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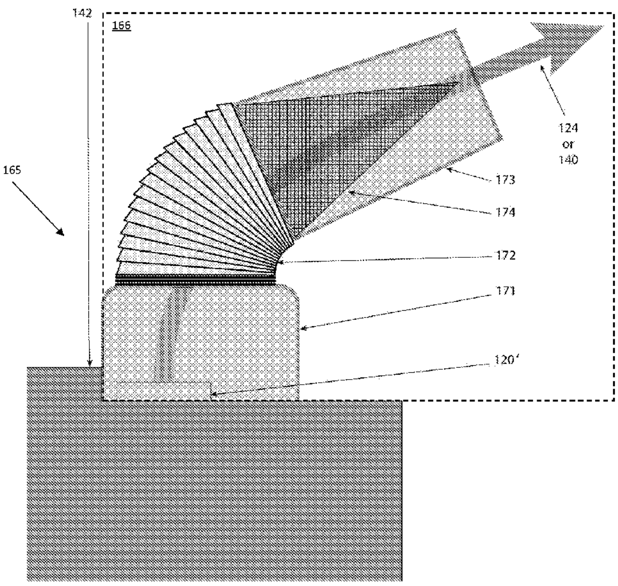
(54) **Title:** OUTFLOW ASSEMBLY AND LOCALISED AIR-CONDITIONING DEVICE

Figure 5



(57) **Abstract:** Disclosed is an outflow assembly configured to control an airflow from an air- conditioner. The outflow assembly includes a nozzle having an upstream end and a downstream end, the airflow passing from the upstream end to, and out of, the downstream end. The outflow assembly also includes an airflow straightener within the nozzle and having an upstream side facing the upstream end and a downstream side facing the downstream end, the airflow passing through the airflow straightener towards the downstream end. The airflow straightener progressively reduces a cross-sectional area of the airflow on the upstream side. In so doing, the airflow straightener reduces vorticity and turbulence in the airflow exiting the nozzle.

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OUTFLOW ASSEMBLY AND LOCALISED AIR-CONDITIONING DEVICE

Technical Field of the Invention

The present invention relates to a localised air-conditioning device, particularly a personal air-conditioning device for cooling one or more people. The present invention also relates to an outflow assembly for controlling an airflow exiting the air-conditioning device.

Background of the Invention

Conventional air conditioning devices work mostly by injecting cool air into an enclosed space in which cooling is desired. The cool air mixes with air in the enclosed space to relatively uniformly decrease the temperature throughout the enclosed space. Usually the air is injected by a fan in the air conditioner through one or more vents at relatively high velocity to encourage mixing of air throughout the enclosed space.

Air inside the cooled space absorbs heat from the walls, floor, people and other objects inside the space being cooled. Additional heat enters the cooled space as warm air passes through open windows, doors, vents or gaps in structural elements. As a result, cooling the entire enclosed space consumes an enormous amount of energy.

Air-conditioners have a heat absorbing side evaporator heat exchanger that absorbs heat from the air in the cooled space (including latent heat obtained by condensing water vapour to liquid water). Air-conditioners also have a heat emitting side condenser heat exchanger where the absorbed heat reappears. In many air-conditioners, outside air is passed through the condenser and increases in temperature as it absorbs heat from the condenser. Absorbing heat often uses evaporation of a refrigerant gas, the compression and liquefaction of which uses energy that results in further heat generated at the heat emitting side. Therefore the heat transferred to the warm outside air at the condenser is greater than the heat absorbed from the cooled space air at the evaporator by an amount roughly equal to the electrical energy supplied to the compressor and fans.

In the case of split system air-conditioners, heated air leaves the condenser heat exchanger outside of the enclosed space, and cooled conditioned air leaves the evaporator heat exchanger within the enclosed space. Split system air-conditioners use fans to drive air through the evaporator and condenser heat exchangers, using further energy. Again, split system air-conditioners endeavour to cool the entire space.

Portable air conditioners and industrial spot coolers are also available. Such air-conditioners and coolers are placed inside the space to be cooled and use a large diameter air tube to vent the heated airflow out of the space – e.g. through a window.

