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(56) Documents Cited:
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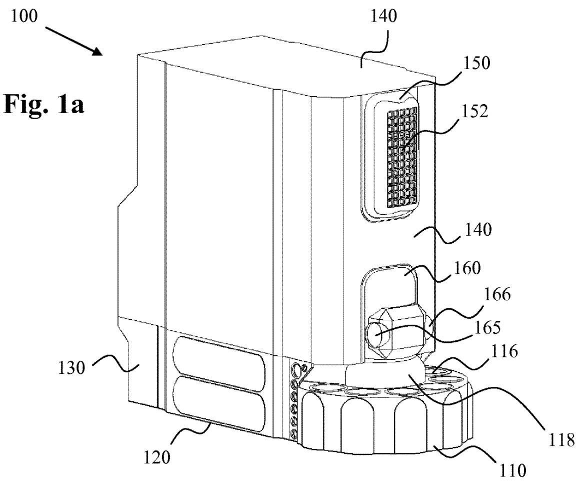
(58) Field of Search:
INT CL **B01D**
Other: **EPODOC, WPI.**

(54) Title of the Invention: **Sealed enclosure and air filtering device**
Abstract Title: **Sealed enclosure and air filtering device**

(57) There is provided a portable apparatus (100) comprising a sealed enclosure (140) and an air filtering device (110, 120). The sealed enclosure is configured to enclose an electronic device therein, and the portable apparatus is operable to drive air though the air filtering device and into the sealed enclosure. The sealed enclosure is sealed except for an air inlet that receives filtered air from the air filtering device into the sealed enclosure during the operation of the portable apparatus, and for an air outlet (150) that exits air from the sealed enclosure during the operation of the portable apparatus. The air filtering device may include a filter media (120) and/or an aqueous stage (110).

Fig. 1a



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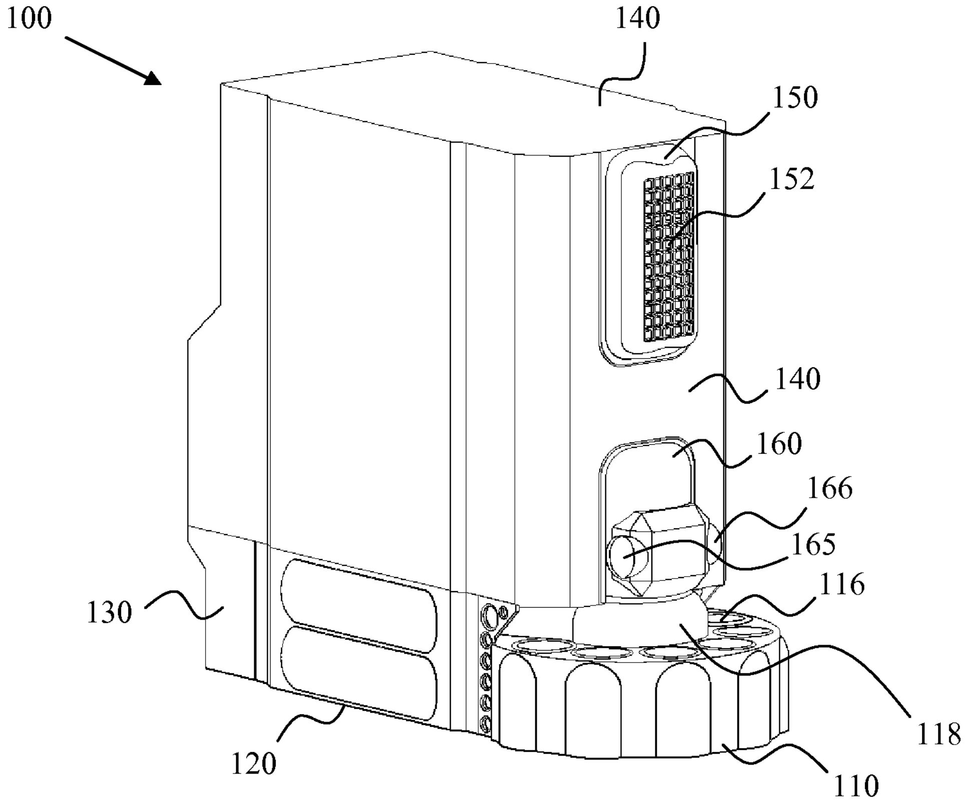
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120
110

Fig. 1a

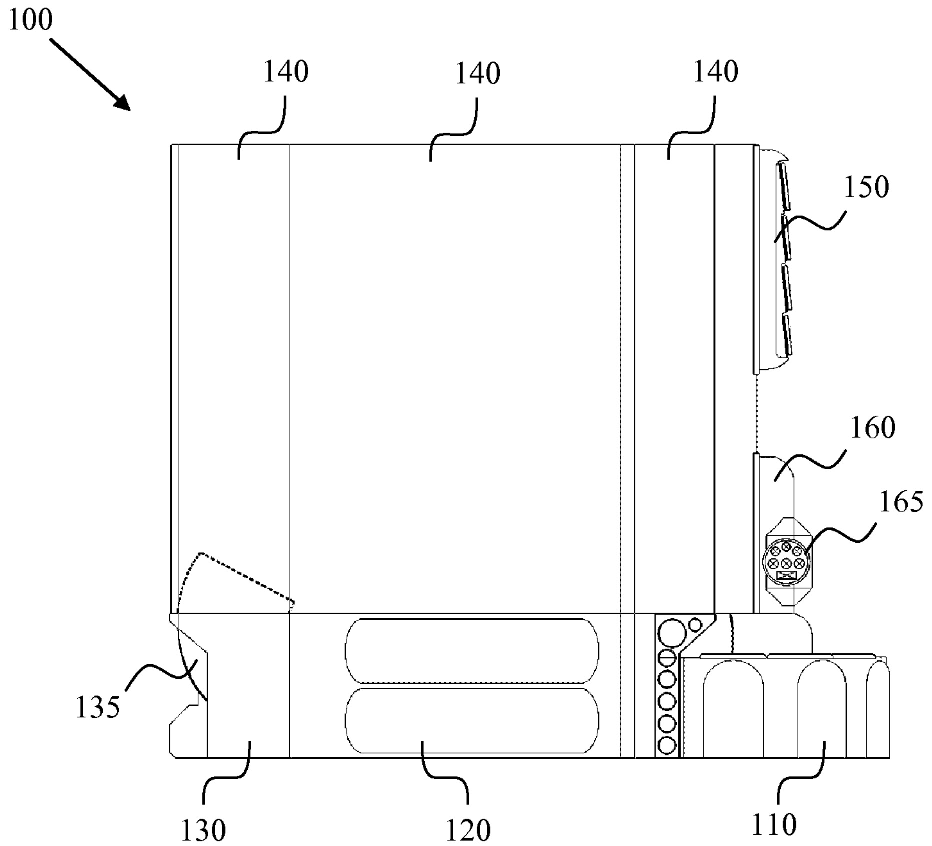
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Fig. 1b

