.

Figures 1a and 1b show a hand dryer 10 according to the present invention. The hand dryer 10 includes an outer case 12, a front wall 14a, a rear wall 14b, two side walls 14c, 14d and a cavity 16. The rear wall 14b may include elements suitable for attaching the hand dryer 10 to a wall surface or other suitable fixture. Elements for connecting the hand dryer 10 to a power source may also be included.

The cavity 16 is defined by opposing arcuate front and rear walls 16a, 16b. The cavity 16 is open at its upper end 18, and the dimensions of the opening are sufficient to allow a user's hands (not shown) to be inserted easily into the cavity 16 for drying. A high-speed airflow is generated by a motor unit having a fan (not shown). The motor unit and fan are located inside the outer case 12. The high-speed airflow is expelled through two slot-like openings 20 disposed at the upper end 18 of the cavity 16 to dry the user's hands. These features are not material to the present invention and will not be described any further here. The cavity 16 is open at the sides as can be seen in Figures 1a and 1b.

As can be seen from Figure 2, a drain channel 22 is located at the lower end 24 of the cavity 16. The drain channel 22 is delimited by the lower edges of the front wall 16a and the rear wall 16b of the cavity 16 and slopes downwardly towards one side of the cavity 16. An outlet 26 is located in the drain channel 22. The outlet 26 can take any suitable form. In this embodiment, it comprises a circular aperture with a central plug 26a. The outlet 26 and plug 26a delimit a narrow, annular opening.

Referring to Figures 2 and 3, a chamber 40 is formed in a lower part of the outer case 12 below the cavity 16. The chamber 40 is delimited by a plurality of chamber walls 40a and has an open lower end. A liquid treatment module 30 is located in the chamber 40 and is held in place by clips, quarter turn fastenings or other fastening means (not shown).

Referring to Figures 3 and 4, the liquid treatment module 30 includes a filter unit 200. The filter unit 200 is designed to filter particulates and impurities from the water, and to

kill bacteria in the water. A filter inlet 202 is located at the upper end of the filter unit 200 and communicates with the outlet 26. A sump 204 is located downstream of the filter inlet 202. The sump 204 has a base 204a. A wall 206 of the sump forms a weir 206a. The height of the weir 206a determines the maximum level of liquid that can be contained within the sump 204. A filter outlet 208 is delimited by the weir 206a, the wall 206 of the sump 204 and the outer walls 210 of the filter unit 200. The filter outlet 208 provides an outlet for water flowing over the weir 206a.

A partition 212 extends from the upper portion of the filter unit 200 adjacent the filter inlet 202 into the sump 204. The partition 212 extends partially into the sump 204 such that the distal end 212a of the partition 212 is spaced from the base 204a of the sump 204. The partition 212 is arranged such that the volume of a first region 204b of the sump 204 beneath the filter inlet 202 is greater than a second region 204c of the sump 204 adjacent the weir 206a.

A sterilising filter 214 is located at the base 204a of the sump 204. The sterilising filter 214 consists of particles of an iodine-loaded resin. The resin is loaded at a concentration of 500 g/l. In this embodiment, the volume of the sterilising filter 214 is 50 ml. The iodine-loaded resin acts as a sterilising compound to kill any bacteria present in the water. The particles of the sterilising filter 214 are substantially spherical and have dimensions in the range of 0.1 to 2 mm (average particle size 0.8 mm). The sterilising filter 214 is dimensioned such that the distal end 212a of the partition 212 extends partially into the sterilising filter 214.

A particulate filter 216 is located above the sterilising filter 214 and comprises glass beads with diameters of 4 mm. The particulate filter 216 is located on top of the sterilising filter 214 in the first region 204b beneath the filter inlet 202 which is bounded by the partition 212 and the sump 204. The particulate filter 216 has a volume of 10 ml. Further, the particulate filter 216 operates as a pre-filter, preventing larger particles of solid matter (in particular soap) from blocking the sterilising filter 214. In order to improve performance, the area of the bed of the particulate filter 216 and sterilising

filter 214 is maximised. A large bed area reduces the pressure drop across the filters and increases the resistance of the filters to fouling and becoming blocked.