A substantial part of the energy used in these conventional air conditioning arrangements results only in cooling of the building structure and the objects inside the cooled space, and removal of heat entering through the roof or ceiling, walls, floor and particularly through open or covered apertures such as the windows and doors.

By localizing the cooling effect of an air conditioner, very large energy savings are possible. To make a person feel comfortable, it is often sufficient to keep the upper body and face cooled. This principle has been described in US Patent 6,425,255 by Karl Hoffman, Dec 26 2000 (issued Jul 30 2002). Further refinements are described in US Patent 2002/0121101 by Asir Iyadurai Jebaraj, 2 Jan 2002 (issued 5 Sep 2002). This patent also refers to China Patents CN2259099 (San Jianhua et al) and CN1163735 (Tan Mingsen et al) that describe air-conditioned mosquito nets in which outside air is conditioned and supplied to the enclosures and all of the air is exhausted outside the enclosure.

It is evident from the above that there is a need for a localised personal air conditioning system in which the conditioned air is used more effectively to cool a person located nearby. Some systems achieve this by directing a cooled airflow over a bed, for sleeping applications. The bed provides a base structure along which the airflow flows. However, such systems may not be adapted to cool people in seated and standing positions where there is no such base structure – note: if the floor is considered a base structure then all the air between the floor and the person's upper body and/or head would need to be cooled, which dramatically reduces the energy saving of localised cooling.

Similarly, turbulence in the jet (i.e. outflow of air from the air-conditioner) promotes mixing with the surrounding air. For a cooled air outflow, this mixing raises the temperature of the jet and reduces the velocity of the jet, both of which reduce the cooling sensation at a given distance from the device. Small velocity fluctuations in the jet are magnified as vortices form around the jet as a result of friction between the moving air in the jet and the substantially stationary room air.

To produce an airflow through the air-conditioner, fans are common. Each fan drives or draws air through a heat exchanger (whether on the heat absorbing or heat emitting side). A fan positioned upstream of the heat exchanger (with respect to the direction of flow of the airflow) increases velocity fluctuations because air leaves different parts of the fan at different velocities and different directions. Non-uniform velocity reduces heat transfer to and from airflow. To achieve more uniform velocity of airflow through the heat exchanger a fan can be positioned downstream of the heat exchanger (with respect to the direction of flow of the airflow) to draw air through the heat exchanger. This reduces velocity fluctuations at heat exchanger but increases turbulence and vorticity of the airflow leaving the fan. This increases mixing with surrounding air.

Mixing with surrounding air is useful for air-conditioners adapted to cool an entire space, but is undesirable for efficient localised personal air-conditioners. In the latter cases, an airflow straightener can be used. One such airflow straightener uses a honeycomb structure made from thin sheet metal such as aluminium. However, such straighteners accumulate dust and often cannot be cleaned without damaging the honeycomb structure. Additionally, substantial pressure is required to force the air through the fine parallel air passages, increasing the power required to generate the air movement.

Some localised air-conditioners use a deflector for controlling the angle of the air jet out of the air-conditioner. One disadvantage of such arrangements is that some mixing occurs as the air jet passes along the underside of the deflector, increasing the average level of turbulence and vorticity in the air jet emerging from the end of the deflector. This mixing causes the average temperature of the air jet to increase because the thermal energy in the air is conserved. This mixing also causes the average jet velocity to decrease because momentum in the original air jet must be conserved. The added turbulence and vorticity increases subsequent mixing with the room air as the conditioned air jet passes from the end of the air deflector towards a nearby user. This effect limits the maximum distance at which a sufficient cooling effect is perceived by the user.

A related problem in designing a low power localised air conditioning device concerns waste heat removal. Where there is little natural ventilation, warm air discharged from the hot side of the air conditioner can significantly heat air in parts of the room. The additional heat in the air ultimately reduces the amount of cooling received by a user and increases radiant heat received from surfaces. This undesirable effect increases with increased insulation of the room, reducing the amount of heat that can be absorbed by the room structure.

