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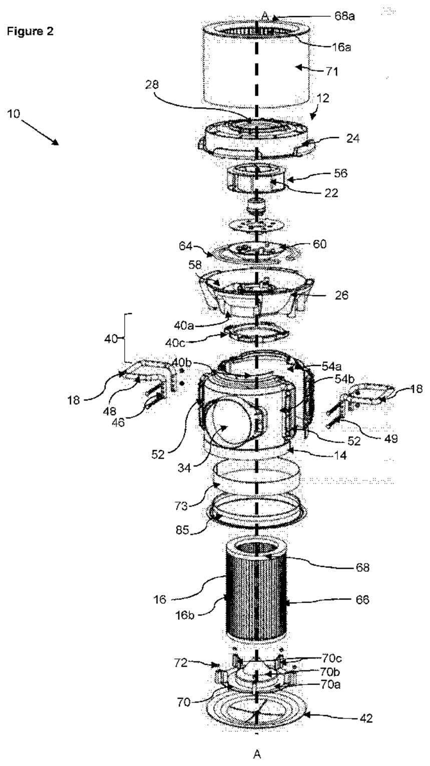
(54) Title of the Invention: **Air Pump, Modular Positive Input Ventilation Apparatus and Positive Input Ventilation Apparatus**
Abstract Title: **An Air Pump for a Ventilation / Air Conditioning apparatus**

(57) An air pump 12 for a ventilation / air conditioning apparatus 10 for locating in a ceiling cavity, the air pump comprises a fan housing 20 having a radial fan 56 located in an internal chamber 58, the housing having an inlet 28 and an outlet 30 in fluid communication via the chamber. The chamber further comprises an air flow passage (74, fig 3) between an outlet (78) of the fan and the outlet of the fan housing, with the passage having a uniform or non-uniform lateral cross-section at least a majority of its longitudinal extent. The fan housing further may comprise a fin (s) (80) in the passage for reducing angular momentum of the air from the fan, and an anti-vortex element 60 for reducing vortex air flow. A heating element 64 may heat the air and the fan may be a backward curved fan. The apparatus may be modular comprising of sub housings 24, 26 of the fan housing releasably and connected without tools via a bayonet intermediate connector 40c to an air distribution housing 14 comprising of identical sub portions 54a, 54b. The apparatus may be supported on ceiling joists (84, fig 6) by adjustable support elements 18.

Figure 2



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(58) Field of Search:
INT CL **F04D, F24F**
Other: **WPI, EPODOC**

Figure 1

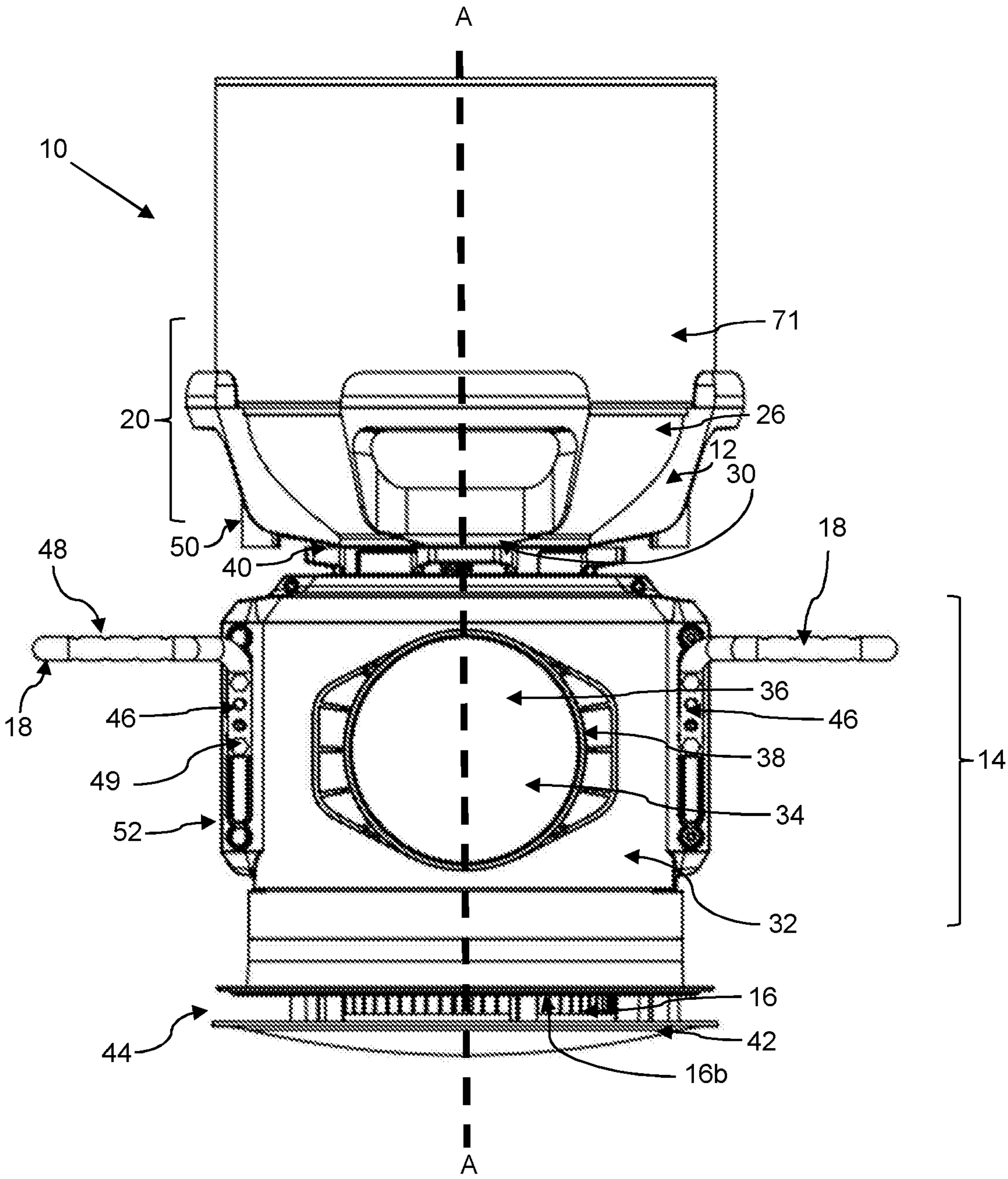
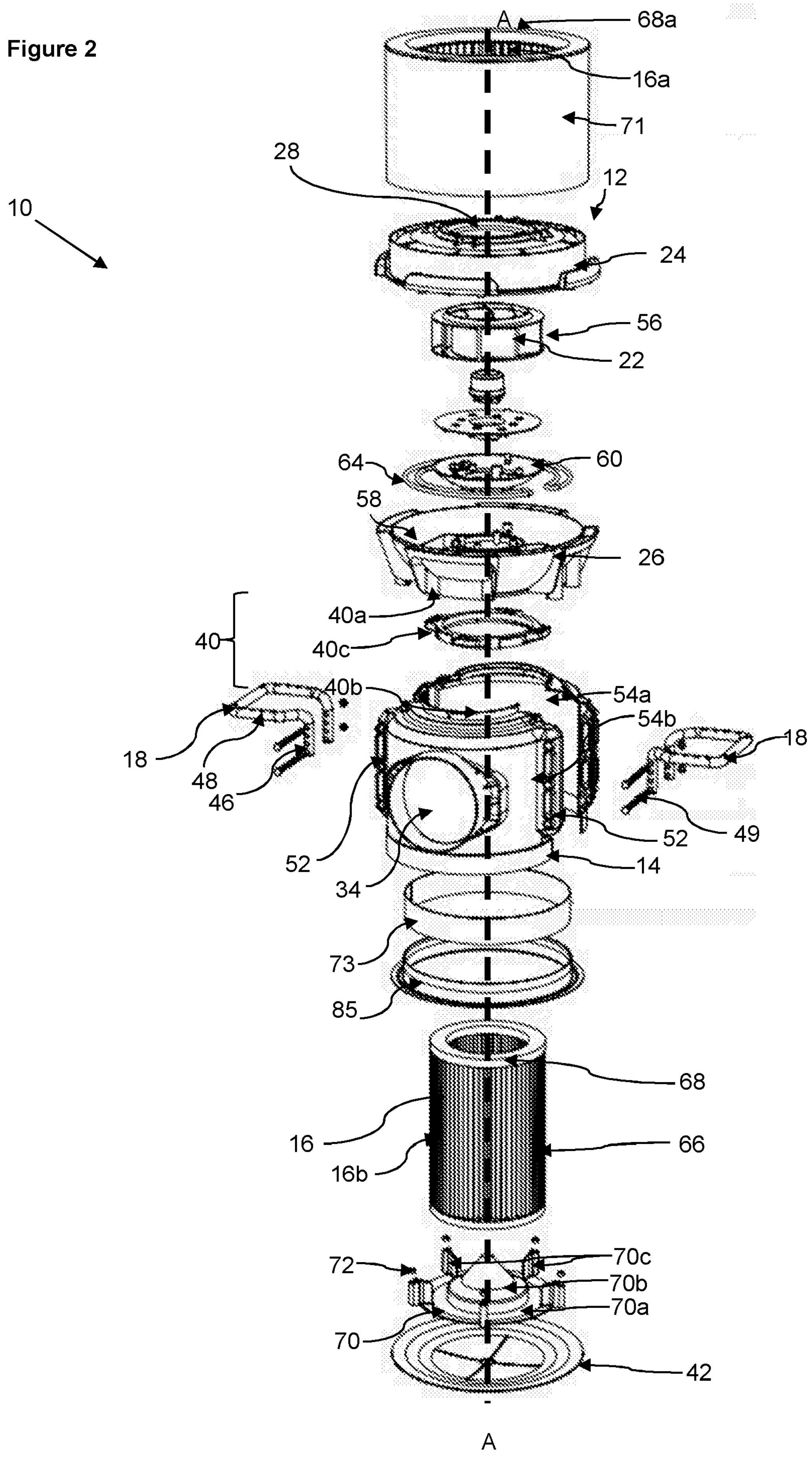

A
10
71
20
26
12
30
50
40
48
18
18
36
46
46
38
49
34
52
14
32
16
44
42
16b
A

Figure 2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68a
16a
71
28
12
10
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56
22
64
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58
26
40a
40c
40
40b
54a
54b
18
48
46
18
52
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34
73
85
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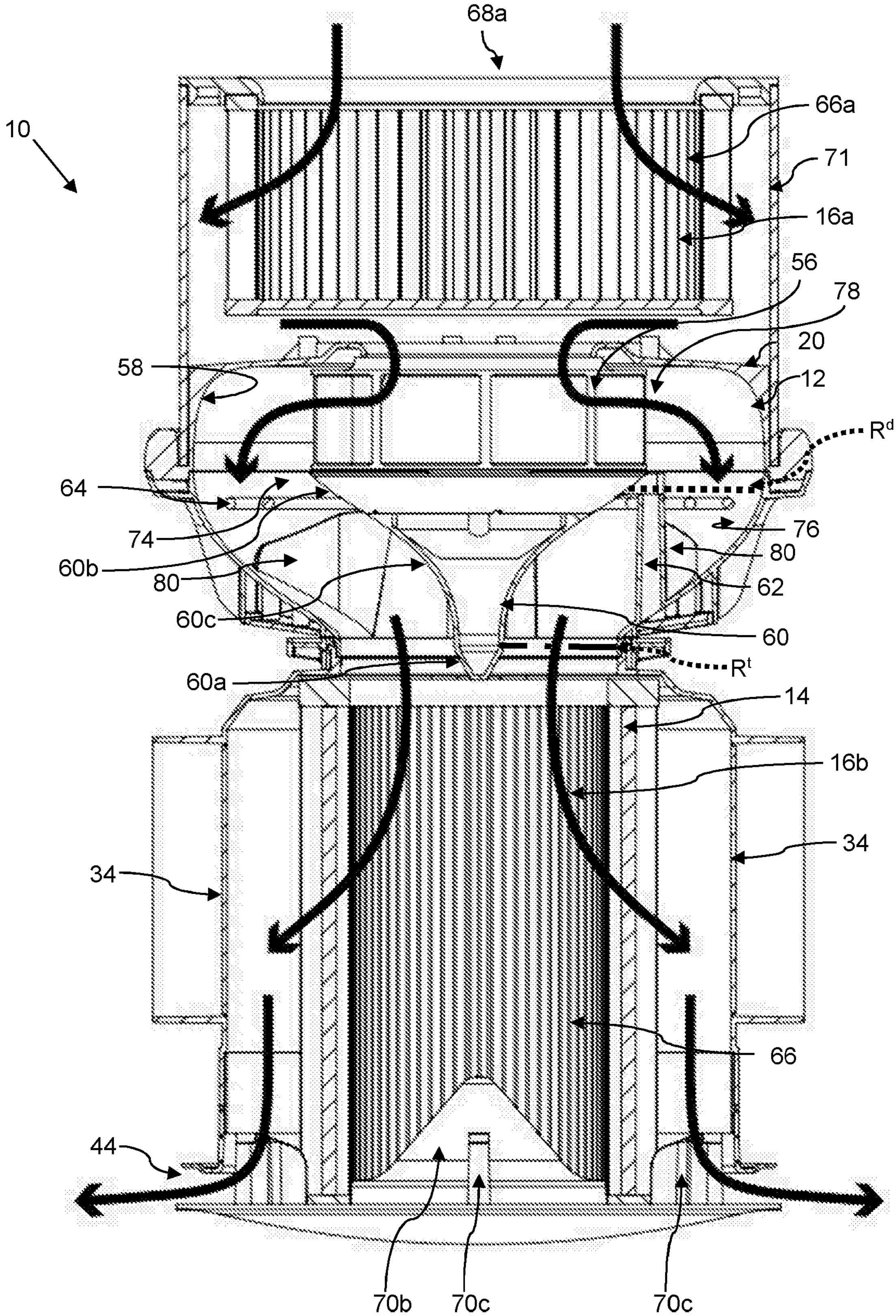
16
66
16b
72
70c
70b
70a
70
42
A