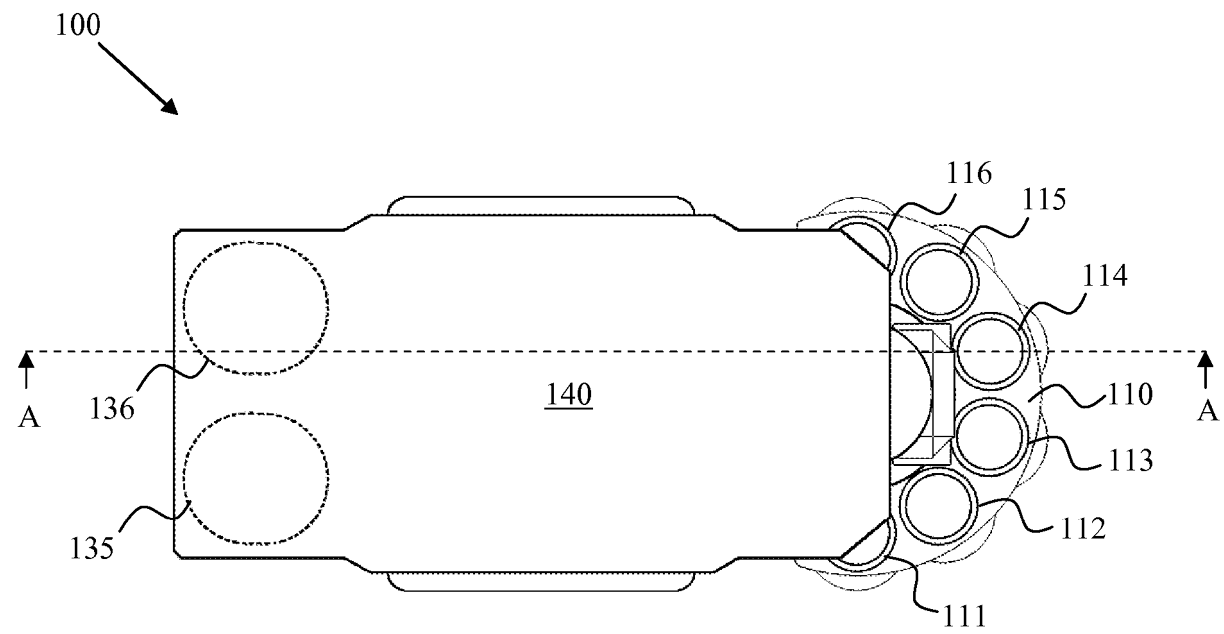


Fig. 1c

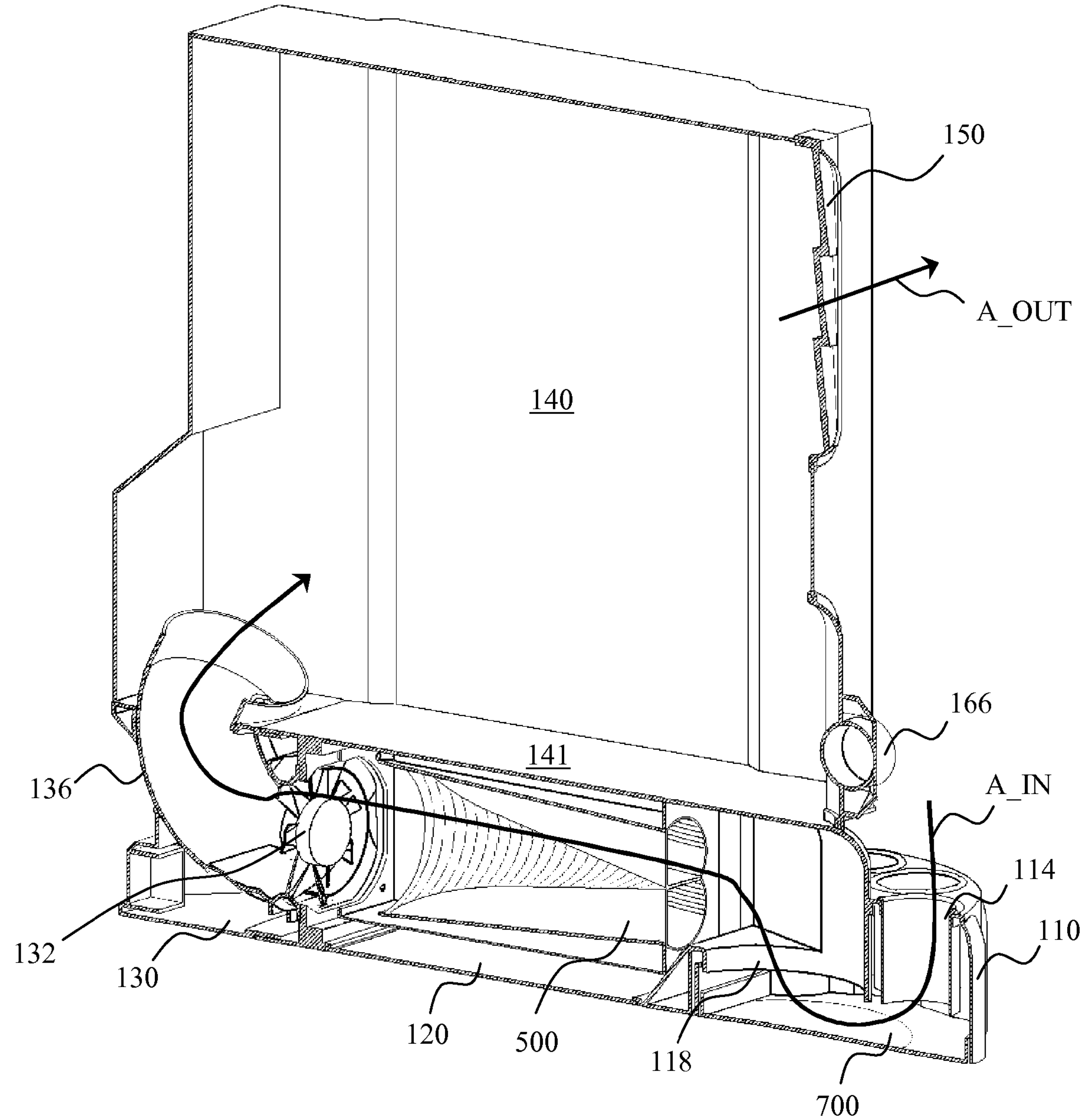


Fig. 2

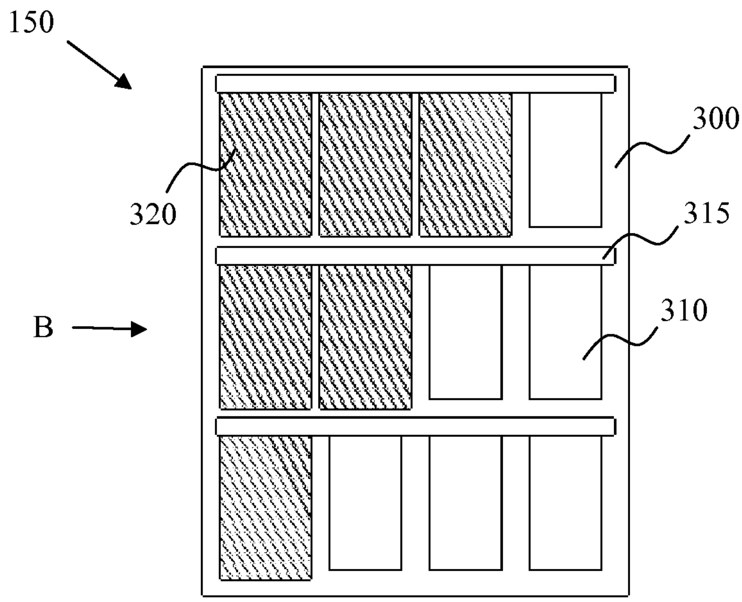


Fig. 3a

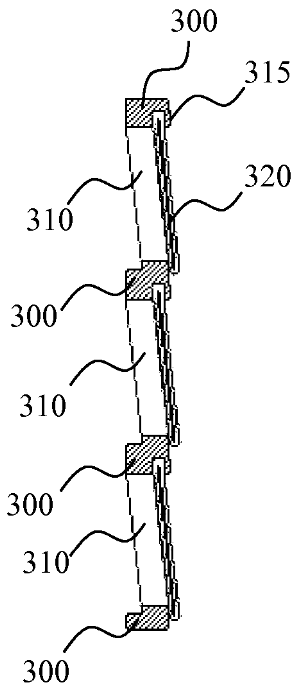


Fig. 3b

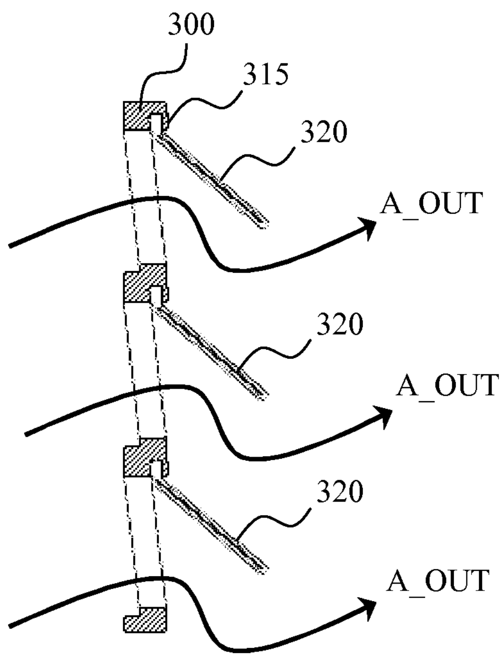


Fig. 3c

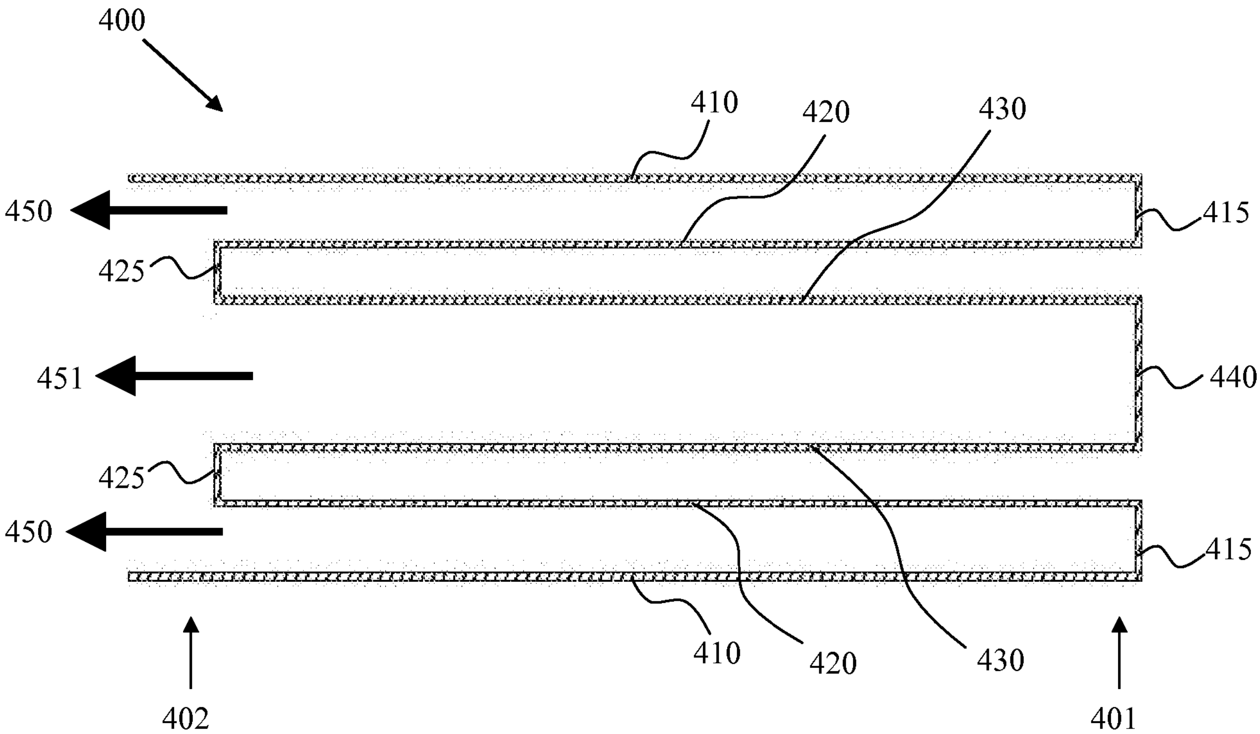
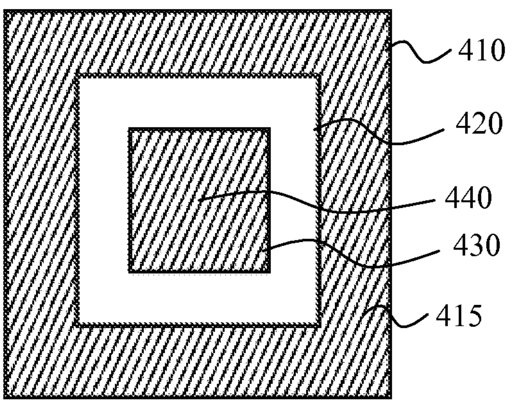