Such air-conditioners therefore often employ a waste heat exhaust pipe. However:

- additional energy is needed to force air through the pipe, increasing energy consumption and heat production;
- the air conditioner must be close enough to the vent opening (e.g. a window) to

be reached by the pipe;

- the pipe conflicts with aesthetics of the room and is difficult to attach to the vent opening;
- air exhausted from the room through the exhaust pipe reduces pressure in the room, causing warm air from outside to enter the room through gaps in the structure and vents and reducing the room cooling effect;
- condensation is produced on cold parts of the air conditioner and, where it is disposed of in the warm airflow leaving the air-conditioner, the rate of disposal is less than the rate at which water enters the room in the warm air drawn into the room by the action of the exhaust pipe, thereby increasing humidity and decreasing comfort.

It is generally desirable to overcome or ameliorate one or more of the above mentioned difficulties, or at least provide a useful alternative.

Summary of the Invention

Disclosed are outflow assemblies for use with localised air-conditioners. The outflow assemblies are arranged to project a jet of conditioned air towards the head and neck of a nearby person or persons. This is advantageous since cooling the head and neck is often sufficient for a person to feel comfortable. To illustrate, when a person sleeps their entire body apart from the head and neck are often covered by bedding. The temperature inside the bedding is typically about 30 – 36 °C with relatively high humidity. A normal person sitting in such an environment would feel uncomfortably hot. However, a sleeping person is comfortable since their face and neck is exposed to air at a much lower temperature, typically 15 – 25 °C. A localized air conditioning device in accordance with the present disclosure, therefore, can provide a sensation of comfort in an uncomfortably hot environment by providing a stream of cool air surrounding the head and neck of a person who may be seated or standing.

Embodiments of the present invention therefore primarily address the need to cool one or more nearby persons who are seated or standing. Surrounding the persons with a fabric enclosure is undesirable because they need freedom to move easily to other parts of the space when needed. Therefore this invention addresses the need to project a jet of cool air directed at the face and upper body of one or more nearby persons.

As used herein, the terms "evaporator" and "condenser" (and similar) are used to refer to components of an air-conditioning device that extract heat from an airflow and transfer heat to an airflow, respectively. These terms, although having specific usage in some contexts, are intended to cover all relevant forms of heat transfer to and from airflow such as via evaporation, condensation, Seebeck effect, Peltier effect, Thomson effect and others. Thus the present disclosure should not be limited to compressor-refrigerant cooling processes.

According to the present disclosure, there is provided an outflow assembly configured to control an airflow from an air-conditioner, comprising:

a nozzle having an upstream end and a downstream end, the airflow passing from the upstream end to, and out of, the downstream end; and

an airflow straightener within the nozzle and having an upstream side facing the upstream end and a downstream side facing the downstream end, the airflow passing through the airflow straightener towards the downstream end, wherein the airflow straightener progressively reduces a cross-sectional area of the airflow on the upstream side.

Also disclosed is a localised air-conditioning device comprising:

a heat absorbing side comprising:

an air inlet through which a first airflow enters the heat absorbing side;

an evaporator heat exchanger that transfers heat out of the first airflow, to produce a conditioned cool airflow; and

a conditioned cool air outlet through which the conditioned cool airflow leaves the heat absorbing side;

a heat emitting side comprising:

an air inlet through which a second airflow enters the heat emitting side;

a condenser heat exchanger that transfers heat captured by the evaporator heat exchanger into the second airflow, to produce a heated airflow; and

a warm air outlet for directing the heated airflow away from the localised air-conditioning device; and

an outflow assembly as described herein, positioned to receive an airflow from one of the conditioned cool outlet and the warm air outlet, the airflow being one of the conditioned cool airflow and heated airflow.