Figure 3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66a
10
71
16a
56
78
20
58
12
R^d
64
76
74
80
60b
62
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60c
60
60a
R^t
14
16b
34
34
66
44
70b
70c
70c

Figure 4

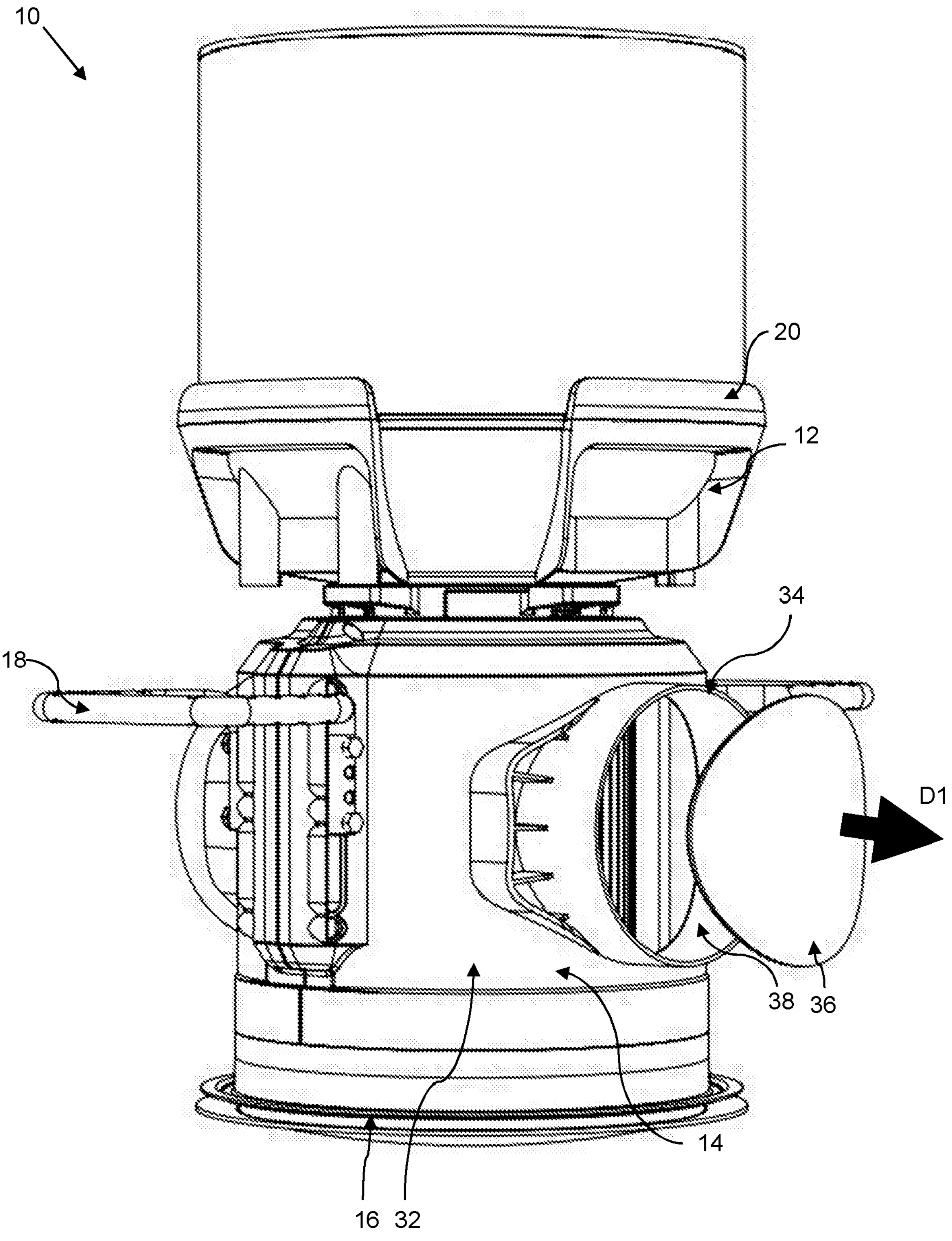


Figure 5

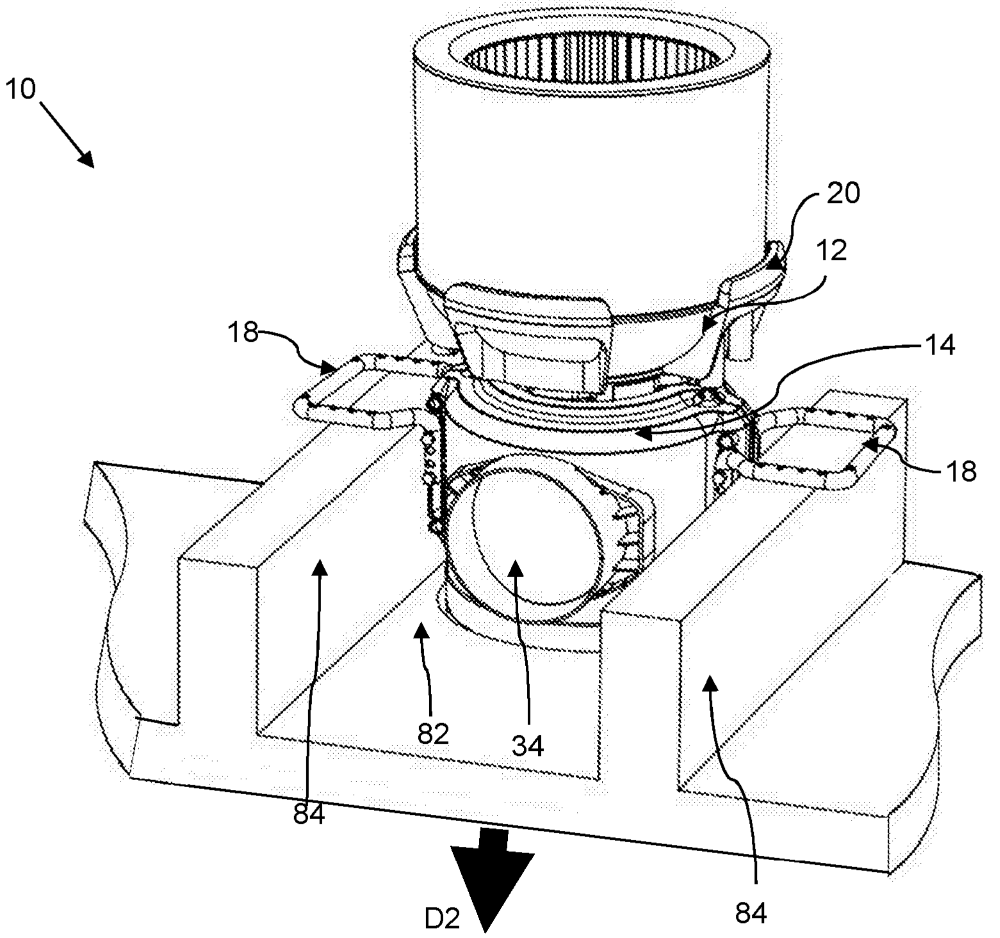


Figure 6

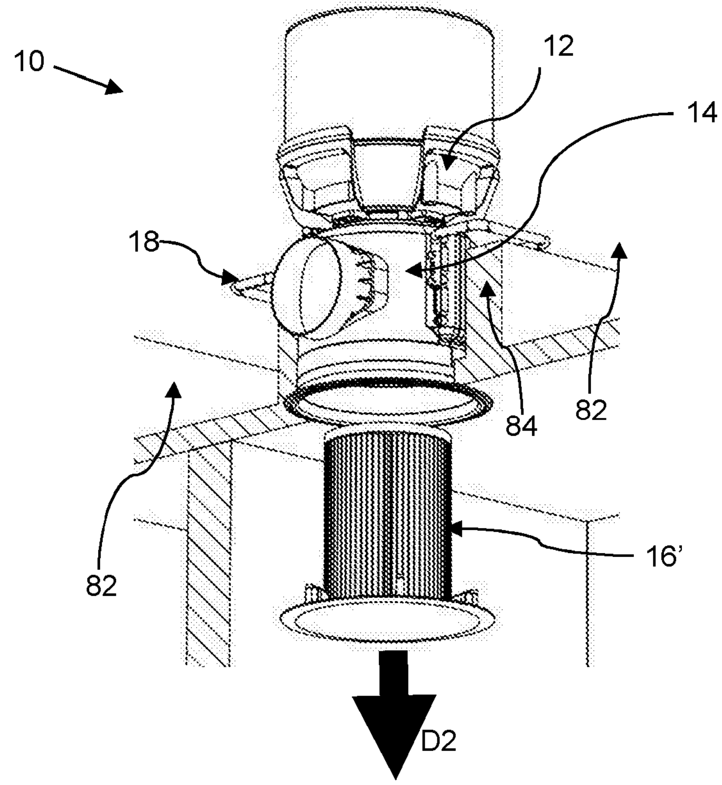