Fig. 4a



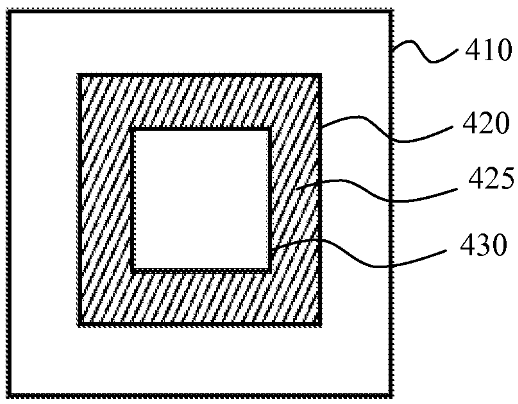
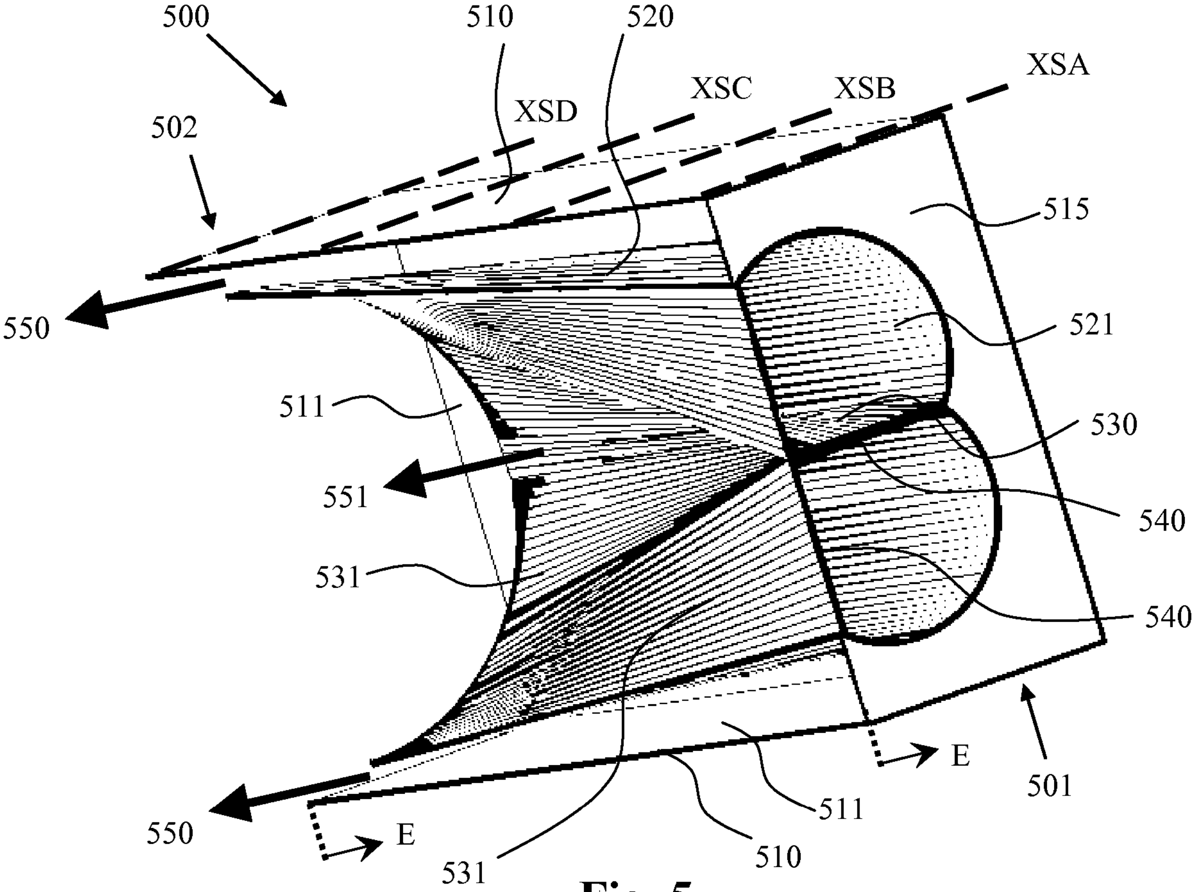


Fig. 4b

Fig. 4c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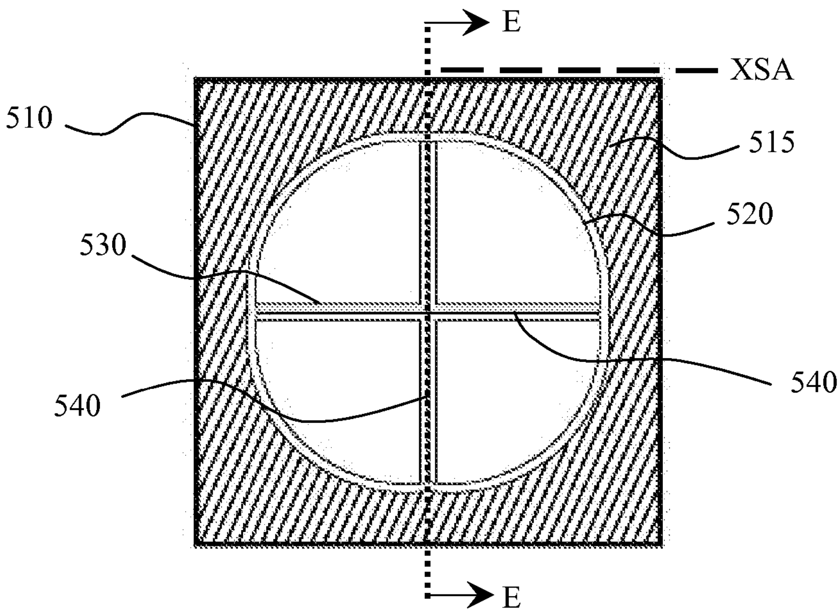
XSA
XSD
XSC
XSB
502
515
550
521
511
530
551
540
531
540
E
501
511
550
E
531
510

Fig. 5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510
515
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540
540
E

Fig. 6a

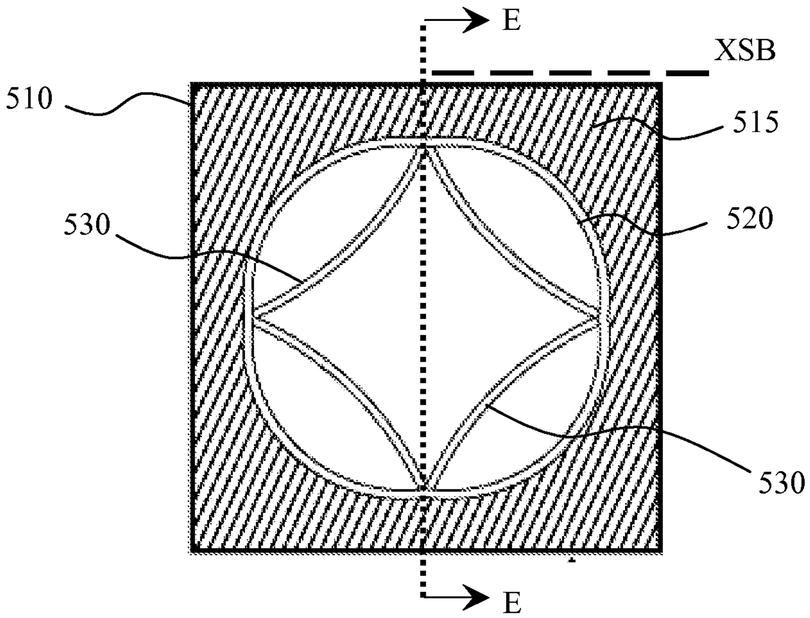


Fig. 6b

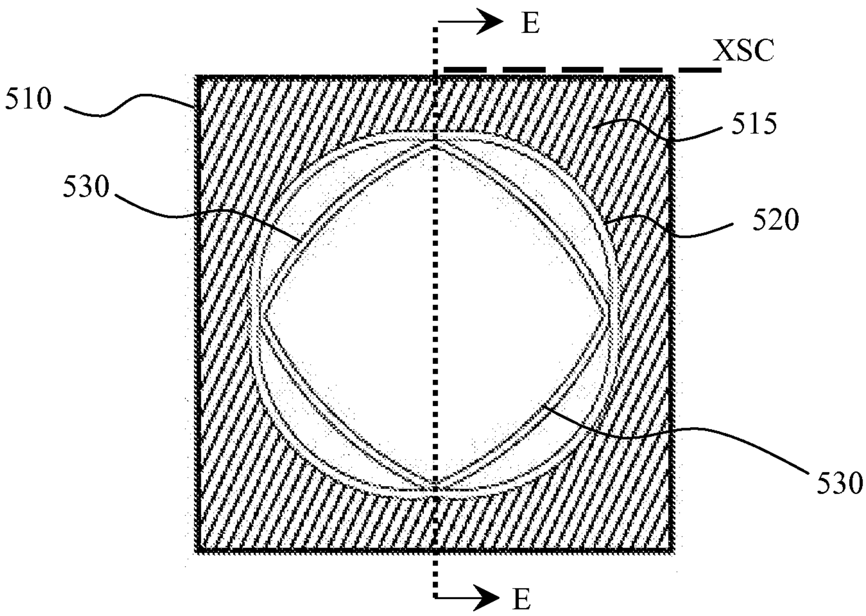
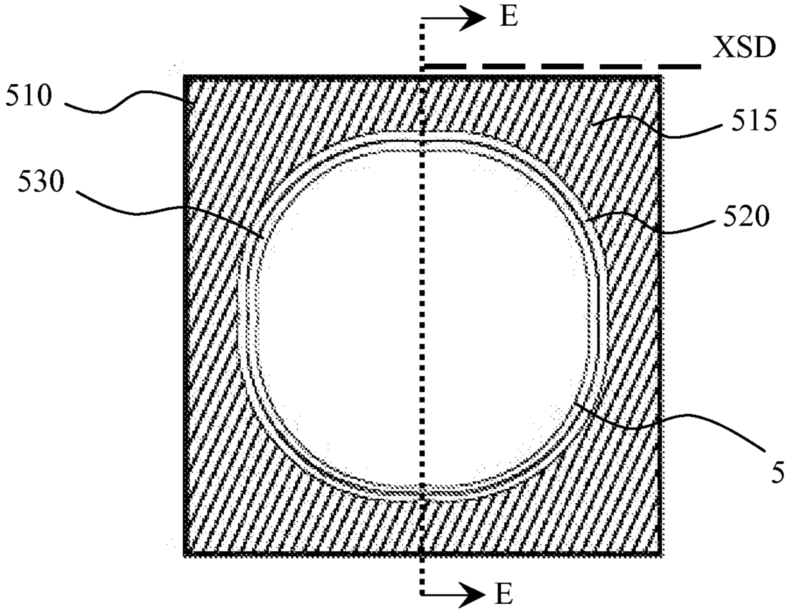