Also disclosed herein is a localised air conditioning device including:

(a) a heat emitting side including:
 (i) a room air inlet;
 (ii) a condenser fan;
 (iii) a condenser heat exchanger; and
 (iv) a warm air outlet located on a upper section of the unit for directing hot air in an upward direction; and

(b) a heat absorbing side including:
 (i) the return air inlet;

(ii) an evaporator fan;

(iii) an evaporator;

(iv) air flow straightening means;

(v) a conditioned air outlet located in an upper section of the unit; and

(vi) a nozzle provided with a suitable articulation means for directing the stream of conditioned air from the outlet towards a user; and

(c) a motor for driving the evaporator fan and the condenser fan,

wherein the air flow straightening means comprises an appropriate combination of vanes or relatively coarse parallel air passages with minimal flow resistance, open cell plastic foam with minimal flow resistance, and one or more inclined or conical mesh screens with minimal flow resistance, for reducing velocity fluctuations caused by turbulence or vorticity in the airflow.

The effectiveness of a localised air conditioning device depends on reducing the velocity fluctuations caused by turbulence at the conditioned air outlet as much as possible. The effectiveness can also rely on choosing the shape of the outlet to minimize mixing of the conditioned air jet with the surrounding room air. In some embodiments, the airflow straightener reduces turbulence and vorticity and a circular nozzle is provided since a circular cross-section generates the least mixing of the air jet with surrounding air due to a circle having the highest circumference to area ratio.

Brief Description of the Drawings

Preferred embodiments of the present invention are hereafter described, by way of non-limiting example only, with reference to the accompanying drawings in which:

Figure 1 shows the principal internal parts of the localised air conditioning device viewed from the right side;

Figure 2a shows an enlarged view of the conditioned air outlet cover and nozzle arrangement;

Figure 2b shows a front view of the nozzle arrangement inside the conditioned air outlet cover;

Figure 3 shows an enlarged view of the conditioned air outlet cover and nozzle arrangement with the cover at a lower elevation angle;

Figure 4 shows an enlarged view of the conditioned air outlet cover and nozzle arrangement with the cover rotated down fully when the device is not in use; and

Figure 5 shows an alternative arrangement for the conditioned air outlet nozzle which can also be used to direct the stream of warm air from the condenser fan outlet duct.

Detailed Description of Preferred Embodiments of the Invention

Outflow assemblies will now be described that reduce turbulence and vorticity in an airflow exiting an air conditioner device. Since the typical application of an air conditioner is to cool air, considerable thought goes into managing the conditioned cool airflow. However, comparatively little thought is given to managing the heated airflow to which heat from the conditioned cool airflow is transferred. The present outflow assemblies can be used with either or both of the conditioned cool airflow and heated airflow. When used with the conditioned cool airflow the outflow assembly can accurately direct air to the desired location, typically the head and/or neck of a person. When used with the heated airflow the outflow assembly can accurately direct air through a vent or opening that is spaced from the air conditioner device, without the need for a tube, or other device, extending between the device and vent or opening.

Provided that velocity fluctuations in the stream of conditioned air caused by turbulence and vorticity are small compared with the average stream velocity inside the nozzle, the air jet formed by the nozzle will reach nearby users with the least possible, or very little, mixing with the surrounding room air, particularly when compared with air conditioning systems that cool the space in its entirety (standard air conditioners). Therefore, for a particular energy usage, the cooling effect experienced by the users will be substantially greater than for standard air conditioners, both from reducing the temperature rise in the conditioned air stream due to mixing, and reducing the average velocity reduction due to mixing.

In some embodiments, outflow assemblies in accordance with the present disclosure can be attached to an existing air conditioner device – e.g. by coupling to the warm air outlet of the heat emitting side of the air conditioner device, or by coupling to the cool, conditioned air outlet of the air conditioner device. In other embodiments, outflow assemblies in accordance with the present disclosure form part of the air conditioner device.

To illustrate usage of outflow assemblies described herein, the outflow assemblies will be shown is attached, connected or otherwise engaged to an outlet or outflow of an air conditioner device. However, outflow assemblies can be supplied as a separate product to the air conditioner device in some embodiments.

With reference to Figure 1, a localised air conditioning device 100 includes a heat absorbing side 101 for absorbing heat from an airflow 112, and the heat emitting side

102 for transferring heat to an airflow 130. The heat absorbing side 101 comprises:

- an air inlet 113;
- an evaporator heat exchanger 114; and
- a conditioned air outlet 120.