Figure 7

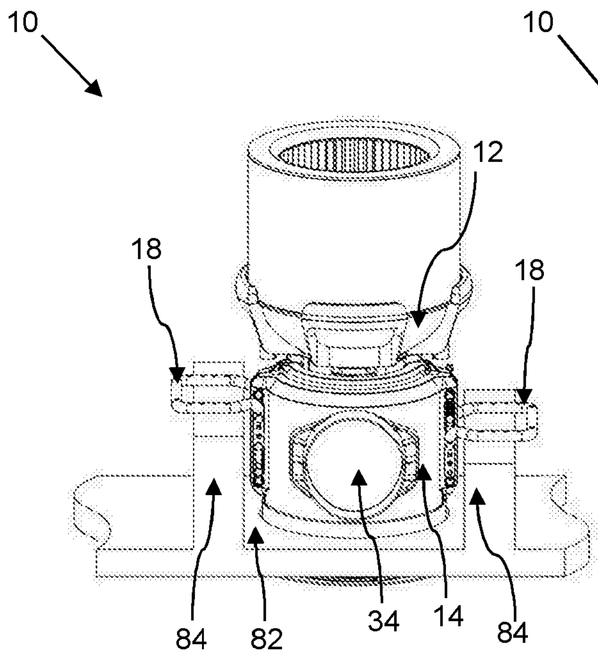


Figure 8

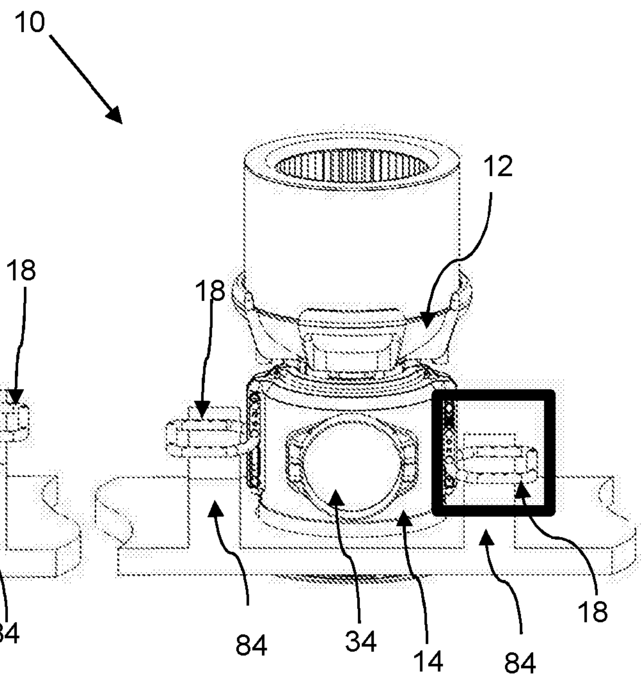


Figure 9

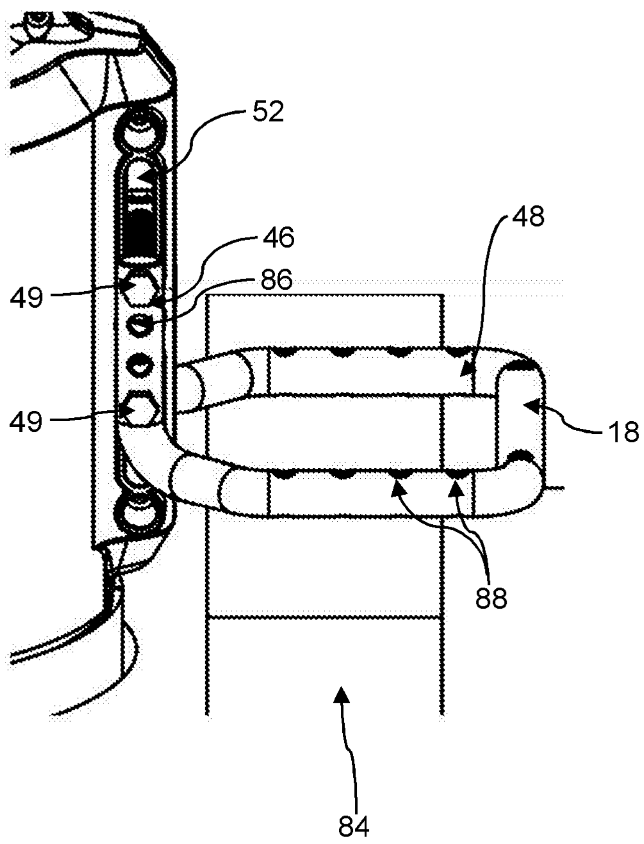


Figure 10

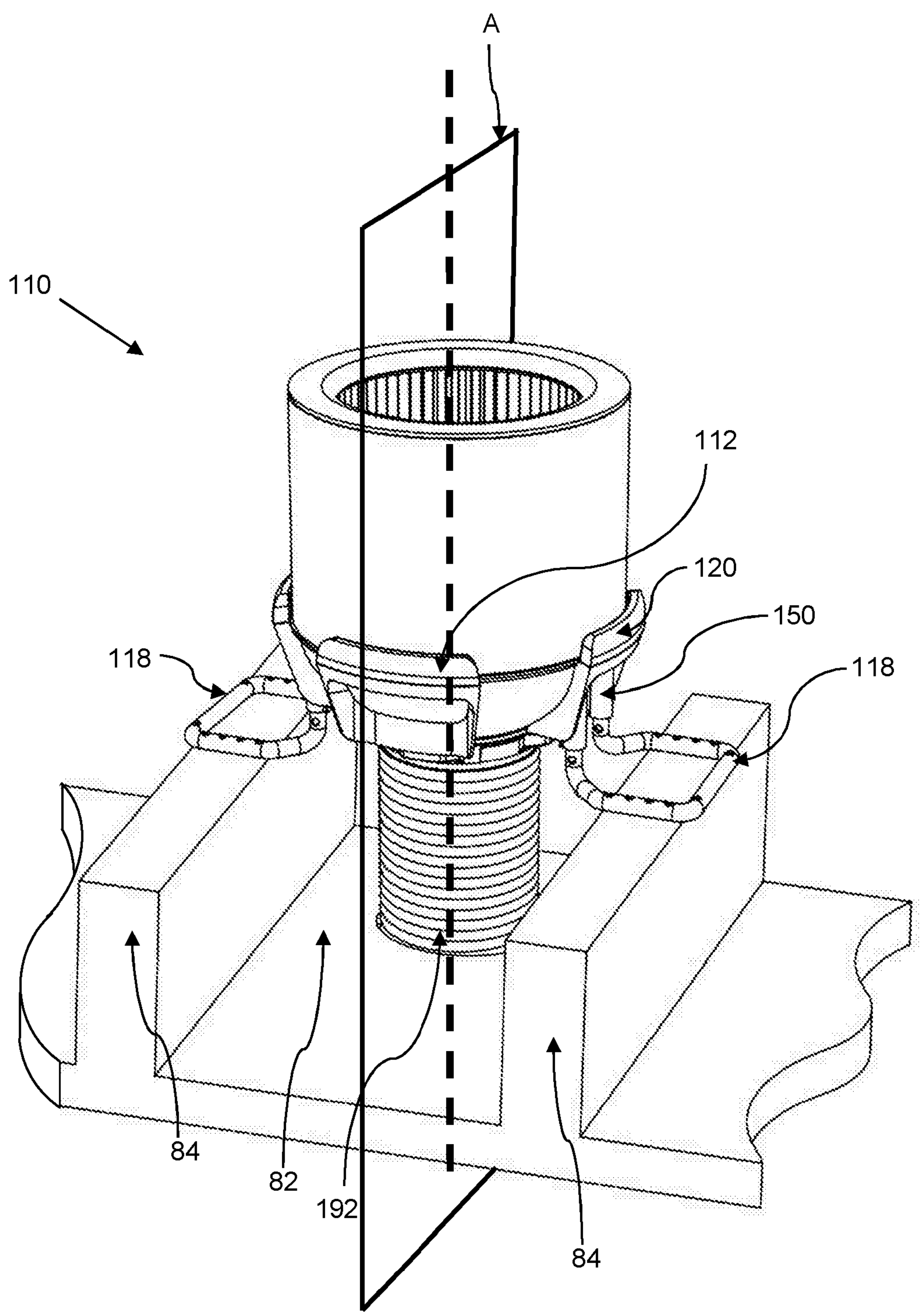


Figure 11

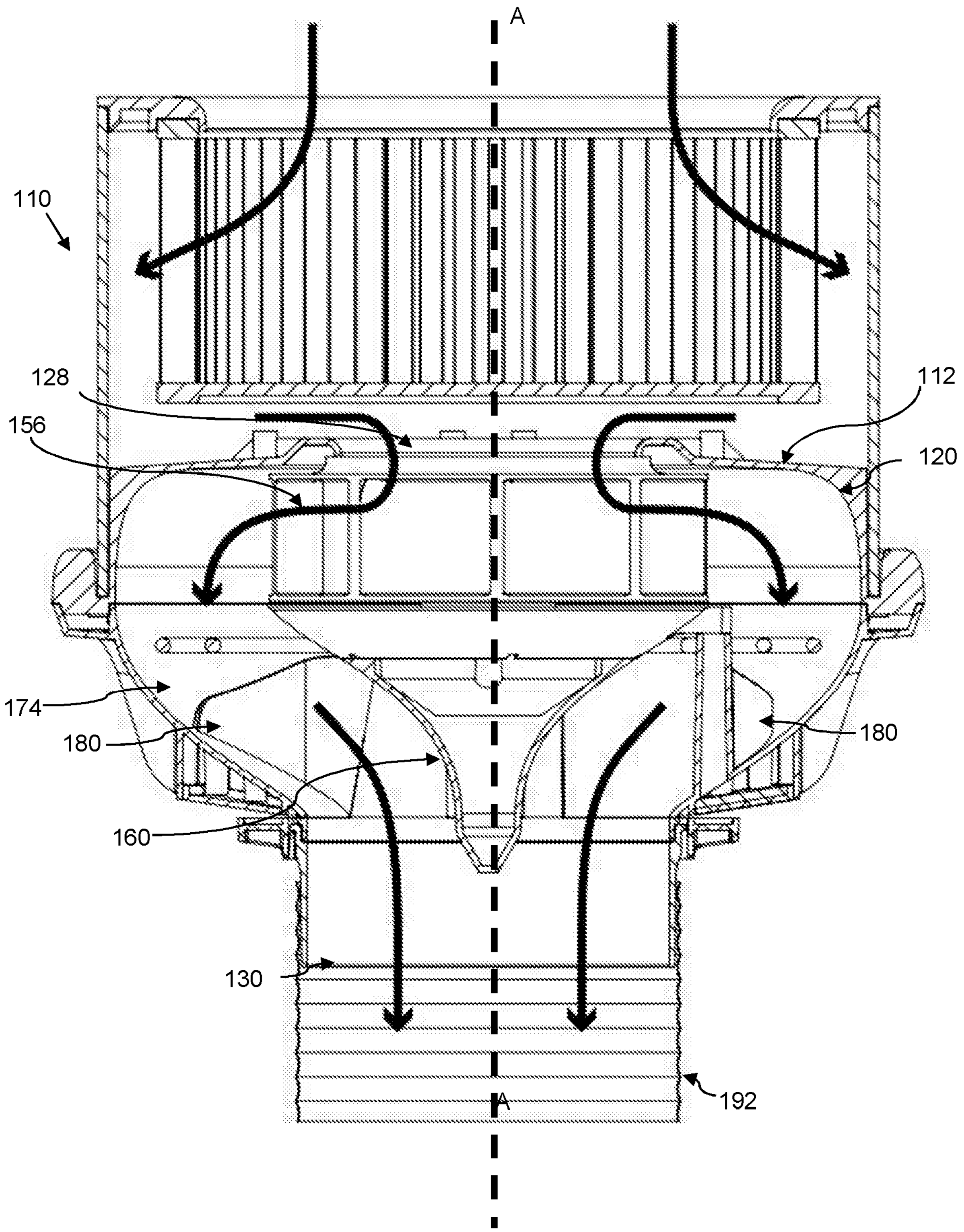


Figure 12

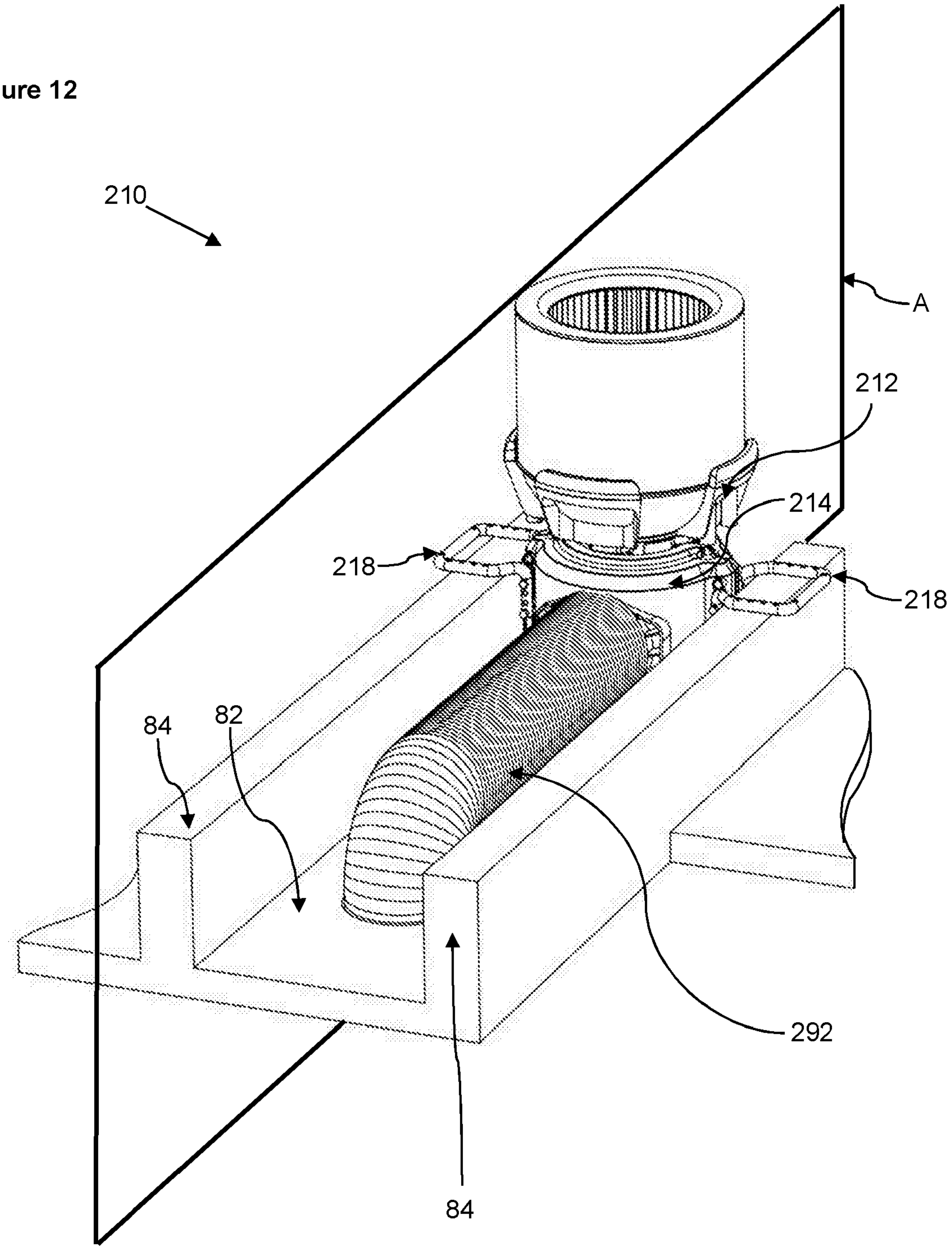
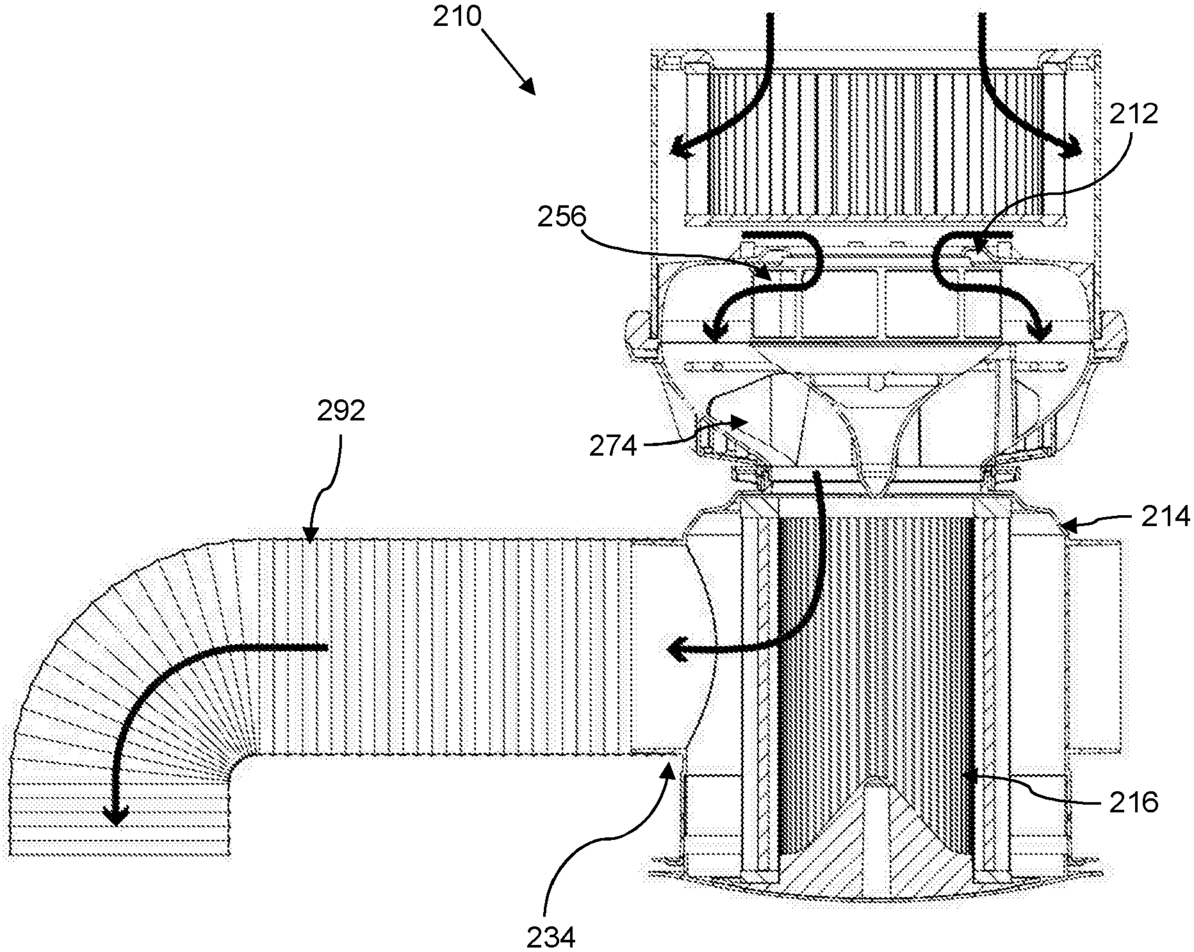