Fig. 6c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XSD
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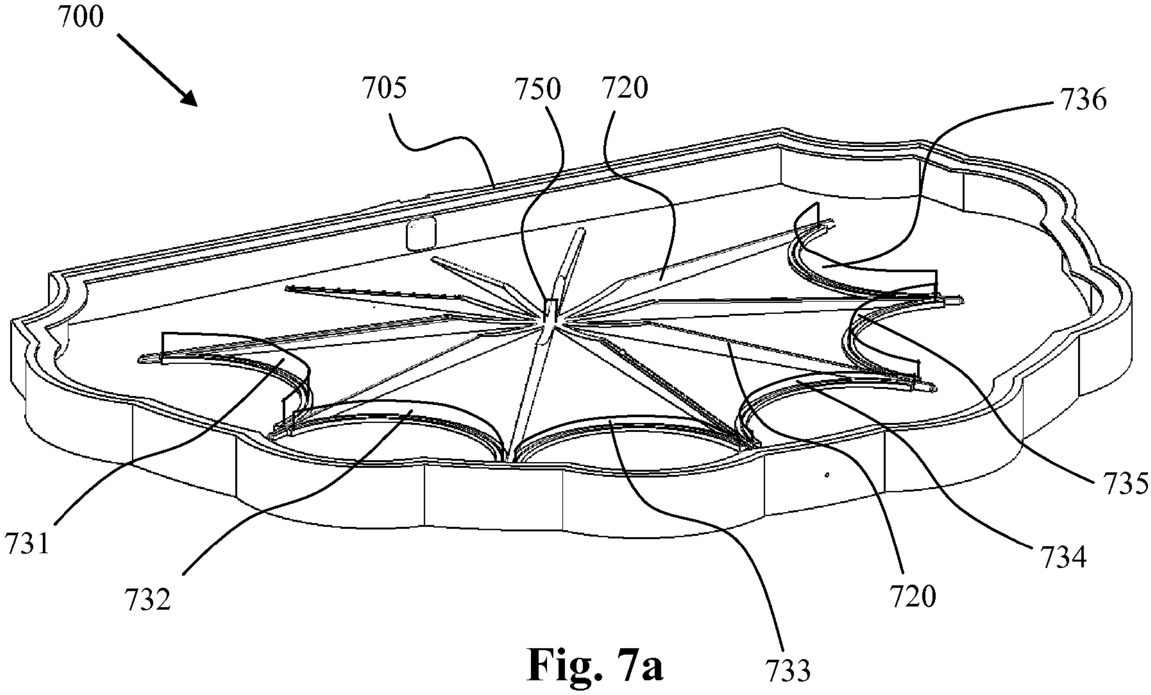
515
530
520
530
E

Fig. 6d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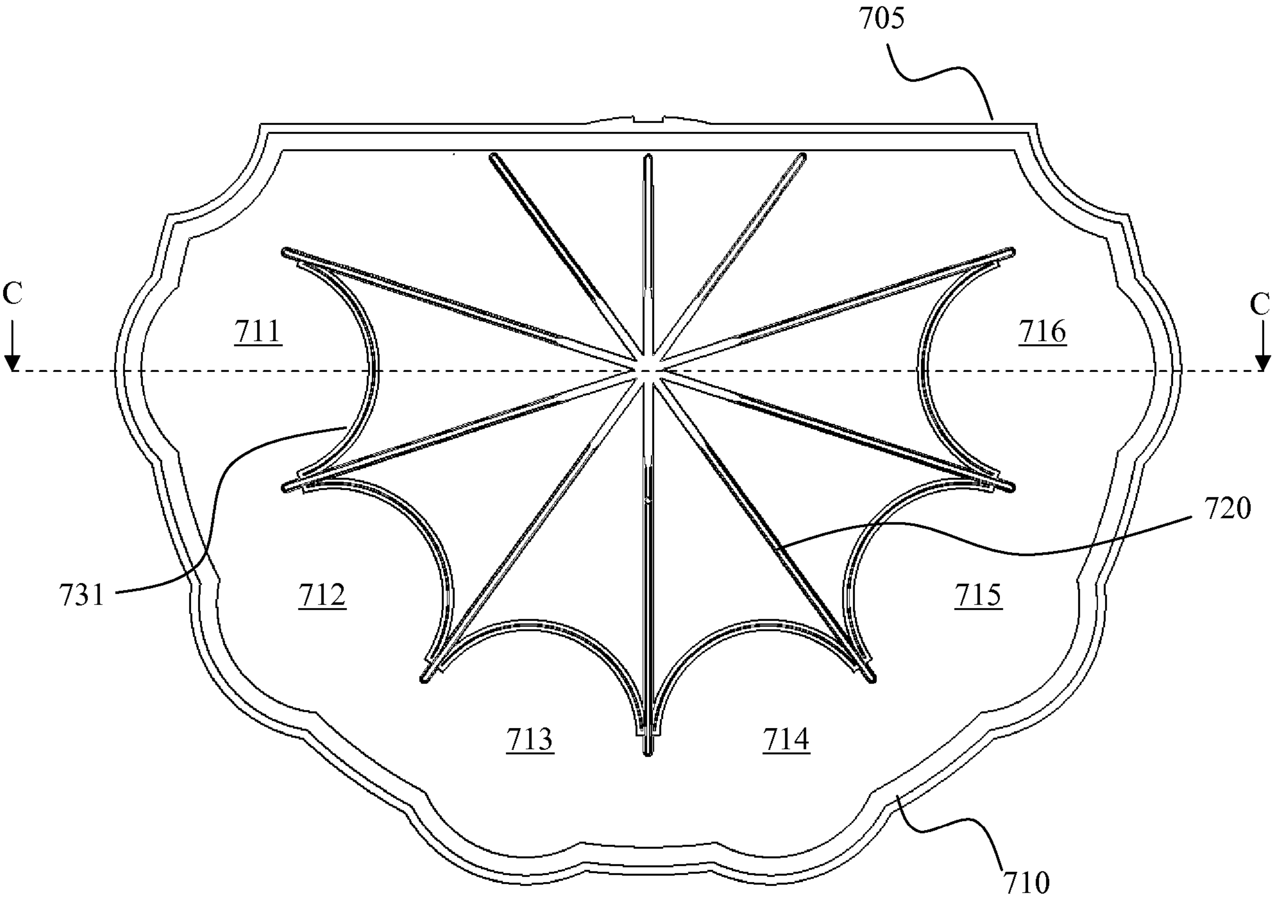
705
750
720
736
731
732
733
720
734
735

Fig. 7a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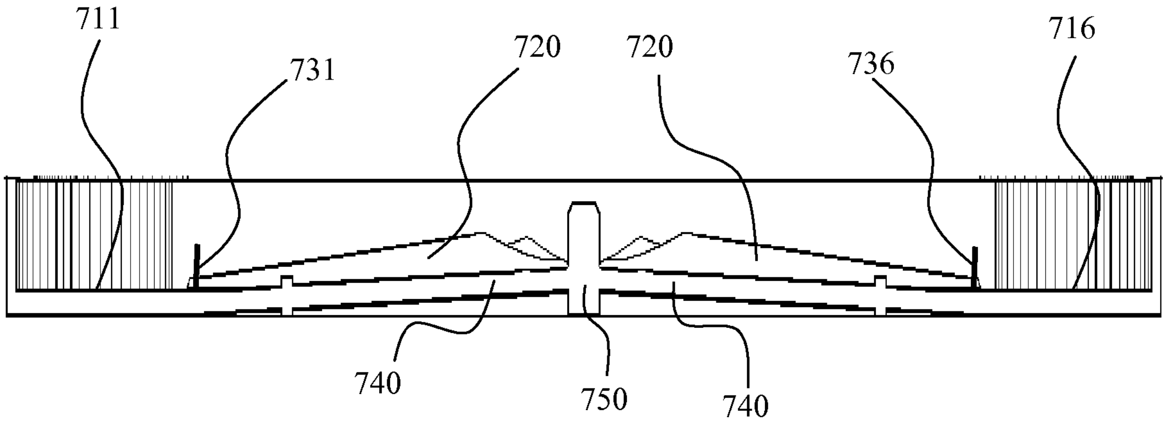
C
C
711
716
731
720
712
715
713
714
710

Fig. 7b


711
731
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720
736
716
740
750
740

Fig. 7c

SEALED ENCLOSURE AND AIR FILTERING DEVICE

DESCRIPTION

The present invention relates to a portable apparatus comprising a sealed enclosure and an air filtering device, wherein the sealed enclosure is configured to enclose an electronic device therein.

Electronic devices typically generate heat which needs to be dispersed to prevent performance degradation and/or overheating of the device. Excess heat can also result in shortening the lifetime of electronic components.

The heat generated by electronic devices typically results in air convection currents flowing through the device which help take the heat away from the device, but often draws dust particles into the device which can settle on electronic components and reduce heat transfer, exacerbating the problem.

A known method to assist in the cooling of an electronic device is to provide a fan to increase the rate of airflow through the device, although this also results in a faster build up of dust on electronic components. The dust acts as an insulator, and can build up to an extent where the cooling is no longer effective and components begin to overheat, reduce in performance, and ultimately fail. Additionally, the dust builds up on the fans themselves and slowly reduces the amount of airflow that the fans are able to generate, and increases the power required to drive them.

A known computer case includes an air filter to help reduce the amount of dust that enters the computer case. The air filter is typically a flat "panel" of fine gauze, 120 x 120 mm in size, placed in front of a PC fan. However, these air filters typically only trap the largest of dust particles and do not prevent significant dust build up from occurring inside the case. Air filters designed to block smaller dust particles exist but present a much greater drag coefficient to the airflow, and fans in common use in PC s are not powerful enough to draw a sufficient amount of airflow through the computer case to provide the required level of cooling.

Increasing the fan speed and/or size is likely to result in increased noise levels and increased power consumption, neither of which is desirable.

Known enclosures for electronics devices such as the aforementioned known PC case typically have a multitude of holes/cracks for ventilation, for providing access to electronic components, sockets, etc, and due to cracks around the edges of external buttons/keys/switches. Many of these holes/cracks act as Venturi holes that suck dust-filled air into the case from the ambient environment during the operation of various fan units.