The air inlet 113 can be referred to as a return air inlet in some embodiments. This is because it can take air from inside the room, that will have potentially been already at least partially cooled. The air inlet 113 includes a filter screen, which is not necessary in some embodiments. A first airflow 112 enters the heat absorbing side 101 through the air inlet 113. It also passes through the screen 111, which may remove dust or simply have pores enough not to restrict airflow but to prevent dust and insects from entering the air-conditioner device 100.

The evaporator heat exchanger 114 transfers heat out of the first airflow 112, to produce a conditioned cool airflow 124. The conditioned cool airflow 124 may be referred to as a conditioned airflow, conditioned air stream, called air stream and other similar terms without departing from the function of the air-conditioner described herein.

The conditioned cool airflow leaves the heat absorbing side 101 through the conditioned air outlet 120. In the present embodiment, an air flow straightener 119 is provided at the conditioned air outlet 120. The air flow straightener 119 may comprise any suitable structure or material. For example, the air flow straightener 119 may be a series of narrow channels (also referred to as "passages"), each of which can be any desired width such as 3 mm to 6 mm. Alternatively, the air flow straightener 119 may comprise a honeycomb channel structure, series of parallel vanes, ribs or other structure. To further reduce vorticity and turbulence in the airflow passing through the conditioned air outlet 120, the conditioned air outlet 120 may include an open cell foam or other porous material through which the conditioned airflow passes.

To draw the airflow 112 into the heat absorbing side 101, and to drive the conditioned airflow 124 out of the heat absorbing side 101, an evaporator fan 116 is provided. The evaporator fan is disposed between the inlet 113 and the outlet 120.

The air-conditioner device 100 further comprises a conditioned air outlet cover 128. The air outlet cover 128 has an open condition as shown, in which the conditioned airflow 124 can leave the air-conditioner device. The air outlet cover 128 also has a closed condition, discussed with reference to Figure 4, when not in use. The closed condition prevents the ingress of dust and other contaminants while the air-conditioner device 100 is not in use.

With further reference to Figure 1, the heat emitting side 102 of the air-conditioner device comprises:

- an air inlet 131;
- a condenser heat exchanger 132; and
- a warm air outlet 136.

A second airflow 130 enters the heat emitting side 102 through the air inlet 131. The air inlet 131 also comprises a screen 161 for the same purpose as screen 111 – both may operate as filter screens.

The condenser heat exchanger 132 transfers heat captured by the evaporator heat exchanger 114 into the second airflow 130, to produce a heated airflow 140. The warm air outlet 136 takes the heated airflow from the condenser heat exchanger 132 and directs it away from the localised air-conditioning device 100. In each case, the outlets 120, 136 may direct air in an upward direction or any other desired direction. Since warm air tends to rise relative to cooler air, the warm air outlet 136 may direct the heated airflow in an upward direction – upward being defined relative to a floor or other surface upon which the air-conditioner device 100 is positioned. The outlets 120, 136 may direct flows in different relative directions – e.g. one outlet may direct an airflow upwards while the other may direct an airflow sidewards or downwards.

To draw the airflow 130 into the heat emitting side 102, and to drive the heated airflow 140 out of the heat emitting side 102, a condenser fan 134 is provided. The condenser fan 134 is disposed between the inlet 131 and the outlet 136.

Between each inlet 113, 131 and the corresponding heat exchanger 114, 132 is a plenum chamber 115, 133. In each case, the plenum chamber 115, 133 is a volume in which turbulence and vorticity in the airflow that has passed through the respective heat exchanger 114, 132 is distributed throughout the airflow prior to its entering the corresponding fan 116, 134.

The fans 116, 134 may be driven each by a separate motor. To reduce power consumption, the present embodiment comprises a single motor 135 for driving the evaporator fan 116 and the condenser fan 134. A particular advantage of the arrangement in which both the evaporator fan impeller 116 and the condenser fan impeller 134 are attached to the same shaft passing through the motor 135 is that only one motor is required to drive both fans. This reduces the cost and provides a relatively compact physical arrangement of the components.