Figure 13



Air Pump, Modular Positive Input Ventilation Apparatus, and Positive Input Ventilation Apparatus

The present invention relates to an air pump for a Positive Input Ventilation apparatus. The present invention also relates to a Positive Input Ventilation apparatus which is modular. The present invention further relates to a Positive Input Ventilation Apparatus for accommodating supports of different heights. The present invention also relates to a Positive Input Ventilation apparatus in which a filter, which may be toollessly connectable and disconnectable, is easily accessible from within an internal space below.

Air quality is known to impact people's health, comfort, well-being, and life expectancy. Poorly ventilated enclosed indoor spaces in which humans live and breathe, such as a home or an office, have poor air quality. Indicators of poor air quality include high levels of carbon monoxide and/or water vapour, volatile organic compounds, particulates, pollen and/or the presence of mould, bacteria or other microbial contaminants.

Solutions to improve indoor air quality include ventilation and air-filtration. Positive Input Ventilation (PIV) involves introducing air of higher quality into an enclosed space to displace the air of poorer quality via a localised increase in pressure and/or airflow. Typically, the air of higher quality is drawn from a ventilated loft space. Within the PIV system, the air is preferably filtered and pushed into an enclosed space below. However, existing PIV systems have drawbacks.

In some existing PIV systems, the externally fitted filters are easily damaged, for example by falling debris, or by pests such as insects or rodents. To replace the filter, the loft or enclosed space containing the filtering portion of the PIV system must be entered or accessed, which may be difficult or hazardous. Externally fitted filters typically accumulate particulates on the outside of the filter. Removal of such a filter involves grasping the soiled exterior thereof, which is unpleasant and unhygienic. Disturbed particulates deposited on the filter are re-suspended in the air or deposited on the surface below.

Internally fitted filters are more difficult to access and replace. If involving a mesh structure extending in a plane normal to a linear airflow path, the cross-sectional area of the mesh structure is relatively small. Particulates may be deposited at a greater density per area compared to an externally fitted filter such that the internal filter is more easily obstructed, resulting in a loss of suction. To compensate for the loss of suction, the filter must be changed more frequently and/or a more powerful motor having greater energy-requirements must be provided. Such motors are often larger, requiring more space. Large, preferably external, filters may also be required. As a result of requiring larger motors and/or larger filters, PIV systems may not fit between ceiling support members.

The present invention seeks to provide a solution to these problems.

According to a first aspect of the present invention, there is provided an air pump for Positive Input Ventilation apparatus locatable in a ceiling cavity, the air pump comprising: a fan housing having an air inlet, an air outlet, and an internal fan chamber via which the air inlet and the air outlet are in fluid communication with one another; and an electrically-energisable radial fan in the fan chamber and positioned in or substantially in axial alignment with the air inlet and the air outlet; the fan chamber having an air-flow passage disposed between an outlet of the radial fan and the air outlet of the fan housing, and the air-flow passage having a uniform or substantially uniform lateral cross-section along at least a majority of a longitudinal extent in an axial direction of the fan housing.

Air enters and exits the air pump axially or substantially axially, whilst being redirected internally by a radial fan. The radial fan may have a greater efficiency than non-radial fans. Whilst air re-direction may lower the efficiency of the air pump, this efficiency reduction is at least partly offset by the constant or substantially constant cross-sectional area. A constant cross-sectional area results in the air velocity, and thereby pressure, being constant or substantially constant throughout the air pump. This effect increases efficiency and/or reduces noise.

Advantageously, the fan housing may further comprise an internal fin-element in the air-flow passage downstream of the outlet of the radial fan, the internal fin-element may extend at least partly along the longitudinal extent of the housing-axis for reducing or eliminating angular momentum imparted to the air by the radial fan. Efficiency is further increased.

Beneficially, the fan housing may further comprise an anti-vortex element for reducing or preventing the formation of a vortex where airflows separated upstream by the radial fan merge together, thereby improving the efficiency of the air pump. airflows merging in a more laminar fashion, thereby generating less turbulence. The formation of a vortex or eddy is inhibited or prevented.

Optionally, the air pump may further comprise a heating element on the air-flow path. Air may be heated.

Furthermore, the radial fan may be a backward curved fan. Air is output radially from such a fan.

According to a second aspect of the present invention, there is provided a modular Positive Input Ventilation apparatus for location in a ceiling cavity, the modular Positive Input Ventilation apparatus comprising: an air-pump device; and an air-distribution housing in fluid communication with the air-pump device, the air-distribution housing having a plurality of selectably-openable feed ports, configured to connect to an air-feed conduit, whereby said air-feed conduit is connectable to one or more corresponding feed ports. A single ventilation apparatus can provide ventilation for a plurality of spaces and/or at a plurality of locations in the same space. Preferably the or all feed ports are output feed ports. Additionally or alternatively, it may easily be envisioned, however, that the, each, or at least one feed port may be an input feed port. This may be advantageous for instance if an air-distribution housing is provided upstream of air-pump device by way of example only.

Beneficially, the feed ports may be in spaced-apart relationship for enabling air distribution in different directions. The feed ports may be opposite or non-opposite to each other. Alternatively or additionally, two feed ports may be axially spaced apart from each other. Optionally, the modular Positive Input Ventilation apparatus may further comprise a said air-feed conduit.

Advantageously, the air-distribution housing may be releasably engageable with an outlet of the air-pump device. Furthermore, there may be an intermediate connector which is engageable with both the air-distribution housing and the air-pump device. Preferably, the intermediate connector may be toollessly engageable with both the air-distribution housing and the air-pump device, and more preferably, the intermediate connector may be engageable with the air-distribution housing and the air-pump device via a bayonet connection. A double bayonet engagement may be preferred. These features enable the ventilation apparatus to be modular by permitting the user to select a suitable air-distribution housing, particularly if a range of different air-distribution housings is available, and connect the air-distribution housing to the air-pump device.

According to a third aspect of the present invention, there is provided a Positive Input Ventilation apparatus for location in a ceiling cavity, the Positive Input Ventilation apparatus comprising: an air-pump device having a pump housing defining an air inlet and an air outlet; and at least one support element for directly or indirectly supporting the air-pump device, the support element being adjustably positionable relative to the pump housing, so as to accommodate engagement with opposing ceiling support members within the ceiling cavity. The ventilation apparatus can be supported by supporting surfaces at different heights. Although the at least one support element is preferably adjustable relative to the pump housing, non-adjustable may be an option. For example, a support element engageable with the pump housing directly may only be connectable thereto in one predetermined or fixed position.

Advantageously, the or a said support element may extend at least partly radially from the pump housing. Additionally, the air-pump device may comprise at least one of: a recess and a rail, the support element being slidably receivable within the recess and/or rail. Optionally, the support element may comprise at least one projection and the at least one of the recess and the rail may comprise at least one indent or vice-versa, the or a said projection being engageable with the or a said indent by interference fit. Preferably, the Positive Input Ventilation apparatus may further comprise a second said support element, which may be operable independently of the first said support element. Optionally, the support element may have an L-shape in side view. These features all enable different heights to be accommodated and/or configurations to be adopted.

Furthermore, the air-pump device of the Modular Positive Input Ventilation apparatus preferably in accordance with the second aspect of the invention, or the Positive Input Ventilation apparatus, preferably in accordance with the third aspect of the invention, may comprise an electrically-energisable radial fan. A radial fan may be more efficient than a non-radial fan.

According to a fourth aspect of the present invention, there is provided a Positive Input Ventilation apparatus for location in a ceiling cavity, the Positive Input Ventilation apparatus comprising: an air-pump device having an air inlet and an air outlet; and an air filter which is toollessly engageable with and releasable from the air-pump device for maintenance and/or replacement. The ease of connection and/or replacement of the air filter is enhanced by not requiring tools.

Preferably, the Positive Input Ventilation apparatus may further comprise a filter housing and the air filter may be insertable into the filter housing. The filter is protected by the filter housing.

Optionally, the air-pump device may comprise an electrically-energisable radial fan. Furthermore, the air filter may be engageable with the air-pump device axially relative to the radial fan. This may avoid any further redirections of air.

Beneficially, the air filter may have a first magnetic element, and at least one of the filter housing and the air pump device may have a second magnetic element complementary to the first magnetic element. Magnetic elements are simple to engage and/or disengage.

Preferably, the air filter may have an air inlet, a base portion opposite the air inlet and a filtering surface disposed therebetween for directing airflow into the air filter through the air inlet and out through the filtering surface to contain or substantially contain filtered matter inside the air filter. Optionally, the air filter may comprise a HEPA filtering surface. The filter configuration maximises the area of the filtering surface.

Advantageously, the base portion may have a flow-separating element for separating airflows and/or guiding air towards the filtering surface. The filtering efficiency is improved. Turbulence may be reduced. Changes in pressure are minimised.