Both the sterilising filter 214 and the particulate filter 216 are located in the sump 204 below the maximum level of liquid that can be contained in the sump 204. This means that, once the level of liquid in the sump 204 has reached the maximum, operational, level, the sterilising filter 214 and the particulate filter 216 are completely submerged in the water. This is beneficial because the sterilising filter 214 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 214 continuously wetted, this problem is avoided. In addition, this configuration ensures that the water flow is well distributed. Further, the maximum level of liquid should be far enough above particulate filter 216 to allow the head of water to apply pressure on the bed of the filters.

The liquid treatment module 30 further includes a liquid dispersion unit 35 located below the filter unit 200. The liquid dispersion unit 35 is arranged to receive water from the filter outlet 208. An exhaust conduit 37 located within the liquid dispersion unit 35 provides a communication path from the liquid dispersion unit 35 to the outside of the outer case 12 of the hand dryer 10. The liquid dispersion unit 35 further includes a collector 100 for collecting water from the filter outlet 208. The collector 100 has a base 100a. A high frequency agitator in the form of a piezo-electric device 102 is located at the base 100a. A fan 104 is supported on one of the chamber walls 40a. The fan 104 is located outside the chamber 40 separate from the liquid treatment module 30. The fan 104 is configured to direct an airflow into the collector 100 through an aperture 38 provided in the liquid treatment module 30.

In use, the water removed from a user's hands during the drying process flows down the front wall 16a and the rear wall 16b of the cavity 16 and into the drain channel 22 disposed at the lower end 24 of the cavity 16. The drain channel 22 collects and guides the water towards the outlet 26.

Upon entering the outlet 26, the water passes into the filter unit 200 through the filter inlet 202 (see arrow A). The water falls onto the particulate filter 216 (arrow B) and spreads evenly across the surface of the particulate filter 216. As the water moves down through the beads of the particulate filter 216 under the influence of gravity, larger particles of dirt and debris will be left behind in the particulate filter 216. When the water reaches the sterilising filter 214 (arrow C), the majority of the solid particulates in the water will have been removed by the particulate filter 216.

The sterilising filter 214 sterilises the water by deactivating bacteria in the water. The 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 down through the sterilising filter 214, is sterilised and is then deposited in the bottom of the sump 204. This process continues and the volume of water collected in the sump 204 increases until it reaches the maximum level permitted by the weir 206a. Up until this point, the water levels either side of the partition 212 experience an equal force due to atmospheric pressure. However, if more water is introduced through the filter inlet 202, the increased head of water in the first region 204b will cause an imbalance in the forces acting on the water levels either side of the partition 212. The effect of this is for the mass of the added water to apply a force downwardly on the water in the sump 204. This causes a net movement of water in the direction shown by the arrow D. The partition 212 directs the flow of water down towards the base 204a of the sump 204, down through a part of the sterilising filter 214 located in the first region 204b of the sump 204, and back up through another part of the sterilising filter 214 located in the second region 204c of the sump 204 to the weir 206a. Therefore, the partition 212 forces the water to follow a convoluted path from the filter inlet 202 to the weir 206a. In this embodiment, the convoluted path is in the form of a U-shaped path. If the partition 212 were not present, then water entering the sump 204 would tend to flow over the weir 206a without passing through the sterilising filter 214, and sterilisation would not take place.

The excess water, now sterilised, spills over the weir 206a (arrow E) and flows down the filter outlet 208. The water collects at the base 100a of the collector 100 which is in communication with the piezo-electric device 102. The piezo-electric device 102 is set to oscillate at a pre-determined frequency and magnitude such that sufficient vibrational energy is imparted to water molecules on the surface of the water in the collector 100 to overcome surface tension effects. Therefore, the water is turned into a fine mist in the interior space of the collector 100.