The air-conditioner device 100 also includes an outflow assembly generally designated

162. The outflow assembly 162 is positioned to receive the conditioned airflow from the conditioned air outlet 119. The outflow assembly 162 is configured to control and airflow from the air-conditioner device, particularly to direct it to a target location with minimal turbulence and vorticity, thereby to avoid mixing with air in the room in which the air-conditioner device is disposed. Presently, the outflow assembly 162 is positioned at conditioned air outlet 119. However, in some embodiments, the outflow assembly is positioned at the warm air outlet 136 to receive the heated airflow from the warm air outlet 136, or a separate outflow assembly can be provided at each outlet 119, 136.

The outflow assembly 162 comprises a nozzle 122 having an upstream 122a and a downstream end 122b. The airflow passing from the air-conditioner device through the outflow assembly passes from the upstream end 122a to, and out of, the downstream end 122b. In some embodiments, the nozzle 122 is an articulated nozzle that projects a stream of conditioned air towards a person, receiving conditioned air from the conditioned air outlet 119.

The nozzle may be directly connected to the respective outlet 119, 136, and may consequently have a fixed orientation relative to the respective outlet 119, 136. In the present embodiment, nozzle 122 is connected to the outlet 119 through flexible duct 121 - presently an expandable bellows tube. The flexible duct 121 connects the nozzle 122. Within the nozzle 122, or incorporated by the nozzle 122, is an airflow straightener 123. The airflow straightener 123 has an upstream side 123a facing the upstream end 122a and a downstream side 123b facing the downstream end 122b. The airflow passes through the airflow straightener 123 towards the downstream end 122b. The cross-sectional area of the airflow progressively reduces (with respect to a direction of flow of the airflow through the airflow straightener 123) from the upstream side 123a to the downstream side 123b. Conversely, the cross-sectional area of the airflow on the downstream side may progressively increase (with respect to a direction of flow of the airflow through the airflow straightener 123). As the airflow passes through the airflow straightener 123, the airflow is straightened. This assists with reducing turbulence and vorticity that would otherwise cause the airflow to mix with surrounding air in the room. Instead, the straightened airflow can be projected some distance from the air-conditioner with high accuracy, to cool the head and neck of a person in the case of a conditioned air outflow, and to vent heated air out of a vent or opening (such as a window) in the case of a heated airflow.

The progressive reduction in cross-sectional area of the airflow from the upstream side 123a reduces tendency to form flow vortices in the boundary layer close to the nozzle inner surfaces. This is to be contrasted with a flat panel airflow straightener extending perpendicular to the flow of air, across the nozzle cross-sectional area. Such a flat panel airflow straightener would straighten the air somewhat, but requires greater force from the fan, increasing the amount of turbulence and vorticity which needs to be removed from the airflow, and also creates a step higher step change in pressure than airflow straightener 123, which increases the energy required to drive the fan 116. The airflow straightener 123 progressively straightens the airflow, minimising velocity fluctuations within the stream of air leaving the nozzle outlet - i.e. at the downstream end 123b.

The air-conditioner device 100 shown in Figure 1 is one possible physical arrangement of the relevant components. Details of interconnecting tubing, electrical connections, and the structural components have been omitted for clarity in explaining the principles that relate to embodiments of the present invention. In this embodiment, the fan 134 and evaporator fan 116 are, for example, considered as centrifugal fans.

The pathway followed by air as it passes through the heat absorbing (i.e. cold) side of the air conditioner 100 is described below in further detail. A person skilled in the art will readily appreciate that the warm air pathway on the heat committing (i.e. warm up) side of the air-conditioner is similar in principle.

Air enters the air inlet, or return air inlet, 113 and passes through the return air inlet filter screen 111 just before passing through the spaces between the fins of the evaporator heat exchanger 114. Air leaving the evaporator heat exchanger 114 enters a plenum space 115 before being drawn into the inlet of the evaporator fan (comprising a centrifugal fan impeller) 116 driven by motor 135, which may be an electric motor. Plenum space 115 is provided to ensure that air flows with a relatively even velocity across the full area of the evaporator heat exchanger 114, maximising the heat exchanger efficiency. Air leaving the centrifugal fan impeller 116 enters a duct 118 surrounding the impeller 116 and extending to the outlet 119. The air passing through the duct 118 flows substantially vertically upwards through the air flow straightener 119, presently comprising a plurality of parallel passages. The air then passes through an open cell foam 163 held in the conditioned air outlet 120. The conditioned air passes through the flexible duct 121 and through the nozzle 122 projecting the conditioned air stream in a substantially horizontal direction (if the nozzle 122 is selected to direct the flow in a horizontal direction) towards the location of a person using the air-conditioner device 100.