The invention will now be more particularly described, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 shows a front representation of a first embodiment of a Positive Input Ventilation apparatus, in accordance with the second, third and fourth aspects of the invention, in an assembled condition;

Figure 2 shows an exploded perspective representation of the Positive Input Ventilation apparatus of Figure 1;

Figure 3 shows a longitudinal cross-section of the Positive Input Ventilation apparatus of Figure 1, taking along axis A-A, in-use with arrows illustrating an airflow path through the apparatus;

Figure 4 shows a side perspective representation of the Positive Input Ventilation apparatus of Figure 1 with a feed port being opened;

Figure 5 shows a perspective representation of the apparatus of Figure 1, in situ installed between two ceiling joists;

Figure 6 shows the apparatus of Figure 5, during removal of the filter;

Figure 7 shows a front perspective representation of the Positive Input Ventilation apparatus of Figure 1, in situ between two ceiling support members having different dimensions to each other such that the supports are assembled in a first arrangement;

Figure 8 shows a front perspective representation of the Positive Input Ventilation apparatus of Figure 1, in situ between two further ceiling support members having different dimensions to each other and to the ceiling support members of Figure 7 such that the supports are assembled in a second arrangement;

Figure 9 shows an enlarged front perspective representation of the inset of Figure 8, showing the engagement of a support element with an air-distribution housing of the Positive Input Ventilation apparatus;

Figure 10 shows a second embodiment of a Positive Input Ventilation apparatus, in accordance with the first aspect of the invention;

Figure 11 shows a vertical cross-section through plane A of the apparatus of Figure 10;

Figure 12 shows a perspective representation of a third embodiment of a Positive Input Ventilation apparatus in accordance with the second, third and fourth aspects of the invention; and

Figure 13 shows a cut-away longitudinal representation of the apparatus along the longitudinal plane A in Figure 12, in-use with arrows illustrating an airflow path through the apparatus.

Referring firstly to Figure 1, there is shown a ventilation apparatus indicated generally at 10, in an assembled condition. Figure 2 shows the same ventilation apparatus 10 in an exploded condition. The ventilation apparatus 10 is preferably a Positive Input Ventilation apparatus 10, also referred to as a PIV apparatus or assembly. As such, the PIV apparatus 10 is preferably located or positionable in a ceiling cavity. The ceiling cavity may be, for example, space between ceiling support members or joists.

The ventilation apparatus 10 has an air-pump device 12, preferably one, although a plurality of air-pump devices may be envisioned. The ventilation apparatus 10 also comprises at least one air-distribution housing 14, at least one air filter 16, and at least one support element 18, although any of these features may be omitted. If the ventilation apparatus 10 has an air filter 16 and/or has the ability to receive a filter 16, the ventilation apparatus 10 may also be referred to as a filtering apparatus or filtration apparatus. The ventilation apparatus 10 or any part thereof may comprise metal, plastics, paper, card, cardboard, magnets, ferrous material, wood, any suitable material or combination of materials.

The air-pump device, or air pump, air-moving device 12 in-use moves air from a first space into a, preferably enclosed, second space in a building. The second space is preferably distinct from the first space, but this may not be the case. Preferably, the first space is a loft or attic space. The second space is preferably a room which may or may not be directly beneath the loft space and/or beneath the in-situ ventilation apparatus 10.

The air-pump device 12 has a fan housing 20 and an air moving element 22. The air moving element 22 can be seen in Figure 2, and is described in more detail therein.

The air-pump device 12 may also have a housing-axis or pump axis A-A. For clarity, any plane which intersects the housing-axis A-A perpendicularly may be referred to as an axial plane, a lateral plane or a transverse plane T. Thus, a cross-section or extent along such a plane may be referred to as an axial, lateral or transverse cross-section or extent.

The terms “radial direction” used herein and throughout is intended to mean a direction away and/or towards the housing-axis A-A in a transverse plane. The terms “radially” or “radial movement” used herein and throughout is intended to mean movement along a radial direction.

Similarly, any plane which contains or is parallel to the housing-axis 30 may be referred to as a longitudinal plane. Thus, a cross-section or extent along such a plane may be referred to as a longitudinal cross-section or extent. The lateral and longitudinal terminology will be adhered to, even if the lateral extent is greater than the longitudinal extent.

The fan housing 20 provides a protective body, housing, or shell for containing at least the air moving element 22. The fan housing 20 may also be referred to as a pump housing. The fan housing 20 may be integrally formed as a one-piece but preferably comprises at least two sub-housing parts 24, 26, which are most clearly shown in the exploded representation of Figure 2. The at least two sub-housing parts 24, 26 are preferably engageable together along a transverse plane so as to form upper and lower sub-housing parts, but engagement along any other plane, such as along a longitudinal plane, could be considered as an alternative. The fan housing 20 has an air inlet 28, which is here positioned at a top surface of the fan housing 20, and an air outlet 30 which vents into the air-distribution housing 14.

The air inlet 28 and the air outlet 30 are openings which respectively let air into and out of the fan housing 20. Preferably, the air inlet 28 and the air outlet 30 are provided opposite each other and/or on opposing sides of the fan housing 20. More preferably, the air inlet 28 and the air outlet 30 may be provided at or adjacent an in-use top end and bottom end respectively of the fan housing 20. Furthermore, the housing-axis A-A may extend from at or adjacent the air inlet 28 to at or adjacent the air outlet 30.

The air-distribution housing 14 provides an extension to the fan housing 20. The air-distribution housing 14 is in fluid communication with the air-pump device 12. The air-distribution housing 14 is upstream or, preferably, downstream of the air-pump device 12. Although there is preferably only one air-distribution housing 14, there may be a plurality in an alternative embodiment. For example, there may be an air-distribution housing upstream and downstream of air-pump device.

A first function of the air-distribution housing 14 is to at least partly receive within and/or protect the filter 16. A second function, in addition to or instead of the first function, is to redirect or divert air drawn in and/or outputted in use by the air-pump device 12. The air-distribution housing 14 has at least one housing body 32 and at least one, and preferably a plurality of feed ports, discharge portions, conduit openings, or apertures 34, although the feed port or ports may be omitted. At least one second said housing body may optionally be provided and connected to an outlet of a first said housing body. The outlet may comprise a feed port and/or a non-feed port aperture. The ventilation apparatus 10 can thus be assembled in a modular fashion.

The housing body 32 is preferably hollow. Furthermore, the housing body 32 is preferably formed and/or dimensioned to at least partly receive the filter 16 therein, although this feature may be omitted. The housing body 32 may alternatively be referred to as a filter housing. The housing body 32 is preferably circular in transverse cross-section but any non-circular cross-section may be envisioned, such as oval, polygonal such as square, rectangular or any other shape, as required.

The feed port or ports 34 may be connectable, connected, or integrally formed with the housing body 32. The feed ports 34 are in spaced-apart relationship longitudinally and/or laterally about the air-distribution housing 14, such as around the periphery of the air-distribution housing 14. Two or more feed ports 34 may or may not be equiangularly distributed around the housing 14. This enables the distribution of air in different directions and/or enables a plurality of conduits to be connected in a row.

One or more feed-ports 34 are preferably selectably-openable, although non-selectably openable may be envisioned. In other words, a user may choose whether and/or when to open the or a said feed port 34. In the present embodiment, this is enabled by each or at least one feed-port 34 having a closure element 36 and a frangible portion 38, although either feature may be omitted. An air-feed conduit or piping may optionally be connectable to one or more feed ports 34, although any of these features may be omitted. Conduit connection is discussed in respect of later embodiments.

The ventilation apparatus 10 preferably further comprises a connector 40, which permits preferably releasable interconnection between the air-distribution housing 14 and the air-pump device 12. This connector may, however, be omitted.

The connector 40 enables the air-distribution housing 14 and/or filter 16 to be selectively engageable and/or disengageable, directly or indirectly, with the air-pump device 12 and/or a further said air-distribution housing 14. Preferably, the connector 40 enables toolless engagement. Tooled connection methods could be supplementarily provided, of course.

The air-distribution housing 14 is connectable to or adjacent to, and/or around the air outlet 30 of the air-pump device 12. This allows for vertical stacking of the components of the ventilation apparatus 10. A cap 42 may be provided which caps off the end of the ventilation apparatus 10 at a base adjacent to the filter 16. A gap 44 may be provided at the cap 42 to permit ventilation through the base of the ventilation apparatus 10 once air has passed through the filter 16.

Optionally, the ventilation apparatus 10 further includes at least one, and more preferably two said support elements 18.

The or each support element 18 in-use directly or indirectly supports the air-pump device 12 and/or accommodates engagement with ceiling support members within the ceiling cavity. The or each support element 18 is preferably adjustably positionable relative to the air-pump device 12 but non-adjustable is an option. Furthermore, the, each, or at least one support element 18 may extend at least partly radially from the pump housing 20.

As there is a plurality of support element 18, a first said support element 18 is preferably operable independently of a second said support element 18 and/or two support elements 18 may extend in opposite directions relative to each other. This may enable engagement of the air-pump device 12 with opposing joists, optionally of different heights. Each support element 18 may be usable in a plurality of different configurations and/or orientations. In other words, each support element 18 may be functionally invertible.

Each support element 18 has an apparatus-engagement portion 46 and a support-engagement portion 48. The apparatus-engagement portion 46 in-use enables engagement with the air-pump device 12 and/or the air-distribution housing 14. The support-engagement portion 48 enables in-use engagement with a supporting surface such as a ground or floor surface, or a joist. Each support element 18 may optionally be referred to as an arm or a foot. Each support element 18 may be curved, partly curved, non-curved and/or planar in side view and/or plan-view. The or each support element 18 preferably in-use extends around a minor extent of a periphery of the air-pump device 12 and/or air-distribution housing 14, but a major extent may be envisioned. In this alternative, only one support element may be required.

Preferably, the or each support element 18 and more preferably the support-engagement portion 48 thereof, may have or may form or substantially form a loop or loop-section as shown. The loop or loop-section may advantageously provide at least two points, lines or surfaces of contact with a support surface, although each support element and/or each loop may only provide a single point of contact.

Although a loop or part of a loop is preferred, any non-loop or non-loop-section alternative embodiment may be envisioned, such as a platform, planar element, a rod, or branch-element, may be envisioned.

Preferably, the, each, or at least one support element 18 is slidably engageable with the air-pump device 12 and/or the air-distribution housing 14 but any non-slidable engagement, such as magnetic, interference fit or fasteners may be envisioned. The engagement with the air-pump device 12 and/or the air-distribution housing 14 may be adjustable and/or non-adjustable. This allows for the support element to be positioned in the most appropriate position for the ventilation apparatus 10.

For engaging with the support element 18, the air-pump device 12 and/or the air-distribution housing 14 may comprise at least one of: a recess 50 and a rail 52, the or at least one support element 18 being at least partly receivable within the recess 50 and/or rail 52. Preferably, the air-pump device 12 comprises at least one, and more preferably four recesses 50. The air-distribution housing 14 preferably has at least one and more preferably four rails 52.

Optionally, the, each or at least one support element 18 may comprise at least one projection or pin or fastener 49 and the at least one of the recess 50 and the rail 52 may comprise at least one indent or bore or vice-versa, but any of these features may be omitted.

An apparatus-engagement portion 46 of each support element 18 may comprise at least one, and preferably two elongate elements or arms, which are dimensioned to engage with the recesses 50 and/or rails 52. Each elongate element may be formed as a rod, projection, tube or tube-like element. The or each elongate element may be connectable to, connected with and/or integrally formed with a support-engagement portion 48. The or each elongate element may extend from the support-engagement portion 48, from any part of the loop, wherein the support-engagement portion is formed as a loop, which is the case for the present embodiment. An elongate element may therefore extend from at least one end of the loop-section but be spaced-apart from the end may be an option. More preferably, as shown, an elongate element extends from each end of the loop-section. The apparatus-engagement portion 46 also preferably meets perpendicularly to a plane of the loop-section, but non-perpendicularly may be an option. As such, each support element 18 may have an L-shape when viewed from the side. The support-engagement portion is therefore dimensioned to rest upon a support surface such as a joist in a ceiling.

Figure 2 shows the ventilation apparatus 10 in an exploded configuration.

The housing body 32 may be formed of at least two sub-portions 54a, 54b. The at least two sub-portions 54a, 54b may be connected and/or connectable together, separably or non-separably, although integrally formed may be an alternative option. Two or more of the sub-portions 54a, 54b may be identical to each other, although non-identical is an option. This may enable the sub-portions 54a, 54b to be formed using the same mould or same shape of mould, thereby simplifying the manufacturing processing and/or requiring fewer moulds. Preferably, the connection between the or at least two sub-portions 54a, 54b may be in a longitudinal plane, rather than in a transverse plane, unlike the sub-housing parts 24, 26 of the air pump device 12. However, two sub-portions 54a, 54b of the housing body 32 may additionally or alternatively connect in any other plane, such as but not limited to a transverse plane, and/or the sub-housing parts 24, 26 of the air-pump device 12 may connect in any other plane, including but not limited to, a longitudinal plane.

The air moving element 22 comprises at least one fan 56. The or each fan 56 is preferably a radial or centrifugal fan. In other words, air entering the fan 56 axially is expelled or outputted radially or tangentially relative to the axis of entry. More preferably, the fan 56 is a radial backcurved or backward-curved fan, although a radial forward curved fan may be envisioned. The fan 56 is electrically-energisable.

The fan housing 20 defines an internal fan chamber 58, although a plurality of any of the above may be provided. The fan housing 20 preferably further comprises an anti-vortex element 60, and a wire-conduit chamber or cable-receiving conduit 62 but either of these features may be omitted.