It is therefore an aim of the invention to improve on the known art.

According to a first aspect of the invention, there is provided a portable apparatus comprising a sealed enclosure and an air filtering device. The sealed enclosure is configured to enclose an electronic device therein, and the portable apparatus is operable to drive air though the air filtering device and into the sealed enclosure. The sealed enclosure is sealed except for:

- an air inlet that receives filtered air from the air filtering device into the sealed enclosure during the operation of the portable apparatus; and
- an air outlet that exits air from the sealed enclosure during the operation of the portable apparatus.

The portable apparatus may be a portable container, the sealed enclosure and the air filtering device being housed within the portable container. Then, the portable apparatus may be conveniently handled, transported, or fitted together for use as a single portable container. Alternatively, the portable apparatus may be formed as separate sealed enclosure and air filtering devices, with a pipe being between them to eject the filtered air from the air filtering device into the sealed enclosure.

The portable apparatus is sufficiently portable to be moved around by an un-assisted person, for example large industrial scale equipment and whole room sized enclosures are outside the scope of the invention. The sealed enclosure may for example have dimensions of less than 2m x 1m x 1m, or of less than 1m x 1m x 0.5m.

The use of a sealed enclosure in which the electronic device can be placed helps isolate the electronic device from external airflows in the environment where the sealed enclosure exists, thereby helping prevent ingress of dust into the sealed enclosure. The sealed enclosure may also help reduce the noise levels of electronics devices that are placed within it.

The sealed enclosure comprises an air outlet and air inlet. When the portable apparatus is operated, an air flow is driven through the air filtering device, then through the air inlet, and then through the air outlet.

The air outlet comprises one or more holes in the sealed enclosure where air exits from the sealed enclosure during the operation of the portable apparatus. Accordingly, a hole can only be considered as an air outlet if air exits the enclosure via the hole during the operation of the portable apparatus.

The air inlet comprises one or more holes in the sealed enclosure where filtered air from the air filtering device is ejected into the sealed enclosure during the operation of the portable apparatus. Accordingly, a hole can only be considered as an air inlet if filtered air enters the sealed enclosure via the hole during the operation of the portable apparatus.

Since the enclosure is sealed, there are no other holes in the sealed enclosure by which a significant amount of air could enter the sealed enclosure from the ambient environment during the operation of the device. Preferably, the only air that can enter the enclosure during the operation of the portable apparatus is air that has passed through the air filtering device.

Known PC cases with standard fan configurations often have too many holes for a significant pressure to build up inside of the case, and accordingly regions of lower pressure than the pressure of the ambient environment are created adjacent to holes having an airflow flowing past them, due to the venturi effect. These regions of lower pressure draw air into the case from the ambient environment, bypassing any filter media that the case may have and drawing dust into the case.

Preferably, the air pressure that builds up inside the sealed enclosure of the present invention during the operation of the portable apparatus is sufficiently high that any holes in the sealed enclosure apart from the air inlet, or any imperfections in the sealing of the sealed enclosure, form part of the air outlet. Stated in another way, the air pressure that builds up inside the sealed enclosure is preferably sufficiently high that any holes apart from the air inlet do not act as venturi holes through which un-filtered air enters the enclosure.

The sealed enclosure is sufficiently well sealed to prevent significant accumulations of dust from building up within the sealed enclosure over time, for example due to air currents that are present around the sealed enclosure. The air currents may be due to heat or air currents generated by the electronic device, or may simply be entirely due the environmental conditions in which the sealed enclosure is placed when the portable apparatus is not operational. A significant level of dust build up may for example be a 1mm depth of dust accumulating inside the sealed enclosure in the space of a year. Preferably, the sealing is such that substantially no air can get in or out of the sealed enclosure, except for via the air inlet and the air outlet. For example, the enclosure may be hermetically sealed.

The sealed enclosure may be configured to enclose an electronic device that is configured to be placed directly in the ambient environment when used, for example a computer base unit, a set top box, an audio amplifier, a computer laptop, or a video processing device. Therefore, an electronic device that is intended by the manufacturer to be normally placed and used in the ambient environment, may be taken and placed within the sealed enclosure of the present invention in order to better shield the electronic device from dust.

The air filtering device is configured to direct filtered air into the sealed enclosure via the air inlet, thereby providing the sealed enclosure with a filtered air flow to take heat away from the electronic device. The filtered air is ejected from the sealed enclosure via an air outlet. The air outlet may comprise a one-way valve to help prevent air from entering the sealed enclosure via the air outlet when the portable apparatus is not being operated, helping to prevent the build-up of dust inside the sealed enclosure.

The airflow through the air filtering device and sealed enclosure may be created by an airflow creation device such as a fan. The airflow creation device preferably creates a greater air pressure inside the sealed enclosure than the air pressure of the ambient environment in which the portable apparatus is present.

The portable apparatus may comprise a cable box formed in a side of the sealed enclosure to provide an electrical interface or enable an electrical connection between an electrical device inside of the enclosure and the outside environment. The cable box enables an electrical path into the sealed enclosure without breaking the sealing of the sealed enclosure. The cable box may for example comprise sockets into which plugs of external cabling may be fitted, and/or may comprise rubber grommets through which cabling may be routed from inside the sealed enclosure to outside the sealed enclosure.

The air filtering device may comprise a filter media. The effective surface area of the filter media is the total area over which incoming air may pass through the filter media. The filter media may be formed as multiple separate areas of filter media that each contribute towards the total effective surface area.

The inventors have realised that a larger airflow through the sealed enclosure may be achieved, without needing to increase the size/speed of a fan, by making the effective surface area of the filter media very large. The filter media preferably has an effective surface area of at least 600 cm^2, over four times the effective surface area of known 120mm x 120mm computer case filters.

The filter media may have an effective surface area of at least 1200 cm^2, more preferably at least 1800 cm^2, more preferably at least 2400 cm^2, more preferably at least 3000 cm^2, and even more preferably at least 3600 cm^2. Typically, the larger the effective area of the filter media, the less drag the filter media presents to the airflow, and the more air can flow for a given sized airflow creation device.

Advantageously, the filter media may be non-planar filter media to reduce the overall dimensions of the filter media. Then, the filter media may be more easily incorporated into the air filtering device, and potentially reduce the overall size of the air filtering device.

Due to the large effective surface area, the filter media may be adapted to filter out dust particles smaller than 200um diameter, without requiring an excessively large airflow creation device to drive airflow through the air filtering device. The filter media may be adapted to filter out dust particles smaller than 100um in diameter, or smaller than 50um in diameter, or smaller than 20um in diameter, or even smaller than 10um in diameter. The above cited dust particle sizes are each valid in combination with each one of the above cited effective surface areas, it being understood that the smaller the effective surface area and the smaller the dust particle size, the more powerful the airflow creation device needs to be to achieve the required airflow.

Preferably, the airflow creation device is located subsequent to the filter media in the direction of airflow. This means that the airflow creation device receives filtered air rather than dusty air, and can help maintain the efficiency of the air flow creation device, for example by reducing dust build up upon fan blades or other parts of the airflow creation device.

Advantageously, the airflow creation device may be at least 50mm away from at least 50% of the effective surface area of the filter media. This can help reduce unwanted turbulence from occurring between the filter media and the airflow creation device, resulting in a more efficient system.

Furthermore, the air filtering device of the portable apparatus may further comprise an aqueous stage for trapping particles in an aqueous solution, the aqueous stage having a base in which the aqueous solution is held.

The use of an aqueous stage in conjunction with an enclosure for an electronic device has been found to be particularly advantageous since the aqueous solution helps to both cool the airflow and increase the humidity of the airflow. The cooling effect is due to evaporation of the aqueous solution into the airflow, and the cooling of the airflow may for example be in the order of two or three degrees Centigrade. The increased humidity can help to reduce the build up of static electricity within the sealed enclosure, helping protect the electronic device. The increased humidity typically increases the specific heat capacity of the air, improving the cooling effect upon the electronic components.

The aqueous solution may for example be tap water. The aqueous stage may comprise a plurality of tubes configured to direct air substantially vertically downwards when the aqueous stage is in its normal orientation during use, such that the air is directed substantially perpendicular to the surface of the aqueous solution. The directing of the air down a plurality of tubes rather than just one larger tube, and the directing of the air substantially perpendicular to the surface of the aqueous solution rather than a significant angle, can both help to improve the trapping of dust particles in the aqueous solution. It will be understood that the intensity of the air flow itself may influence the exact angle at which the airflow strikes the aqueous solution, for example due to the incoming airflow slightly displacing the aqueous solution.

A proportion of the dust particles in the air reach the surface of the aqueous solution and become trapped in the aqueous solution, thereby filtering the air. Larger dust particles are more likely to be trapped by the aqueous stage than smaller sized particles, as larger sized particles have greater momentum, and so are less likely to be deflected away from the surface of the aqueous solution along with the airflow.

Advantageously, the aqueous stage may comprise an air outlet, and the plurality of tubes may be arranged in an arc shape around the air outlet. Accordingly, the air may have a similar distance to travel between the end of each tube and the air outlet, smoothing the passage of air through the aqueous stage to reduce turbulence. The presence of turbulence can create drag and reduce the amount of airflow through the aqueous stage. The use of the word tube does not imply any restrictions on the cross-sectional shape of each tube, for example the tubes may be circular, triangle, rectangular etc. Preferably, the tubes have a circular or oval cross section to minimise any turbulence created where the air exits the tubes.

The base of the aqueous stage may be downwardly away from a central portion of the base, and in the direction of the plurality of tubes to form a gradually deepening trough for holding the aqueous solution. Accordingly, the angled base helps prevent the airflow from pushing the aqueous solution away from where the air exits the tubes.

Advantageously, the aqueous stage may further comprise an air regulator that partially obstructs the flow of air from one of the plurality of tubes to the air outlet of the aqueous stage, there being another differently sized air regulator or no air regulator obstructing the flow of air from another one of the plurality of tubes to the air outlet of the aqueous stage.

Accordingly, an air regulator can be implemented to help regulate the amount of air exiting one of the tubes and entering the air outlet of the aqueous stage. Using air regulators, the airflows exiting the various tubes can be made similar to one another, thereby smoothing the overall airflow and minimising turbulence. For example, a first tube that is closer to the air outlet of the aqueous stage than a second tube is to the air outlet of the aqueous stage, may have an air regulator that presents an obstruction to the airflow between the first tube and the air outlet, in order to better match the airflow between the first tube and the air outlet to the airflow between the second tube and the air outlet.