The fan 104 directs an airflow downwardly into the collector 100. This directs the fine mist towards, and down, the exhaust conduit 37 which leads to the outside of the outer case 12. This process continues until all the water contained within the collector 100 is efficiently and hygienically removed from the collector 100.

Figures 5a and 5b illustrate the removal of the liquid treatment module 30 from the outer case 12 for maintenance or replacement. The liquid treatment module 30 is removed downwardly from the hand dryer 10. In this embodiment, the filter 200 forms part of the liquid treatment module 30 and is removable from the outer case 12 with the liquid treatment module 30.

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.

For example, the drying apparatus need not take the form of a hand dryer. The drying apparatus could be a condenser-type laundry dryer. In such a laundry dryer, water evaporated from wet textiles in the drum (cavity) of the laundry dryer can be condensed, filtered by a filtration unit and then removed by agitation or evaporation.

Further, the invention could be utilized in other forms of drying apparatus; for example, other forms of domestic or commercial drying apparatus such as washer-dryers, ventilation-type laundry dryers or full-length body dryers.

Additionally, other forms of liquid dispersion unit can be used to disperse the collected liquid; for example, an ultrasonic generator, a fan, a heating element or electrolysing apparatus. Any of these devices could be used in place of a piezo-electric device to agitate, evaporate or electrolyse the water (or other liquid) as required.

The liquid treatment module need not be located inside a chamber present in the drying apparatus. Other arrangements are possible; for example, the module could form a part of the outer case, or could be mounted on or outside the outer case of the drying apparatus.

Further, the liquid treatment module need not be removed from the lower part of the drying apparatus. The liquid treatment module may form part of the upper side or top of the drying apparatus, and be removed sideways or upwardly depending upon the requirements of the drying apparatus. Additionally, it need not be removable and could remain fixed inside the drying apparatus.

As a further variation, other forms of airflow generator are possible. For example, an air bleed or exhaust airflow could be taken from a motor unit. For example, the motor unit for driving the drying process of the hand dryer has a fan. This fan could be used to generate an airflow to vent the evaporated water to the outside of the drying apparatus rather than using an additional fan.

Additionally, the dimensions of the glass beads need not be 4 mm. They may be varied in size from 1 mm to 6 mm. Additionally, other types of particulate filter media could be used; for example, glass-fibre brushes, plastic brushes, porous ceramics, plastic beads or small stones. What is important is that the particulate filter is formed from an inert material with a density greater than 1 g/l. 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.

As an additional variation, a number of particulate filters may be provided. They may be located outside of the sump, for example in the filter inlet to pre-filter water before it reaches the sump.

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. Further, 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. 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 wholly in the sump. They could be located above the sump, out of the water in the sump, or partially submerged in the water in the sump.

As a further variation, the particulate-filtering media and the bacteria-killing media need not form separate stages in the filter and may be combined to form a single unit.

As a further variation, the filter need not be removable from the drying apparatus. The filter could remain inside the casing of the drying apparatus when the liquid treatment module is removed. The filter could either be removable separately from the liquid treatment module or be fixed permanently inside the casing of the drying apparatus.

**CLAIMS**

1. Drying apparatus comprising an outer case, a portion of the outer case defining a cavity in which articles can be dried, an outlet disposed at the lower end of the cavity and a filter unit arranged downstream of the outlet, wherein the filter unit comprises a particulate filter and a sterilising filter.

2. Drying apparatus according to claim 1, wherein the sterilising filter is located downstream of the particulate filter.

3. Drying apparatus according to claim 1 or 2, wherein the filter unit further comprises a filter inlet, a filter outlet and a sump having a maximum level of liquid.

4. Drying apparatus according to claim 3, wherein the sterilising filter is located in the sump.

5. Drying apparatus according to claim 4, wherein the sterilising filter is located below the maximum level of liquid.

6. Drying apparatus according to any one of claims 3 to 5, wherein the particulate filter is located in the sump.

7. Drying apparatus according to claim 6, wherein the particulate filter is located below the maximum level of liquid.

8. Drying apparatus according to any one of claims 3 to 7, wherein the filter outlet includes a portion which determines the maximum level of liquid.