The connector 40 may optionally be a multi-part connector. The connector 40 may comprise a first connector portion 40a which is formed or otherwise associated with the air outlet 30 of the air-pump device 12, and a second connector portion 40b which is formed as part of or otherwise associated with the air-distribution housing 14. An intermediate connector member 40c is provided which couples the first and second connector portions 40a, 40b together.

In the embodiment disclosed, the intermediate connector member 40c has a plurality of bayonet-type connectors which respectively engage with the first and second connector portions 40a, 40b in a bayonet twist-lock manner. Alternative connection methods could be considered, such as screw-threading engagement, preferably in a toolless connecting manner.

Optionally, the ventilation apparatus 10 may further include at least one heating element 64, preferably inside the fan chamber 58. Preferably, the heating element 64 is associated with the air-pump device 12, but may alternatively or additionally be associated with the air-distribution housing 14. The heating element 64 increases the temperature of air exiting the ventilation apparatus 10 relative to that of air entering the ventilation apparatus 10. This may be particularly desirable if air is drawn in from a loft space when the temperature of the outdoors, and consequently the temperature of the air in the loft, is low.

The air filter 16 in-use filters air traversing or moving through the ventilation apparatus 10. The air filter 16 has at least one filtering surface 66. The air filter 16 also has a filter air inlet 68, and, optionally, a base portion 70. The cap 42 of the ventilation apparatus 10 may engage with the base portion 70, thereby forming an air diffuser.

The base portion 70 is preferably positioned opposite or substantially opposite the filter air inlet 68. As shown, the air filter 16 is engageable with the housing body 32. However, the air filter may alternatively be at least partly insertable into or receivable in or on the fan housing 20 and/or at least partly insertable into the housing body. For example, a bore in a ceiling of a building may receive the filter therein instead, by way of example only. The air filter 16 is preferably engageable with the air-pump device 12 and/or air-distribution housing 14 axially relative to the fan 56, but non-axially may be an option. For example, the filter 16 may extend along an axis parallel and offset from the housing-axis and/or along an axis non-parallel and non-colinear with the housing-axis. The filter 16 may optionally comprise cardboard, card, and/or paper. The filter 16 may optionally also comprise a QR code, barcode, or other authenticity mark or identifier. This may help a user locate a suitable filter 16 when a used filter 16 needs to be replaced, and/or check the authenticity, origins and/or filtering characteristics of the filter by way of example only.

The filtering surface 66 is preferably disposed between the filter air inlet 68, and the base portion 70. Optionally, the filtering surface 66 may be shaped to as to form or provide the filter air inlet 68. The shape of the filter 16 and/or the filter air inlet 68 enable airflow to be directed into the air filter 16 through the filter air inlet 68. Preferably, the filtering surface 66 forms or substantially forms cylinder as shown, but any non-cylindrical alternative may be envisioned. Optionally, a top portion and/or a bottom portion may be provided which may cause or substantially cause the filtering surface 66 to have a predetermined cross-sectional shape. The top portion may also have at least one opening corresponding to the filter air inlet 68. The filtering surface 66 may have one or more filtering layers. One layer may comprise activated carbon. Additionally or alternatively, a layer may be a HEPA layer. The total area of the filtering surface 66 may further be increased by providing corrugations.

The base portion 70 is preferably non-permeable to air, but could be at least partly air-permeable. In other words, the base portion 70 closes or seals the filter 16. Thus, the base portion 70 has a first function of forcing at least some of, and more preferably all the air entering the filter 16 out through the filtering surface 66, although it may be envisioned that the base portion may also provide an additional filtering surface and/or an aperture through which air may exit the filter. The base portion 70 is separable here from the filtering surface 66 to enable easy removal of the filtering surface 66 but nonseparable may be envisioned. The base portion 70 includes a plate or plate-element 70a, a flow-separating element 70b and at least one, and here five holding projections 70c, although any of these features may be omitted.

The plate or plate-element 70a preferably has a similar or same shape in plan view as the filtering surface 66. In this case, the plate-element 70a is circular but non-circular may be envisioned. Furthermore, the plate-element 70a is at least partly concave, but non-concave, such as planar or partly planar, or convex are alternative options.

The flow-separating element or baffle 70b in-use separates airflows and/or guides air towards the filtering surface 66. Furthermore, the shape of the filter 16 and the base portion 70 together enable airflow to be directed out through the filtering surface 66. This advantageously contains or substantially contains or traps filtered matter inside the air filter 16, thereby increasing the hygiene. Whilst the flow-separating element 70b and the anti-vortex element 60 are preferably aligned, they are preferably oriented in opposite direction. The flow-separating element 70b is at least partly conical or frustoconical as shown although other shapes may be envisioned. For example, the flow-separating element 70b may flare outwards and/or form or substantially form a trumpet shape. The flow-separating element 70b may or may not be identical in shape to the anti-vortex element 60.

The at least one holding projection 70c is integrally formed with, connected or connectable to the plate-element 70a, and/or may extend in-use towards the air-pump device 12. The or each holding projections 70c may be or be substantially wedge-shaped, although this feature may be omitted. As shown, the at least one holding projection 70c at least partly surrounds the flow-separating element 70b. Furthermore, the at least one holding projection 70c is preferably spaced-apart from the flow-separating element 70b to provide a gap in which the filtering surface 66 or part thereof may be receivable. This provides a snug engagement between the base portion 70 and the filtering surface 66. Furthermore, the at least one holding projection 70c may space apart the cap 42 from an end of the air-distribution housing 14 to provide the gap 44 axially therebetween for enabling airflow therethrough.

The air filter 16 preferably also comprises at least one first engagement portion 72. At least one of the housing body 32 and the air-pump device 12 may have at least one second engagement portion 73 which is complementarily engageable with the first engagement portion 72. Preferably, the air filter 16 is toollessly engageable with and releasable from the ventilation apparatus 10 for ease of maintenance and/or replacement, but non-toolless, in other words, engagement requiring tools, may be envisioned. More preferably the air filter 16 is toollessly engageable with and releasable from the air-pump device 12 and/or the air-distribution housing 14. More preferably, the first and second engagement portions 72, 73 are magnetically engageable.

In the preferred embodiment, the base portion 70 includes the or at least one said first engagement portion 72. More preferably, each or at least one first engagement portion 72 has a first magnetic element. The second engagement portion is optionally formed as a collar or ring, as shown, which seats into the base of the housing body 32. The ring or collar preferably comprises ferrous material.

In an alternative embodiment, the, each or a said first engagement portion may comprise ferrous material, and the, each or a said second engagement portion may comprise a magnetic element.

Alternatively, both first and second engagement portions may comprise magnetic elements.

Although magnetic elements are preferred, any non-magnetic engagement may be envisioned, such as complementary screw threads, a bayonet engagement, slidable interlocking features, hook and loop engagement, any other suitable fastener, or combination of fasteners.

The filter 16 is provided downstream of the air-pump device 12. However, a further filter 16 is preferably provided upstream of the air-pump device 12, although either or both filters may be omitted. For clarity, the upstream filter 16 may be referred to as filter 16a whilst the downstream filter 16 may be referred to as filter 16b. Preferably, the upstream filter 16a collects and contains particulates within, similarly to the downstream filter 16b but this need not be the case. The upstream filter 16a is similar to the downstream filter 16b, having a filtering surface 66a and filter air inlet 68a. Detailed description of the common features is omitted for brevity. A base portion may optionally be provided in the upstream filter 16a. Preferably, no cap is connectable thereto, to form a diffuser. An upstream filter housing or filter receiving element 71 may need to be provided in order to draw the air into the filter 16a, out through a filtering surface 66a then into the air-pump device. Optionally, the upstream filter housing 71 may comprise one or more feed ports. The feed ports may be inlet feed ports, for receiving air therethrough. The filter receiving element 71 may comprise plastics, metal, cardboard, paper, any other suitable material, or combination of materials.

Figure 3 shows the cross-section through the ventilation apparatus 10 so as to illustrate the internal dimensions.

The internal fan chamber 58 enables the air inlet 28 and the air outlet 30 to be in fluid communication with each other. At least part of the fan chamber 58 provides or defines an air-flow passage 74. The fan 56 is preferably positionable or positioned in the fan chamber 58. Preferably, the fan 56 is positioned in or substantially in axial alignment with the air inlet 28 and the air outlet 30. In other words, the axis of rotation of the radial fan 56 is preferably colinear or parallel to the housing-axis A-A.

The internal fan chamber 58 is defined at least in part by an inward-facing surface 76. The inward-facing surface 76 in cross-section along a longitudinal plane may have or have a longitudinal profile. The longitudinal profile preferably in-use redirects flow whilst minimising airflow turbulence and/or maintaining or substantially maintaining the laminarity of the airflow. To this effect, the inward-facing surface 76 is at least partly planar and/or, preferably, at least partly curved. Even more preferably, the longitudinal profile of at least part of the fan housing 20 is or is substantially C-shaped, S-shaped, question-mark-shaped or hook-shaped, although any other shape may be envisioned. Most preferably, the longitudinal profile of the fan housing 20 is lachrymiform.

Furthermore, the inward-facing surface 76 in an axial or transverse cross-section may have or have a shape, referred to as a transverse profile. The transverse profile is or is substantially a circle or an oval, but non-circular or non-oval may be envisioned. The transverse profile is preferably the same regardless of where the transverse cross-section is taken along the housing-axis A-A, but the transverse profile may alternatively change along at least some of the housing-axis A-A.

The air-flow passage 74 is considered to start downstream of the fan 56, and more preferably at an outlet of fan 56, referred to, for clarity, as a fan outlet 78. For clarity, the air-flow passage 74 is only a portion of an airflow path which extends outside of the ventilation apparatus 10. Optionally, the air-flow passage 74 or at least a fan-housing path-portion thereof, may be considered to end at or adjacent the air outlet 30. In other words, the air-flow passage 74 or at least a sub-portion thereof, is disposed between the outlet of the fan 56 and the air outlet 30 of the fan housing 20. If a conduit and/or an air-distribution housing is provided, a conduit-path-portion and/or a distribution-housing path portion, respectively, may be provided.

The air-flow passage 74 and/or the internal fan chamber 58 in an axial or transverse cross-section have a shape, referred to as a transverse profile. Due to the present and position of components, such as the anti-vortex element 60 inside the fan housing 20, the transverse profile of the air-flow passage 74 and/or the internal fan chamber 58 along at least some of the longitudinal extent of the fan housing 20 may be or be substantially a ring or two-dimensional torus. The ring may be defined by inner and outer circles and the difference in radii between the circles may be referred to as the radius differential or radius difference. The radius differential R^d indicated as a dotted line in Figure 3.

Additionally or alternatively, the transverse profile of the air-flow passage 74 and/or the internal fan chamber 58 may be or be substantially a disc along at least some of the longitudinal extent of the fan housing 20. A radius R^t to the of the disc transverse profile is also shown in Figure 3, as dash-dotted lines.

In the preferred embodiment, as the anti-vortex element 60 does preferably not extend to the outlet 30, in other words, is spaced apart therefrom, preferably, the transverse profile of the air-flow passage 74 and/or the internal fan chamber 58 is a ring along some of the longitudinal extent of the fan housing 20 and a disc along a distinct, longitudinal extent of the fan housing 20.

In one preferred embodiment, the total area of the transverse cross-section of the air-flow passage 74 and/or the internal fan chamber 58 is or is substantially uniform or constant along at least a majority of the longitudinal extent of the fan housing 20.

The radius of the disc transverse cross-section may be different and preferably greater than the radius differential of the ring transverse cross-section, in order to maintain a constant or substantially constant cross-sectional area along some or all the housing-axis A-A.

A constant or substantially constant cross-sectional area means the air velocity in-use remains constant or substantially constant throughout the air-pump device 12. As a result the pressure is or is substantially constant or uniform along the longitudinal extent of the fan housing 20. This increases the efficiency and/or reduces the noise of the air-pump device 12, particularly compared to an air-pump device having changes in air velocity and consequently pressure.

However, in an alternative embodiment, the radius of the disc transverse cross-section may be greater, the same or substantially the same, or smaller than as the radius differential, along at least some of the longitudinal extent. In this case, the area of the transverse cross-section of the air-flow passage 74 and/or the internal fan chamber 58 may not necessarily be constant or substantially constant. A greater radius differential however may be necessary to provide a uniform or substantially uniform area in transverse cross-section due to the presence of internal features through which air cannot travel.

The wire-conduit chamber 62 provides a space or conduit through which the wiring arrangement may be at least partly inserted into the air-pump device 12 to connect to the fan 56. This enables the fan 56 to be electrically energisable by an external power source. Optionally, the air-pump device 12 may comprise a source of power. Said source of power may be in the form of a battery. Preferably however, the air-pump device 12 may comprise a wiring arrangement, not shown, which enables the fan 56 to be electrically-energiseable or powered when connected to an external source of power. A suitable source of power may be the electric mains via a direct wired connection.