Each air regulator may be formed as one or more protrusions extending upwardly from the base, and that partially block the flow of air between one of the tubes and the air outlet of the aqueous stage. Every tube may have an associated air regulator, or just some of the tubes, depending on the particular configuration of the tubes and air outlet. The air regulators of multiple tubes could be formed as a single protrusion extending upwardly from the base, the height of the protrusion varying according to the amount of air obstruction required between each tube and the air outlet.

Preferably the aqueous stage precedes the filter media in the direction of airflow through the air filtering device, the aqueous stage trapping larger sized particles and the filter media trapping smaller sized particles. The use of the aqueous stage before the filter media can help prevent the filter media from becoming blocked by larger sized particles.

The aqueous stage may be periodically topped up with aqueous solution by a user of the portable apparatus, or the portable apparatus may further comprise a water reservoir to automatically keep the aqueous solution at the desired level, for example by a pipe connected to an airtight water reservoir, the pipe opening into the aqueous stage at the same level that the aqueous solution is to be filled up to.

The aqueous stage may further comprise ultra-violet lighting to help prevent harmful bacteria such as Legionella from building up within the aqueous solution.

According to a second aspect of the invention, there is provided a filter media comprising a first elongated pipe having near and far ends, the first elongated pipe being open at the far end and being connected to a second pipe at the near end, the second pipe extending towards the far end inside of the first pipe, wherein the first and second pipes both form part of the effective surface area of the air filtering device.

Advantageously, the filter media may further comprise a third pipe connected to the second pipe at the far end, the third pipe extending towards the near end inside of the second pipe. The third pipe further increases the total effective surface area of the filter media. The third pipe may be closed by a closure at the near end, and the closure of the third pipe may comprise at least three elongate portions that meet together at a centre portion to help maximise the effective surface area of the filter media. For example, with three elongate portions the closure may be in a Y shape, and with four elongate portions the closure may be in an X shape.

The filter media may for example be made of a polyester material, such as polyester needlefelt.

The filter media of the second aspect of the invention may be used as the filter media discussed in relation to the first aspect of the invention. The filter media discussed in relation to the first aspect may also have one or more of the features discussed in relation to the filter media of the second aspect of the invention.

According to a third aspect of the invention, there is provided a portable air filtering device comprising an aqueous stage for trapping particles in an aqueous solution, and a filter media having an effective surface area of at least 600 cm^2, the aqueous stage having a base in which the aqueous solution is held. The filter media may be according to the filter media of the second aspect of the invention, and/or according to the filter media discussed in relation to the first aspect of the invention. The aqueous stage may be according to the aqueous stage discussed in relation to the first aspect of the invention. The portable air filtering device may be used as the air filtering device of the first aspect of the invention.

The portable air filtering device is sufficiently portable to be moved around by an un-assisted person, for example large industrial scale equipment is outside the scope of the invention.

Preferably the aqueous stage precedes the filter media in the direction of airflow through the air filtering device, the aqueous stage configured to trap larger sized particles and the filter media configured to trap smaller sized particles.

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

Fig. 1a shows a schematic perspective diagram of a portable apparatus comprising a sealed enclosure and an air filtering device according to an embodiment of the invention;

Fig. 1b shows a schematic side diagram of the portable apparatus shown in Fig. 1a;

Fig. 1c shows a schematic plan diagram of the portable apparatus shown in Fig. 1a;

Fig. 2 shows a schematic cross-sectional diagram taken along the line A-A marked on Fig. 1c;

Fig. 3a shows a schematic plan diagram of a one-way valve of the portable apparatus shown in Figs.1a-1c;

Fig. 3b shows a schematic side diagram of the one-way valve of Fig. 3a looking in from a direction B marked on Fig. 3a when the valve is closed;

Fig. 3c shows a schematic side diagram of the one-way valve of Fig. 3a looking in from the direction B marked on Fig. 3a when the valve is open;

Fig. 4a shows a schematic sectional diagram of a filter media suitable for use in the fig. 1 embodiment;

Fig 4b shows a schematic front view of the filter media of Fig. 4a;

Fig 4c shows a schematic rear view of the filter media of Fig. 4a;

Fig. 5 shows a cut-away schematic perspective diagram of an alternate filter media suitable for use in the fig. 1 embodiment;

Figs 6a ‘ 6c show schematic cross-sectional diagrams taken at various points along the filter media of Fig. 4a;

Fig. 7a shows a perspective diagram of a base of an aqueous stage suitable for use in the Fig. 1 embodiment;

Fig.7b shows a plan diagram of the base of Fig. 7a; and

Fig. 7c shows a cross sectional diagram looking in along the line C-C marked on Fig. 7b.

An embodiment of the invention according to the first aspect of the invention will now be described with reference to Figs 1a ‘ 3c. Figs. 1a ‘ 1c show perspective, side, and plan schematic diagrams respectively of a portable apparatus 100 that comprises a sealed enclosure 140 and an air filtering device 110 and 120. In this embodiment, the portable apparatus takes the form of a portable container that houses (or includes) the sealed enclosure and the air filtering device. The sealed enclosure 140 is sealed except for an air inlet in the form of ducts 135 and 136, and an air outlet in the form of a vent 150.

The sealed enclosure 140 is configured to enclose a PC base unit, which is fitted inside of the enclosure, instead of just being placed in the ambient environment as usual. In alternate embodiments, the inside of the sealed enclosure may be configured to hold other types of electronic devices that are normally placed directly in the ambient environment, for example a set top box, an audio amplifier, a computer laptop, or a video processing device. Alternatively, the sealed enclosure may be configured to hold electronic devices such as computer motherboards, data storage devices, and/or other electronic circuitry.

The portable apparatus comprises a cable box 160 on the side of the sealed enclosure, and the cable box 160 provides an electrical interface between an electrical device inside of the enclosure and the outside environment. The cable box enables an electrical interface into the sealed enclosure without breaking the sealing of the sealed enclosure. The cable box 160 comprises electrical interfaces 165 and 166 to which external plugs may be connected to provide power and/or signals to an electrical device inside of the enclosure. The cable box may also, or alternatively, include rubber grommets through which cabling may be routed from inside the sealed enclosure to outside the sealed enclosure.

The air filtering device comprises an aqueous stage 110 and a filter media stage 120 that are arranged beneath the sealed enclosure 140. The aqueous stage 110 has six air inlet tubes/pipes 111, 112, 113, 114, 115, and 116 that draw air in from the ambient environment, and direct the air onto the surface of puddle of aqueous solution such as tap water, thereby trapping dust particles in the aqueous solution. The air filtering device also comprises a filter media stage 120 for further filtering the air after it has passed through the aqueous stage 110.

In use, an airflow generation section 130 sucks air through the aqueous stage 110 and the filter media stage 120, and blows the filtered air into the sealed enclosure 140 via duct 135 and 136. After passing over one of more electrical devices to provide a cooling effect, the air exits the sealed enclosure 140 through an air outlet 150. The airflow generation section 130 is in this embodiment powered by a power connection from the cable box 160, although could have its own separate power connection.

A cross-sectional view of the portable apparatus of Figs. 1a ‘ 2c is shown in Fig. 2. The cross-sectional view is taken along line A-A marked on Fig. 1c, and shows the internals of the aqueous stage 110, filter media stage 120, and airflow generation section 130.

The sealed enclosure 140 has a base 141 upon which a PC base unit can sit, and sufficient space remaining inside the sealed enclosure for cabling to be routed externally from the PC base unit to the cable box 160.

The cross section is taken through the tube 114 of the aqueous stage, and shows that the tube 114 is directed vertically downwardly towards a base 700 of the aqueous stage. A puddle of aqueous solution is holdable in the base 700 such that the tube 114 directs air perpendicular to the surface of the aqueous solution, and the momentum of larger dust particles causes the dust particles to enter the aqueous solution and become trapped within it.

A filter media 500 is present within the filter media stage 120, and the cross-section is taken through the centre of the filter media 500. The structure of the filter media 500 is discussed in more detail further below in relation to Figs.5 and 6a ‘ 6d.

An airflow creation device in the form of a fan 132 is present within the airflow generation section 130, and the fan 132 sucks air through the aqueous stage 110 and filter media 500, and forces it into the sealed container 140 via the duct 136. Another filter media (not shown in Figs) the same as the filter media 500 is present adjacent the filter media 500, and another fan (not shown in Figs) is present adjacent to the fan 132, and sucks air through the another filter media, and feeds the air into the sealed enclosure via the duct 135 that is adjacent to the duct 136. The two filter media both receive incoming air from the aqueous stage 110 and collectively form the filter media of the air filtering device.

The path taken by the airflow through the air filtering device 110, 120, airflow generation section 130, and duct 136 is shown by the arrow A_IN. In particular, it can be seen that airflow exiting the tube 114 strikes the aqueous solution in the base 700, and is then forced upwardly through an air outlet 118 of the aqueous stage 110 and into the filter media stage 120. The tubes 111 ‘ 116 are arranged in an arc shape around the air outlet 118; also refer to Fig. 1a. The entrance into the air outlet 118 is circular or ovular to help smooth the airflow. The base of the aqueous stage 110 may simply be a flat surface, or may have further features, for example those described further below in relation to Fig. 7a ‘ 7c.

The fan 132 is for example 120mm in diameter, and using that scale it can be seen in Fig. 2 that the fan 132 is more than 50mm away from more than 50% of the effective surface area of the filter media 500, helping minimise any turbulance present between the fan and the filter media to maintain airflow efficiency.

The airflow generation section 130 forces air into the sealed enclosure 140, and since the enclosure is sealed, the pressure inside of the sealed enclosure 140 is raised sufficiently high that any imperfections in the sealing of the sealed enclosure 140 form part of the air outlet from the sealed enclosure, rather than allow unfiltered air to enter the enclosure.

In some embodiments, the sealed enclosure may further comprise apertures which are normally sealed closed, but which may be temporarily opened to provide access to a device inside the sealed enclosure. During the temporary opening the pressure inside the sealed enclosure ensures that air only flows outward, the temporary opening thereby temporarily forming part of the air outlet of the sealed enclosure. Such normally sealed apertures may for example be implemented so that an optical disk tray of the electronic device can temporarily pass through the aperture for receiving an optical disk.