9. Drying apparatus according to any one of claims 3 to 8, wherein the filter unit further comprises flow directing means for guiding liquid through the filter unit.

10. Drying apparatus according to claim 9, wherein the flow directing means comprises a partition for guiding liquid through the filter unit.

11. Drying apparatus according to claim 10, wherein the partition defines a convoluted path from the filter inlet to the filter outlet.

12. Drying apparatus according to claim 11, wherein a part of the partition located within the sump is arranged to guide the liquid along a U-shaped path.

13. Drying apparatus according to any one of claims 9 to 12, wherein the partition is arranged to separate at least a part of the sterilising filter.

14. Drying apparatus according to any one of the preceding claims, wherein the sterilising filter comprises a material including an anti-bacterial agent.

15. Drying apparatus according to claim 14, wherein the material is a resin.

16. Drying apparatus according to claim 15, wherein the resin comprises particles having a dimension of at least 0.1 mm

17. Drying apparatus according to claim 15 or 16, wherein the resin comprises particles having a dimension no more than 2 mm.

18. Drying apparatus according to any one of claims 14 to 17, wherein the anti-bacterial agent comprises a halogen-containing material or a precursor to a halogen-containing material.

19. Drying apparatus according to claim 18, wherein the halogen-containing material includes a component selected from the group: Chlorine, Bromine, Iodine, Hypochlorite or Hypobromide.

20. Drying apparatus according to any one of claims 14 to 19, wherein the resin is arranged to release the anti-bacterial agent into the liquid at a concentration of at least 1 ppm.

21. Drying apparatus according to any one of claims 14 to 20, wherein the resin is arranged to release the anti-bacterial agent into the liquid at a concentration no greater than 5 ppm.

22. Drying apparatus according to any one of the preceding claims, wherein the particulate filter comprises a layer of beads.

23. Drying apparatus according to claim 22, wherein the diameter of the beads is at least 1 mm.

24. Drying apparatus according to claim 22 or 23, wherein the diameter of the beads is no more than 6 mm.

25. Drying apparatus according to any one of the preceding claims, wherein the filter unit forms part of a liquid treatment module which is removable from the drying apparatus.

26. Drying apparatus according to claim 25, wherein the liquid treatment module further comprises a liquid dispersal unit including a collector located downstream of the filter unit and an evaporation unit in communication with the collector for evaporating liquid collected therein.

27. Drying apparatus according to claim 26, wherein the evaporation unit is a high frequency agitator.

28. Drying apparatus according to any one of the preceding claims, wherein the drying apparatus is a hand dryer and the cavity is dimensioned to receive a user's hands.

29. Drying apparatus substantially as hereinbefore described with reference to the accompanying drawings.

For Innovation

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|---|---|---|---|
| **Application No:** | GB0602075.4 | **Examiner:** | Mr Mike Leaning |
| **Claims searched:** | 1-29 | **Date of search:** | 4 May 2006 |

## Patents Act 1977: Search Report under Section 17

**Documents considered to be relevant:**

| Category | Relevant to claims | Identity of document and passage or figure of particular relevance |
|---|---|---|
| A | - | JP11244192 A (MATSUSHITA SEIKO CO LTD) Please see the figures noting what appears to be a filter 13 in the water outlet 7. |
| A | - | GB2144325 A (ANDA LTD) Please see the figures noting filtration unit 5 which sterilises air going into the device. Representative of many broadly similar devices which purify the air used for drying, as opposed to the waste water blown off the user's hands. |

Categories:

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|---|---|---|---|
| X | Document indicating lack of novelty or inventive step | A | Document indicating technological background and/or state of the art |
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A4V

Worldwide search of patent documents classified in the following areas of the IPC

A45D

The following online and other databases have been used in the preparation of this search report

Online: WPI, EPODOC.