Optionally, the fan housing 20 may further comprise at least one fin-element, fin-like element or fin 80. The or each fin-element 80 in-use may reduce or eliminate angular momentum imparted to the air by the radial fan 56. The or each fin-element 80 is preferably positioned or positionable in the internal fan chamber 58, although outside thereof may be an option. As such, the fin-element 80 may be referred to as an internal fin-element. The or each fin-element 80 is preferably disposed in or on the air-flow passage 74 and/or downstream of the outlet 78 of the fan 56. The or at least one fin-element 80 preferably extends at least partly along the longitudinal extent of the housing-axis A-A. The or at least one fin-element 80 may be at least partly curved in cross-section along any of: the longitudinal extent, a radial direction, and a transverse cross-section of the fan housing 20. Additionally or alternatively, the fin-element 80 may be at least partly planar in any of the above.

The or each fin-element 80 may extend at least partly in a tangential, circumferential or peripheral direction around the housing-axis A-A but these features may be omitted. By way of example only, the or each fin-element 80 may be partly helical or a spiral. If so, the direction of winding or rotation of the or each helical or spiralling fin-element 80 is preferably opposite that of the radial fan 56, although the same direction may be envisioned. Opposite directions of winding may be more effective at cancelling or reducing angular momentum.

The fan housing 20 preferably further comprises an anti-vortex element 60 but this feature may be omitted. A first function of the anti-vortex element 60 may to in-use reduce or prevent the formation of a vortex where airflows separated upstream to travel through the internal fan chamber 58 on either side of the fan 56 and/or anti-vortex element 60 merge together, thereby improving the efficiency of the ventilation apparatus 10. The anti-vortex element 60 may alternatively be referred to as a baffle, a merging baffle, or a flow-merging element. A second function of the anti-vortex element 60 may be to cause the cross-sectional area of the airflow passage to be constant or substantially constant, at least along the longitudinal extent of the anti-vortex element 60 along the housing-axis A-A. The third function of the anti-vortex element 60 may be to redirect at least some of the airflow towards the outlet 30. Any of the above functions may be omitted. Any of the above functions may have a greater importance than another, or all functions may be of equal importance.

To fulfil the above functions, a longitudinal profile of the anti-vortex element 60 may match or substantially match the longitudinal profile of the inward-facing surface 76. More preferably, the anti-vortex element 60 may have a tip or tip portion 60a, an opposing portion 60b and an intermediate body portion 60c disposed therebetween. The tip portion 60a may be oriented towards the outlet 30 and/or may be colinear or parallel to the housing-axis A-A. Optionally, the tip 60a may be rounded, truncated and/or chamfered. 28. The opposing portion 60b may even provide a fan-receiving portion or housing for at least some of the fan 56. The intermediate body portion 60c may be tapering in at least one dimension, preferably towards the outlet 30. The anti-vortex element 60 may be or be substantially conical or frustoconical, although non-conical or non-frustoconical may be envisioned. Optionally, the intermediate body portion 60c may be at least partly curved and/or planar in longitudinal cross-section. The degree of curvature of the longitudinal profile of the anti-vortex element 60 may be constant and/or non-constant. In other words, the anti-vortex element 60 may optionally be or be substantially trumpet-shaped and/or flaring. This may be desirable to reduce turbulence and/or keep or substantially keep the flow laminar or as laminar as possible when redirecting air towards the outlet 30.

In-use, the user assembles the ventilation apparatus 10 prior to use.

To assemble the air-pump device 12, the user obtains the at least one fan 56 and installs this in the fan housing 20. Cables are preferably threaded through the wire-conduit chamber 62 to enable the fan to be electrically energisable. Preferably, the fan 56 or part thereof is receivable in, above or adjacent to the opposing portion 60b of the anti-vortex element 60.

If the or each internal fin-element 80 is non-integrally formed with the fan housing 26, the or each internal fin-element is positioned and/or connected to the fan housing 26. If desired, the heating element 64 is associated with the fan housing 20, preferably by being installed therein. The air-pump device 12 may be used as is, without any further attachments although one or more support elements 18 are preferable, to ventilate a space. Optionally, tubing may be provided and engaged with the air inlet 28 and/or an air outlet 30.

Preferably however, the ventilation apparatus 10 may be provided with any or any combination of the following: at least one support element 18, at least one air-distribution housing 14, tubing, and at least one air filter 16. The ventilation apparatus 10 may therefore be modular.

When in use to ventilate a space, the air-pump device 12 draws in air through the air inlet 28, indicated by the bold arrows in Figure 3.

Air drawn in through the air inlet 28 enters the internal fan chamber 58 and the fan 56 which is preferably electrically energised. The air then exits the fan 56 into the air-flow passage 74. As the fan 56 is preferably a radial or centrifugal fan, the electrically energised fan rotates and drives air in the radial direction. Furthermore, as the fan 56 is a backward curved radial fan, the air outputted by the fan 56 preferably exits the fan 56 radially and/or perpendicularly relative to the axis of entry into the fan 56 and/or inlet 28.

The rotation of the fan 56 imparts rotational or angular momentum to air in addition to linear momentum.

Without any fin-elements, the air moves through the fan housing 20 in a helical or spiralling fashion around the housing axis A-A of the fan housing 20 and/or around the anti-vortex element 60 towards the outlet 30. However, if one or more fin-elements 80 are provided, upon encountering the one or more fin-elements 80, spirally or helically-moving air becomes linear or substantially linear, or at least more linear. In other words, if provided, the one or more fin-elements 80 reduce or cancel the angular momentum imparted to the air exiting the radial fan 56.

If a heating element 64 is provided along the air-flow passage 74, air is heated by the heating element 64.

The shape of the internal fan chamber 58 redirects the air radially exiting the fan 56 towards the outlet 30. As such, the redirected air may exit the air-pump device 12 via the outlet 30 axially or substantially axially. Whilst redirection of air typically reduces the efficiency of the ventilation apparatus 10 and/or increases noise, this reduction in efficiency is countered by the increase in efficiency due to the shape of the air-flow passage 74 and/or the fin-like elements 80.

Upon exiting the outlet 30 of the air-pump device 12, air enters the filter air inlet 68 and therefore an inner space or cavity of the filter 16. The air is forced out through the filtering surface or surfaces 66. Particulates are therefore trapped within the filter 16. The flow-separating element 70b helps separate the airflow in the filter 16 and/or guides air towards the filtering surface or surfaces 66. The flow-separating element 70b may also have a second function of preventing or inhibiting the formation of a vortex and/or turbulence at or adjacent the base portion 70. Any vortices and/or turbulence would other reduce the filtering efficiency of the filter, for example by resuspending particulates deposited on the inward-facing face of the filtering surface 66. The shape of the filter 16 further improves the filtering efficiency by providing a greater surface area compared to a planar or substantial planar filter extending perpendicularly to the housing-axis A-A. The corrugation of the filtering surface 66 further increases the filtering area.

Air is then channelled down through the filter 16 and out through the base of the ventilation apparatus 10, preferably via gap 44, into the room below.

If air is to be output at a location and/or drawn from a further location laterally spaced apart relative to the ventilation apparatus 10 laterally spaced apart from, ducting may be provided via feed ports 34. This may involve breaking the frangible portion 38 and/or removal of the closure element 36, as shown in Figure 4 and indicated by arrow D1. One or more feed ports 34 may be permanently open, for example, if no closure element is provided. Ducting may be engaged with the flange neck of the feed port 34, as is discussed in more detail below.

A generic installation of ventilation apparatus is shown in Figure 5 in situ in a ceiling cavity 82 positioned between two ceiling support members 84, here indicated as joists. The support elements 18 rest directly on the joists 84, whilst the air-distribution housing 14 seats on the base of the ceiling cavity 82. Part of the apparatus 10 descends through an aperture in the ceiling. The air-distribution housing 14 may optionally comprise a ceiling engagement portion 85. The ceiling engagement portion 85 may provide a snug engagement with the ceiling aperture and/or be more sightly by obstructing from view the aperture in the ceiling.

As can be seen in Figure 6, the filter 16 can then be installed and/or replaced from below, preferably in a toolless manner. For example, the filter assembly 16’ can be installed magnetically without the use of any tools. This can be achieved by separation of the first and second engagement portions 72, 73. The reverse is true, and the filter assembly 16’ can be removed by extraction along direction D2.

Where joists are of different heights, the ventilation apparatus 10 can be adjusted. This is shown in detail in Figures 7 and 8.

If at least one support element 18 is used, the ventilation apparatus 10 can be supported on or above a support surface, which may be the ground, and/or a ceiling support member. The provision of at least two support elements 18 may optionally enable the ventilation apparatus 10 to be supported by two opposing joists 84. Furthermore, as the support elements 18 are preferably independent of each other and adjustable relative to the air-pump device 12, the ventilation apparatus 10 can be accommodated by joists 84 of different heights.

To support the ventilation apparatus 10, the apparatus-engagement portion 46 is engaged with at least one, and preferably two recesses 50 or at least one, and preferably two rails 52 of either the air-pump device 12 and/or the air-distribution housing 14. The support-engagement portion 48 is engaged with the support surface. Engagement may be simply by abutment as shown in Figure 9. If the support-engagement portion 48 provides a surface or at least two spaced-apart points and/or lines of contact with the support surface, as shown in Figure 9, this may further increase the stability of the ventilation apparatus 10 and/or reduce the risk of the apparatus 10 falling sideways into the cavity.

The height of the support element 18 is adjustable relative to the housing body 32, which is how the different heights of joist 84 can be accommodated in Figures 7 and 8.

The at least one fastener, latch or detent 49 is provided with, in or on the support element 18 which engages with one or more notches, bores or holes 86 of the rail 52. This allows for a telescoping effect of the position of the support-engagement portion 48. The rail 52 and/or one or a plurality of recesses 50 may be dimensioned so as to accept a support element 18 installed in either direction, which may increase the range of joist heights accepted due to the L-shape of the support element 18.

One or more apertures 88 in the support-engagement portion 48 may also be provided, which could be used to anchor the support portion 18 to the joist 84 in use.

The stability of the ventilation apparatus 10 may optionally be further increased by the use of fastenings means or fasteners, such as nails, screws, adhesives, hook and loop fasteners, or any other suitable means of enhancing the engagement between the support-engagement portion 48 and the joist 84.

The same or a similar steps are repeated for each further support element 18 used.

When assembling the ventilation apparatus 10, the following steps can therefore be performed. An air-distribution housing 14 is formed when the user connects the at least two sub-portions 54a, 54b together to form the air-distribution housing 14. The support element 18 may optionally help connect and/or bridge the connection between the sub-portions 54a, 54b, for example by being connected to a rail or recess on either side of the connection. Thus, a support element 18 may have a further function of preventing or inhibiting disengagement of the sub-portions 54a.

The housing 14 is then connected to the air-pump device 12, whether indirectly and/or directly. In the present embodiment, an indirect connection is preferred, with each of the air-pump device 12 and the air-distribution housing 14 connecting to the intermediate connector element 40c independently of each other.

If a user wants to use the ventilation apparatus 10 to filter air, at least one air filter 16 needs to be connected to the ventilation apparatus 10. The filtering surface is provided as or is formed into a cylinder and engaged with the base portion 70. The base portion 70 thereby forms a plug element. Optionally, the base portion 70 may be connected to a cap 42 to form an air diffuser. Alternatively, it may be envisioned that the air cap 42 and the base portion 70 are connected or integrally formed with each other, rather than separably connectable.

The or each filter 16 may be connected to the air-pump device 12 either directly and/or indirectly. A said filter 16 may be connected to the inlet 28 and/or to the outlet 30 of the air-pump device 12, preferably both. Preferably, the downstream filter 16b is inserted into the air-distribution housing 14, if at least one air-distribution housing 14 is connected to air-pump device 12. If the cap 42 is provided, the gap 44 is provided to enable air to exit the ventilation apparatus 10. In the present embodiment, this may involve axially spacing apart the cap 42 from the air-distribution housing 14 and/or provide an air diffuser having at least one aperture and/or a dimension which is less than that of the air-distribution housing 14.

The open end of the filtering surface 66 is made to encircle or surround the outlet 30, preferably sealingly, to force air exiting the air-pump device 12 to enter the filter air inlet 68 and a cavity within the filter 16b.

The first engagement portion or portions 72 and second engagement portion or portions 73 are engaged to secure the filter 16 in place.

The upstream filter 16a is similarly formed. The filtering surface 66a of desired height is selected. For either filter, there may be a plurality of heights to select from. This may, for example, provide a filter 16a of selectable height, as required. The open end of the filtering surface 66a is made to provide the filter air inlet 68a. The opposite end is preferably engaged with a base portion. The filtering surface 66a is inserted into the upstream filter housing 71 if provided. The filter 16a is engaged with the air-pump device 12. The base portion and the upstream filter housing 71 force the air drawn in through the filter air inlet 68a through the filtering surface 66a. The upstream filter housing 71 redirects air towards the air inlet 28.