The air exits the sealed enclosure through the air outlet 150, as shown on Fig.2 by the arrow A-OUT. In this embodiment, the air outlet 150 is a 1-way valve, such that it allows air to exit the sealed enclosure, but not to enter it. As the pressure inside the sealed enclosure is higher than that of the ambient environment, the function of the optional 1-way valve is to prevent unfiltered air from entering the sealed enclosure via the air outlet when the airflow creation devices (fans) are not operating.

The air outlet 150 is fitted with a grille 152 (see Fig. 1a) to shield the 1-way valve. The 1-way valve will now be described in more detail with reference to Fig. 3a ‘ 3c.

The schematic diagram of Fig. 3a shows a plan view of the 1-way valve 150, which fits behind the grille 152, and as would be seen if the grille 152 were removed. The 1-way valve comprises a grid-like frame 300 having apertures 310, and strips 315 on the frame 300 for securing petals 320 that overlie the apertures. For illustrative purposes, only the top left half of the frame 300 is shown fitted with petals 320. In practical use, the bottom right half of frame 300 would also be fitted with petals 320.

Figs 3b and 3c show side views of the 1-way valve 150 when looking from the direction B marked on Fig. 3a. In particular, Fig. 3b shows the position of the petals 320 when the 1-way valve is closed, i.e. when the portable apparatus is not being operated, and Fig.3c shows the position of the petals 320 when the 1-way valve is open, i.e. when the portable apparatus is being operated.

During the operation of the portable apparatus, the pressure inside the sealed enclosure 140 is raised and so the petals 320 are forced outwardly away from the frame 300, allowing air A_OUT to flow out of the sealed enclosure 140 through the apertures 310.

When the portable apparatus is not being operated, the airflow generation section 132 does not drive any airflow into the sealed enclosure, and so the petals 320 rest substantially vertically against the frame 300 under their own weight/bias, thereby preventing unfiltered air from entering the sealed enclosure 140 via the apertures 310.

Other types of 1-way valve suitable for use as the 1-way valve 150 will also be apparent to those skilled in the art.

An embodiment of a filter media according to the second aspect of the invention will now be described with reference to Figs. 4a ‘ 4c. The filter media is suitable for use in the embodiment of Fig. 1.

The schematic sectional diagram of Fig. 4a is taken along the length of a filter media 400. The filter media 400 has a near end 401 that faces towards the incoming airflow, and a far end 402 where filtered air is ejected from the filter media. Fig. 4b shows a front view of the filter media 400 at the near end 401, and Fig. 4c shows a rear view of the filter media 400 at the far end 402.

The filter media 400 comprises a first pipe 410 which is open at the far end 402, and which is connected to a second pipe 420 at the near end 401 by an outer front face 415. The second pipe 420 extends towards the far end 402 inside of the first pipe 410.

The filter media further comprises a third pipe 430 connected to the second pipe 420 at the far end 402 by a rear face 425. The third pipe 430 extends towards the near end 401 inside of the second pipe 420. The third pipe 430 is closed at the near end by an inner front face (closure) 440.

In use, an airflow is directed towards the near end 401 of the filter media, and passes through the filter media to the far end 402. In particular an airflow 450 exits the far end of the filter media after passing though the walls forming the first pipe 410, or through the front outer face 415, or through the walls forming the second pipe 420. An airflow 451 exits the far end of the filter media after passing through the rear face 425, or through the walls of the third pipe 430, or through the inner front face 440. Therefore, the first 410, second 420, and third 430 pipes all form part of the effective surface area of the air filtering device, as well as the inner 440 and outer 415 front faces and the rear face 425.

In alternate embodiments, the second pipe may be closed at the far end 402 such that the third pipe 420 is not be implemented, and /or the pipe widths may be tapered so that the faces 415, 425, and 440 are not required. Although the pipes are shown as having square cross-sections, other shaped cross-sections could also be used, for example rectangles, circles, or ovals.

The filter media of the air filtering device of Fig. 1 may comprise two of the filter media 400, which may be used together to make up the total effective surface area of the filter media. The total effective surface area of the filter media may for example be at least 600cm^2, at least 1200 cm^2, at least 1800 cm^2, at least 2400 cm^2, at least 3000 cm^2, or at least 3600 cm^2. The total filter media may be made of N filter media 400, with substantially 1/N of the incoming airflow passing through each filter media 400.

The filter media 400 is adapted to filter out particles of less than 200um in diameter, less than 100um in diameter, less than 50um in diameter, less than 20um in diameter, or less than 10um in diameter, for example 3um.

A further embodiment of a filter media according to the second aspect of the invention will now be described with reference to Figs. 5 ‘ 6d. The filter media is also suitable for use in the embodiment of Fig. 1.

The schematic diagram of Fig. 5 shows a cut-away perspective diagram of the filter media 500. The filter media 500 has a square cross-section, and is shown when cut through the centre of the square along the length of the filter media. The cross-sectional diagram of Fig. 6a is taken along the line XSA at a near end 501 of the filter 500, and the portion of the filter shown in Fig.5 corresponds to the right side of Fig.6a, looking in at E-E. The cross-sectional diagram of Fig. 6b is taken along the line XSB, the cross-sectional diagram of Fig. 6c is taken along the line XSC, and the cross-sectional diagram of Fig. 6d is taken along the line XSD.

Referring to Fig. 5, it can be seen that the filter media 500 comprises a first pipe 510 with an inner surface 511, a second pipe 520 with an inner surface 521, and a third pipe 530 with an inner surface 531. The first pipe 510 is open at a far end 502, and is connected to the second pipe 520 at the near end 501 by an outer front face 515. The second pipe 520 extends towards the far end 502 inside of the first pipe 510.

The filter media 500 further comprises a third pipe 530 directly connected to the second pipe 520 at the far end 502. The third pipe 530 extends towards the near end 501 inside of the second pipe 520. The third pipe 530 is closed at the near end by a cross-shaped closure 540.

The cross-shaped closure 540 is best understood with reference to Fig. 6a taken at the near end 501 of the filter media 500. The cross shaped closure 540 has four elongate portions that meet at a centre portion. In this embodiment the elongate portions extend outwards to meet the inner walls 521 of the second pipe 520, although this is not essential.

The cross sectional diagrams of Figs. 6b and 6c show how the cross-sectional area of the third pipe 530 progressively increases towards the far end 502 of the filter media, and the cross-sectional diagram of Fig. 6d shows the third pipe 530 connecting with the second pipe 520 at the far end 502 of the filter media.

In use, an airflow is directed towards the near end 501 of the filter media 500, and passes through the filter media to the far end 502. In particular, an airflow 550 exits the far end of the filter media after passing though the walls forming the first pipe 510, or through the front outer face 515, or through the walls forming the second pipe 520. An airflow 551 exits the far end of the filter media after passing through the walls of the third pipe 530. Therefore, the first 510, second 520, and third 530 pipes all form part of the effective surface area of the air filtering device, as well as the outer front face 515.

The cross-shaped closure increases the effective surface area of the filter, and other shaped closures such Y shaped closures instead of X shaped closures are also possible. The cross-sectional shapes of each of the pipes could also be modified if desired.

The filter media of the air filtering device of Fig. 1 may comprise two of the filter media 500, which are used together to make up the total effective surface area of the filter media. The total effective surface area of the filter media may for example be at least 600cm^2, at least 1200 cm^2, at least 1800 cm^2, at least 2400 cm^2, at least 3000 cm^2, or at least 3600 cm^2. The total filter media may be made of N filter media 500, with substantially 1/N of the incoming airflow passing through each filter media 500.

The filter media 500 is adapted to filter out particles of less than 200um in diameter, less than 100um in diameter, less than 50um in diameter, less than 20um in diameter, or less than 10um in diameter, for example 3um.

The terms ’near end and ’far end are simply used to reference each end of the filter media shown in Figs. 4 ‘ 6, and do not place any restrictions on the filter media or the use thereof. It will be understood that when a part of the filter media is stated to be at the near end it is substantially at the near end, for example more than 75% of the way from the far end to the near end, and when a part of the filter media is stated to be at the far end it is substantially at the far end, for example more than 75% of the way from the near end to the far end.

Further details of the base 700 will now be described with reference to Figs. 7a ‘ 7c. The schematic diagram of Fig. 7a shows a perspective view of the base 700, and the base 700 is suitable for forming the base of the aqueous stage 110 with the side 705 of the base 700 facing towards the filter media stage 120, and the side 710 of the base surrounding the exits of the tubes 111 ‘ 116.

The base 700 comprises a plurality of ribs 720 extending outwardly from a centre portion 750. The centre portion 750 locates beneath the air outlet 118 of the aqueous stage, and the ribs 720 form channels for directing the airflow from each one of the plurality of tubes 111 ‘ 116. In particular, as shown in the plan view of Fig. 7b, the base comprises an area 711 that locates beneath the tube 111, an area 712 that locates beneath the tube 112, an area 713 that locates beneath the tube 113, an area 714 that locates beneath the tube 114, an area 715 that locates beneath the tube 115, and an area 716 that locates beneath the tube 116. Each of these areas is associated with a pair of ribs 720 leading from the area to the centre portion 750. Accordingly, the base has a pair of ribs 720 for directing the airflow from each one of the tubes towards the centre portion 750, where it rises up through the air outlet 118.

Fig. 7c shows a schematic cross-sectional diagram of the base 700 taken along line C-C marked on Fig.7c and looking towards the side 710 of the base. The base is angled downwardly away from the centre portion 750 along intermediate portions 740 between the centre portion 750 and the areas 711- 716, thereby forming a trough around the periphery of the base including the areas 711-716. The angled intermediate portions 740 gradually deepen the trough from the centre portion 750 to the areas 711 ‘ 716. The schematic diagram of Fig. 7c has been stretched in the vertical direction so that the angle of the intermediate portions 140 can be seen. The angle of the intermediate portions is set according to the rate of airflow that is to exit from the tube, the higher the airflow, the steeper an angle is likely to be needed. The angle may for example be less than 10 degrees to the horizontal, and may also be less than 5 degrees to the horizontal, for example 3 degrees to the horizontal. The angles are measured with the base in its normal orientation during use of the aqueous stage.