With reference to Figure 3, the outflow assembly 162 comprises a frame or frame member 125 connecting outflow assembly 162 to the cover 128. Constructing a section of the nozzle from (impervious) flexible material, including plastics and others, joining the air outlet 120, 136 with the folding or articulated section 121 of the outflow assembly 162 provides a flexible means of transferring conditioned air from the outlet 120, 136 to the nozzle 122. This flexibility enables the direction of the nozzle 122 to be adjusted independently of the air conditioning device 100, either manually or by motor driven means, so as to adjust the direction of the jet of conditioned air. The use of fabric on the outside of the impervious flexible material, as described herein, substantially eliminates surface condensation and also provides very little additional resistance when adjusting the direction of the nozzle. This permits a very small driving motor to change the direction of the nozzle when required.

To facilitate articulation, the frame is presently attached to a pivot 126, comprising first portion 126a connected (e.g. pivotally connected) to the cover 128 and a second portion 126b connected to the outflow assembly 162. The first and second portions 126a, 126b are movable relative to one another to change a direction of the nozzle 122 and thereby change a direction of the airflow passing through the outflow assembly 162. The first and second portions 126a, 126b are presently plates connected together by a pin 126c that permits the two plates 126a, 126b to pivot relative to one another. It will be appreciated that full control of the direction of the airflow through the nozzle 122 requires the nozzle 122 to be able to pivot around two axes. For illustration purposes, the axis provided by pin 126c is perpendicular to a pivot axis of the cover 128 provided at hinge point or line 129, and the second axis is parallel to the hinge point or line 129 and provided at pivot 127 that attaches the plate 126a to the cover 128.

The nozzle structure 122 is thus pivotally connected at pivot 126 to frame member 125 enabling the direction of the nozzle to change from side to side as shown in – i.e. within the plane extending perpendicularly from the page as shown in Figure 2a. The frame member 125 is also pivotally connected at pivot 127 to the conditioned air outlet cover 128 enabling the nozzle elevation angle to be adjusted as shown in Figure 3 (compare with Figure 2a). These nozzle direction adjustments can either be manual by providing the pivots with appropriate friction, or by means of a motor such as small electric motors (not shown – one motor for each axis of rotation) inside the conditioned air outlet cover 128. The conditioned air outlet cover is pivotally attached 129 to the casing 142 such that the elevation angle of the cover can be adjusted to elevate or depress the angle of the stream of conditioned air projected towards a user. A lower elevation angle is shown in Figure 3. The angle of the cover 128 can be adjusted manually by providing a suitable friction at pivot 129 or by means of an electric motor (not shown).

As shown with reference to Figures 2b and 4, the present nozzle 122 has an expanded condition (shown in Figure 2b) in which airflow passes through the nozzle, and a collapsed condition (shown in Figure 4) for storage of the outflow assembly 162.

To facilitate collapse and expansion of the nozzle 122, the nozzle may be formed from a flexible material. However, unless the flexible material is pulled taut when expanding the nozzle, it may introduce additional turbulence at the interface between the flexible material and airflow passing through the nozzle. In the embodiments shown in Figure 2b, the nozzle 122 is formed from a plurality of interconnected panels, some of which are referenced by reference numeral 122c. The interconnected panels 122c are hinged together to enable the nozzle 122 to move between the expanded condition in the collapsed condition – thus the nozzle can be collapsed inside a protective cover 128 when the localised air conditioning device is not in use, minimizing the overall space requirement. In the present embodiment, there are six panels 122c. To ensure the nozzle 122 opens into a substantially regular polygonal shape and can collapse flat as shown in Figure 4, it is desirable that the number of panels 122c is even.