It will be apparent that, given the modularity of the ventilation apparatus, that other configurational variants are possible. Figures 10 and 11 show a second embodiment of a ventilation apparatus, indicated globally at 110, in which the air-distribution housing is replaced by a flexible duct 192 or similar conduit. This allows the air pump device 112 to be used in isolation, which may be of particular use where only a small area is to be ventilated, and the flexibility of assembly of the air-distribution housing is unnecessary.

In this arrangement the airflow through the air pump device 112 is identical to that as previously described, in that air is drawn in via the air inlet 128, radially output via the fan 156 into the air-flow passage 174, which has a uniform or substantially uniform width. This uniformity of width can be achieved by shaping of the anti-vortex element 160, and the fins 180 serve to reduce flow rotation. Air is then output via the air output 130 to exit the ducting 192.

A third embodiment of a ventilation apparatus is indicated globally at 210 in Figures 12 and 13. This is a multiple outlet apparatus, and therefore requires the presence of an air-distribution housing 214, unlike for the previous embodiment described.

The air-pump device 212 is located on top of the air-distribution housing 214, and seats in the ceiling cavity 82 between joists 84 using the support elements 218. However, ducting 292 is now provided so as to engage with feed port 234, so that a lateral flow path can be created, and ducted through the ceiling below.

As shown in Figure 13 which is the cross-section through plane A of Figure 12, air is drawn in through the air-pump device 212 and fan 256 along air-flow passage 274, and through air-distribution housing 214. The air is filtered by at least one of, and preferably both filters 216, and vented out of feed port 234, to be exhausted via ducting 292. This can be upscaled so that a single air-pump device 212 can control many different exhausts to create a full PIV system.

Although preferably providing positive input ventilation, the ventilation apparatus may not be for Positive Input Ventilation. Instead, the ventilation apparatus may be for negative input or output ventilation or provide negative pressure. Alternatively, the ventilation apparatus may be neutral input or output, for instance, by having the air intake and air output in the same room or space.

Optionally, a second air-distribution housing may be provided upstream, to draw air from a plurality of locations and/or downstream of the air-pump device.

Although preferably each feed port is non-closeable after being opened by virtue of having a frangible portion, in an alternative embodiment, each or at least one feed port may be closeable and/or recloseable. This may be provided by a bung, plug or similar closure element which can be engaged with or inserted into the opening of the feed port.

Although a preferred shape may have been specified for any of the above-described features, any above-described feature may have an alternative shape, profile, and/or cross-section, whether latitudinal and/or longitudinal. Said alternative shape, profile, or cross-section may be curved, part curved, non-curved, circular, oval, ovoid, linear, polygonal, whether regular or irregular, such as square, rectangle, triangular, hexagonal, octagonal, chamfered, rounded, or truncated, any abstract shape, or any combination thereof.

It is therefore possible to provide a PIV apparatus which is more energy-efficient than traditional PIV systems. Simultaneously, the PIV apparatus delivers a uniform or substantially uniform airflow to the room below. A radial fan is more effective than an axial fan. The fan housing reduces or eliminates turbulence, and/or reduces or prevents the formation of vortices. The internal geometry of the fan housing preferably maintains a constant or substantially constant air velocity, and/or pressure throughout, removing further inefficiencies. The noise may be reduced. The PIV apparatus may be modular to be adaptable to a range of environments and various requirements. The filter is easily accessible and replaceable from the space below. Magnetic attachments alleviate the need for tools, further improving the ease of replacement. The geometry and arrangement of the filter relative to the airflow path result in the particulates being internally held, thus providing a more effective and hygienic disposal. The adjustability of the supports enables the PIV filtering apparatus to be stably supported by joists or any other similar structure of different dimensions.

The words ‘comprises/comprising’ and the words ‘having/including’ when used herein with reference to the present invention are used to specify the presence of stated features, integers, steps or components, but do not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

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

The embodiments described above are provided by way of examples only, and various other modifications will be apparent to persons skilled in the field without departing from the scope of the invention as defined herein.

Claims

1. An air pump for Positive Input Ventilation apparatus locatable in a ceiling cavity, the air pump comprising:

    a fan housing having an air inlet, an air outlet, and an internal fan chamber via which the air inlet and the air outlet are in fluid communication with one another; and

    an electrically-energisable radial fan in the fan chamber and positioned in or substantially in axial alignment with the air inlet and the air outlet;

    the fan chamber having an air-flow passage disposed between an outlet of the radial fan and the air outlet of the fan housing; and

    the air-flow passage having uniform or substantially uniform lateral cross-section along at least a majority of a longitudinal extent in an axial direction of the fan housing.

2. An air pump as claimed in claim 1, wherein the fan housing further comprises an internal fin-element in the air-flow passage downstream of the outlet of the radial fan, the internal fin-element extending at least partly along the longitudinal extent of the housing-axis for reducing or eliminating angular momentum imparted to the air by the radial fan.

3. An air pump as claimed in claim 1 or claim 2, wherein the fan housing further comprises an anti-vortex element for reducing or preventing the formation of a vortex where airflows separated upstream by the radial fan merge together, thereby improving efficiency of the air pump.

4. An air pump as claimed in any one of the preceding claims, further comprising a heating element on the air-flow path.

5. An air pump as claimed in any one of the preceding claims, wherein the radial fan is a backward curved fan.

6. A modular Positive Input Ventilation apparatus for location in a ceiling cavity, the modular Positive Input Ventilation apparatus comprising:

    an air-pump device; and

an air-distribution housing in fluid communication with the air-pump device,

the air-distribution housing having a plurality of selectably-openable feed ports configured to connect to an air-feed conduit.

7. A modular Positive Input Ventilation apparatus as claimed in claim 6, wherein the feed ports are in spaced-apart relationship for enabling air distribution in different directions.

8. A modular Positive Input Ventilation apparatus as claimed in claim 6 or claim 7, wherein the air-distribution housing is relesably engageable with an outlet of the air-pump device.

9. A modular Positive Input Ventilation apparatus as claimed in claim 8, further comprising an intermediate connector which is engageable with both the air-distribution housing and the air-pump device.

10. A modular Positive Input Ventilation apparatus as claimed in claim 9, wherein the intermediate connector is toollessly engageable with both the air-distribution housing and the air-pump device.

11. A modular Positive Input Ventilation apparatus as claimed in claim 10, wherein the intermediate connector is engageable with the air-distribution housing and the air-pump device via a bayonet connection.

12. A modular Positive Input Ventilation apparatus as claimed in any one of claims 6 to 11, wherein the air-distribution housing is formed of at least two identical sub-portions connectable together.

13. A Positive Input Ventilation apparatus for location in a ceiling cavity, the Positive Input Ventilation apparatus comprising:

an air-pump device having a pump housing defining an air inlet and an air outlet; and

at least one support element for directly or indirectly supporting the air-pump device, the support element being adjustably positionable relative to the pump housing, so as to accommodate engagement with opposing ceiling support members within the ceiling cavity.

14. A Positive Input Ventilation apparatus as claimed in claim 13, wherein the or a said support element extends at least partly radially from the pump housing.

15. A Positive Input Ventilation apparatus as claimed in claim 13 or claim 14, further comprising at least one of: a recess and a rail, the support element being slidably receivable within the recess and/or rail.

16. A Positive Input Ventilation apparatus as claimed in claim 15, wherein the support element comprises at least one projection and the at least one of the recess and the rail comprises at least one indent or vice-versa, the or a said projection being engageable with the or a said indent by interference fit.

17. A Positive Input Ventilation apparatus as claimed in any of claims 13 to 16, further comprising a second said support element, which is operable independently of the first said support element.

18. A Modular Positive Input Ventilation apparatus as claimed in any one of claims 6 to 12 or a Positive Input Ventilation apparatus as claimed in any one of claims 13 to 17, wherein the air-pump device comprises an electrically-energisable radial fan.

19. A Positive Input Ventilation apparatus for location in a ceiling cavity, the Positive Input Ventilation apparatus comprising:

    an air-pump device having an air inlet and an air outlet; and

    an air filter which is toollessly engageable with and releasable from the air-pump device for maintenance and/or replacement.

20. A Positive Input Ventilation apparatus as claimed in claim 19, further comprising a filter housing and the air filter is insertable into the filter housing.

21. A Positive Input Ventilation apparatus as claimed in claim 19 or claim 20, wherein the air-pump device comprises an electrically-energisable radial fan.

22. A Positive Input Ventilation apparatus as claimed in claim 21, wherein the air filter is engageable with the air-pump device axially relative to the radial fan.

23. A Positive Input Ventilation apparatus as claimed in any one of claims 19 to 22, wherein the air filter has a first magnetic element, and at least one of the filter housing and the air pump device has a second magnetic element complementary to the first magnetic element.

24. A Positive Input Ventilation apparatus as claimed in any one of claims 19 to 23, wherein the air filter has an air inlet, a base portion opposite the air inlet and a filtering surface disposed therebetween for directing airflow into the air filter through the air inlet and out through the filtering surface to contain or substantially contain filtered matter inside the air filter.

25. A Positive Input Ventilation apparatus as claimed in claim 24, wherein the base portion has a flow-separating element for separating airflows and guiding air towards the filtering surface.

Intellectual Property Office

Application No:	GB2104527.3	**Examiner:**	Stephen Hart
Claims searched:	1 - 5	**Date of search:**	11 August 2021

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	1 - 5	CN 105626552 A (CHAI) 01.06.16 (see figs 1 - 5c, EPODOC Abstract and also unofficial English translation of paras, [0013], [0014] & [0035]).
X	1 & 5	US 2014/038509 A1 (SOLER & PALAU RES SL) see figs 1 & 2.
X	1, 2 & 5	WO 2012/130441 A1 (BERLING) see figs 1 & 2.
X	1 & 5	EP 3368773 A1 (BERLING) see figs 1 & 4.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
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&	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

F04D; F24F

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

WPI, EPODOC

Intellectual Property Office

International Classification:

Subclass	Subgroup	Valid From
F24F	0007/10	01/01/2006
F04D	0017/00	01/01/2006
F04D	0017/08	01/01/2006
F04D	0029/42	01/01/2006
F24F	0001/0022	01/01/2019
F24F	0001/0047	01/01/2019
F24F	0007/007	01/01/2006
F24F	0007/06	01/01/2006
F24F	0013/02	01/01/2006
F24F	0013/32	01/01/2006
F24F	0001/009	01/01/2019
F24F	0001/0373	01/01/2019

Intellectual Property Office

Application No:	GB2104527.3	**Examiner:**	Stephen Hart
Claims searched:	6 - 12 & 18 when appended to claim 6	**Date of search:**	11 August 2021

Patents Act 1977
Further 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	6, 8, 9 & 18	JP H0694279 A (TOSHIBA CORP) 05.04.94 (see fig 1 and EPODOC Abstract).
X	6, 7 & 18	JP 2018021739 A (MITSUBISHI ELECTRIC CORP) 08.02.18 (see fig 1 and EPODOC abstract).
X	6, 7 & 18	JP 2001027428 A (DAIKIN IND LTD) 30.01.01 (see figs 1 - 3 and EPODOC Abstract).
X	6 & 18	KR 1020160036861 A (JINDO LIVINGTEC CO LTD) 05.04.16 (see figs 1 - 7 and EPODOC Abstract).
X	6 & 18	JP 2011226719 A (MITSUBISHI ELECTRIC CORP) 10.11.11 (see fig 1 and EPODOC Abstract).

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F04D	0029/42	01/01/2006
F24F	0001/0022	01/01/2019
F24F	0001/0047	01/01/2019
F24F	0007/007	01/01/2006
F24F	0007/06	01/01/2006
F24F	0013/02	01/01/2006
F24F	0013/32	01/01/2006
F24F	0001/009	01/01/2019
F24F	0001/0373	01/01/2019

Intellectual Property Office

Application No:	GB2104527.3	**Examiner:**	Stephen Hart
Claims searched:	13 - 18	**Date of search:**	11 August 2021

Patents Act 1977
Further 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	13 - 15, 17 & 18	JP H10132373 A (TOKYO GAS CO LTD) 22.05.98 (see figs 1 - 9 and EPODOC Abstract).
X	13, 14, 17 & 18	JP H04136636 A (TOSHIBA CORP) 11.05.92 (see figs 1 & 2 and EPODOC Abstract).
X	13 - 15, 17 & 18	JP H09126542 A (ZEXEL CORP) 16.05.97 (see figs 1 - 7 and EPODOC Abstract).
A		CN 107957125 A (GREE ELECTRIC APPLIANCES INC ZHUHAI) 24.04.18 (see lone figure and EPODOC Abstract).

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F04D	0017/08	01/01/2006

Intellectual Property Office

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F24F	0001/0022	01/01/2019
F24F	0001/0047	01/01/2019
F24F	0007/007	01/01/2006
F24F	0007/06	01/01/2006
F24F	0013/02	01/01/2006
F24F	0013/32	01/01/2006
F24F	0001/009	01/01/2019
F24F	0001/0373	01/01/2019