The trough is intended to hold puddles(s) of aqueous solution in the areas 711 ‘ 716 and at least partially over the intermediate portions 740 between the ribs 720. The angling of the intermediate portions 740 helps keep the aqueous solution in the areas 711 ‘ 716, as well as at least partially over the intermediate portions 740, during the exiting of air from the tubes 111 ‘ 116.

Since the areas 731 and 736 are located closest to the filtering stage 120, there is a tendency for more air to flow through the tubes 111 and 116 than through the other tubes. Accordingly, to help balance the airflow between the various pipes and thereby maximise the dust-capturing capability of the aqueous solution and avoid turbulence, the base 700 further comprises air regulators 731 - 736 associated with the areas 711 ‘ 716 respectively.

The air regulators each comprise a protrusion in the form of a strip of material that extends upwardly from the base and partially obstructs the flow of air from the respective area to the air outlet 118. As can be seen in Fig. 7a, the air regulator strips 731 and 736 are higher than the air regulator strips 732 and 735, and the air regulator strips 732 and 735 are higher than the air regulator strips 733 and 734.

The further (higher) the air regulator strip extends away from the base 700, the greater the obstruction that the air regulator presents to the airflow. Accordingly, the different strip heights counteract the tendency of the airflows from the tubes 111 and 116 closest to the filtering stage 120 to be higher than the airflows from the tubes 113 and 114 furthest from the filtering stage 120.

The air regulator strips 733 and 734 may alternatively be removed entirely, with the air regulator strips 731, 732, 735, 736 sized to balance the airflow from each of the tubes 111, 112, 115, 116 with the airflow from the tubes 113 and 114.

The air regulators may be implemented differently in alternate embodiments, for example they may extend from other parts of the aqueous stage.

An embodiment of a portable air filtering device according to the third aspect of the invention comprises the aqueous stage 110 and filter media stage 120. The portable air filtering device may be applied to a sealed enclosure as shown in Fig. 1a, or may be applied to other situations requiring a portable filtering apparatus.

Further alternate embodiments falling within the scope of the appended claims will also be apparent to the skilled person. For example, the air filtering device of the portable apparatus may comprise other types of air filter than the ones disclosed herein, such as electrostatic or centrifugal air filters.

CLAIMS

1. A portable apparatus comprising a sealed enclosure and an air filtering device, the sealed enclosure configured to enclose an electronic device therein, the portable apparatus being operable to direct air though the air filtering device and into the sealed enclosure, the sealed enclosure being sealed except for:

- an air inlet that receives filtered air from the air filtering device into the sealed enclosure during the operation of the portable apparatus; and

- an air outlet that exits air from the sealed enclosure during the operation of the portable apparatus.

2. The portable apparatus of claim 1, wherein the portable apparatus is a portable container, the sealed enclosure and the air filtering device being housed within the portable container.

3. The portable apparatus of claim 1 or 2, wherein the air filtering device comprises filter media

4. The portable apparatus of claim 3, wherein the filter media has an effective surface area of at least 600 cm^2.

5. The portable apparatus of claim 3 or 4, wherein the filter media has an effective surface area of at least 1200 cm^2, or at least 1800 cm^2, or at least 2400 cm^2, or at least 3000 cm^2, or at least 3600 cm^2.

6. The portable apparatus of claim 3, 4, or 5, wherein the filter media is adapted to filter out particles of less than 200um in diameter, or less than 100um in diameter, or less than 50um in diameter, or less than 20um in diameter, or less than 10um in diameter.

7. The portable apparatus of claim 3, 4, 5, or 6, wherein the filter media is non-planar.

8. The portable apparatus of claim 7, wherein the filter media comprises a first elongated pipe having near and far ends, the elongated pipe being open at the far end and being connected to a second pipe at the near end, the second pipe extending towards the far end inside of the first pipe, wherein the first and second pipes both form part of the effective surface area of the air filtering device.

9. The portable apparatus of claim 8, wherein the filter media further comprises a third pipe connected to the second pipe at the far end, the third pipe extending towards the near end inside of the second pipe, wherein the third pipe also forms part of the effective surface area of the air filtering device.

10. The portable apparatus of claim 9, wherein the third pipe is closed by a closure at the near end.

11. The portable apparatus of claim 10, wherein the closure of the third pipe comprises at least three elongate portions that meet together at a centre portion.

12. The portable apparatus of any preceding claim, wherein the air filtering device comprises an aqueous stage for trapping particles in an aqueous solution, the aqueous stage having a base in which the aqueous solution is held.

13. The portable apparatus of claim 12, further comprising a plurality of tubes configured to direct air perpendicular to the surface of the aqueous solution.

14. The portable apparatus of claim 13, wherein the aqueous stage comprises an air outlet, and wherein the plurality of tubes are arranged in an arc shape around the air outlet.

15. The portable apparatus of claim 13 or 14, wherein the base of the aqueous stage is angled downwardly away from a central portion of the base, and in the direction of the plurality of tubes to form a gradually deepening trough for holding the aqueous solution.

16. The portable apparatus of any one of claims 13 ‘ 15, wherein the aqueous stage further comprises an air regulator partially obstructing the flow of air from one of the plurality of tubes to the air outlet, there being another differently sized air regulator or no air regulator obstructing the flow of air from another one of the plurality of tubes to the air outlet.

17. The portable apparatus of claim 16, wherein each air regulator comprises a protrusion extending upwardly from the base and partially blocking the flow of air.

18. The portable apparatus of any one of claims 12 to 17 when appended to at least claim 3, wherein the aqueous stage precedes the filter media in the direction of airflow through the air filtering device.

19. The portable apparatus of any preceding claim, further comprising an airflow creation device.

20. The portable apparatus of claim 19, wherein the airflow creation device is subsequent to the filter media in the direction of airflow.

21. The portable apparatus of claim 19 or 20, wherein the airflow creation device is at least 50mm away from at least 50% of the effective surface area of the filter media.

22. The portable apparatus of claim 19, 20, or 21, wherein the airflow creation device creates a greater air pressure inside the sealed enclosure than the air pressure of the ambient environment in which the portable apparatus is present.

23. The portable apparatus of any preceding claim, wherein the air outlet of the sealed enclosure comprises a 1-way valve to help prevent air from entering the sealed enclosure via the air outlet when the portable apparatus is not being operated.

24. The portable apparatus of any preceding claim, wherein the electronic device is an electronic device that is configured to be placed directly in the

ambient environment when used, for example a computer base unit, a set top box, an audio amplifier, a computer laptop, or a video processing device.

25. The portable apparatus of any preceding claim, wherein the sealed enclosure has dimensions of less than 2m x 1m x 1m.

26. A filter media comprising a first elongated pipe having near and far ends, the first elongated pipe being open at the far end and being connected to a second pipe at the near end, the second pipe extending towards the far end inside of the first pipe, wherein the first and second pipes both form part of the effective surface area of the air filtering device.

27. The filter media of claim 26, wherein the filter media further comprises a third pipe connected to the second pipe at the far end, the third pipe extending towards the near end inside of the second pipe, wherein the third pipe also forms part of the effective surface area of the air filtering device.

28. The filter media of claim 27, wherein the third pipe is closed by a closure at the near end.

29. The filter media of claim 28, wherein the closure of the third pipe comprises at least three elongate portions that meet together at a centre portion.

30. A portable air filtering device comprising an aqueous stage for trapping particles in an aqueous solution, and a filter media having an effective surface area of at least 600 cm^2, the aqueous stage having a base in which the aqueous solution is held.

31. The portable air filtering device of claim 30, further comprising a plurality of tubes configured to direct air perpendicular to the surface of the aqueous solution.

32. The portable air filtering device of claim 31, wherein the aqueous stage comprises an air outlet, and wherein the plurality of tubes are arranged in an arc shape around the air outlet.

33. The portable air filtering device of claim 31 or 32, wherein the base of the aqueous stage is angled downwardly away from a central portion of the base, and in the direction of the plurality of tubes to form a gradually deepening trough for holding the aqueous solution.

34. The portable air filtering device of any one of claims 31 ‘ 33, wherein the aqueous stage further comprises an air regulator partially obstructing the flow of air from one of the plurality of tubes to the air outlet, there being another differently sized air regulator or no air regulator obstructing the flow of air from another one of the plurality of tubes to the air outlet.

35. The portable air filtering device of claim 34, wherein each air regulator comprises a protrusion extending upwardly from the base and partially blocking the flow of air.

36. The portable air filtering device of any one of claims 30 to 35, wherein the aqueous stage precedes the filter media in the direction of airflow through the portable air filtering device.

37. A portable apparatus comprising a sealed enclosure and an air filtering device substantially as described herein with reference to the accompanying drawings.

38. A filter media substantially as described herein with reference to the accompanying drawings.

39. A portable air filtering device substantially as described herein with reference to the accompanying drawings.

INTELLECTUAL
PROPERTY OFFICE

Application No:	GB1202374.3	**Examiner:**	Dr Albert Mthupha
Claims searched:	1-25, 37	**Date of search:**	8 June 2012

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
X,Y	X: 1-3, 19, 22, 24-25, 37; Y: 6.	US5163870 A (SYSTEMS ALTERNATIVES INC), see whole document, note particularly Fig. 1 and the claims, disclosing an electronic component sealed in a portable housing with an air filtering device, wherein filtered air is supplied to the electronic component before exit from the housing.
X	1-3, 19, 22, 24-25, 37.	US5223006 A (MORAN), note particularly column 2 lines 58-65, column 3 lines 5-22, the Figures and the claims, disclosing a portable enclosure for housing a portable piece of electronic equipment with an air filtering device, wherein filtered air is supplied to the electronic component before the air exits.
Y	6.	US5730770 A (SEH AMERICA INC), see whole document, note particularly claims 1-2, disclosing a housing permitting fluid communication between an air intake for said equipment and the atmosphere and an air filter media, which can filter out particles of from 1 to 500 microns diameter.
A	-	US6474410 A (MINICH et. al.), see whole document, disclosing a portable, hermetically sealed apparatus for housing electronic devices for outside use having slidable shelves for housing a TV, VCR, DVD, stereo, with means for conditioning the environment of said apparatus.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

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

B01D

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

EPODOC, WPI.

International Classification:

Subclass	Subgroup	Valid From
B01D	0047/02	01/01/2006
B01D	0050/00	01/01/2006
G06F	0001/16	01/01/2006
G06F	0001/18	01/01/2006
G06F	0001/20	01/01/2006
H05K	0005/00	01/01/2006