In any case, the nozzle 122 comprises a plurality of panels arranged with appropriate ability to fold or articulate so that the nozzle 122 can be stored in flattened or collapsed form when not in use. While the nozzle 122 consists of six, substantially rectangular (generally rectangular but tapering towards the downstream end 122b), panels as shown in Figure 2b, alternative shapes, numbers of panels and nozzle arrangements are possible. One advantage of the deflector arrangement is that it also serves as a dust cover when the appliance is not in use. Very little space needs to be allocated in the design of the air conditioner device for the deflector when it is rotated into the down position or closed condition (see Figure 4) as it serves as a cover for other parts of the air conditioner device. Apart from internal ribs that provide rigidity, the thickness of the air deflector is often mainly due to foam insulation applied to the underside. This insulation foam reduces heat absorption from the air deflector, reducing the tendency for moisture to condense on the outside of the air deflector when the air conditioner is used in a humid atmosphere. Condensation causes numerous problems and inconveniences for the user, such as water dripping onto the floor creating a slip hazard, or dripping onto a carpet, promoting more rapid deterioration of the carpet and possible the growth of bacteria or mould in the carpet over time.

For embodiments with a rigidly shaped – e.g. circular – nozzle, additional space is required within the envelope of the air conditioner device if it is to be rotated or folded into the body of the air conditioner when not in use. Either the air conditioner must be larger and possibly heavier, or the internal components must be made smaller and therefore possibly less efficient or require greater lengths of tubing to carry air between internal components. Alternatively, the nozzle has to be detached from the air conditioner when it is not in use and stored separately. Thus, a collapsible and/or detachable outflow assembly is very useful.

The nozzle 122 may move to the expanded condition from the collapsed condition under action of gravity, such as when the panels 122c are sufficiently heavy. In the embodiment shown, hinges between the panels 122c may comprise one or more biasing elements such as springs to bias the nozzle 122 in the expanded condition. The biasing elements may also be incorporated elsewhere into the nozzle for the same purpose.

In some embodiments, e.g. when a cover is provided and the nozzle 122 is connected (directly or through a frame) to the cover, when the cover 128 is raised into an operating position, the nozzle panels 122c either fall into the open configuration because the panels pivot relatively freely with one another or small springs or biasing elements between the panels provide sufficient torque at the hinge lines for the nozzle 122 to open fully. In other embodiments, two or more panels can be selectively hinged (e.g. locked in position with panels parallel, or opened up to increase nozzle width), such that a width of the nozzle can be changed as desired.

The nozzle 122 tapers towards the downstream end 123b. This reduces the cross-sectional area of the nozzle 122 towards the downstream end 123b. The reduction in cross-sectional area of the nozzle 122 caused by the taper can be any desired amount such as about 20%. The taper accelerates the conditioned airflow 124 as it passes through the airflow straightener in the nozzle 122, reducing turbulence and vorticity. The airflow straightener comprises any screen, filter or device shaped to straighten the flow of air progressively as discussed above. In some embodiments, an inclined panel or screen is used, extending at an angle to the flow (i.e. not parallel to the airflow and not directly, laterally across the nozzle) to progressively reduce the cross-sectional area of the airflow on the upstream side 123b. In the present embodiment, the airflow straightener 123 comprises a conical mesh screen 123. The airflow straightener reduces the relative magnitude of velocity variations in the airflow caused by turbulence and vorticity. This enables the downstream end 122b of the nozzle 122 two accurately direct the airflow to a person, or through a vent opening, with only a small amount of mixing with air in the room.

In some embodiments, the airflow straightener 123 comprises a screen that uniformly reduces the cross-sectional area of the nozzle 122 from a periphery of the cross-sectional area to a centre of the airflow. For example, a circular nozzle such as nozzle 122 may comprise a conical mesh screen 123 is the airflow straightener, the screen terminating at a centre of the airflow within the nozzle 122, whereas a square nozzle may comprise a pyramidal mesh screen as the airflow straightener. In other embodiments, the reduction in cross-sectional area is non-uniform across the cross-sectional area of the nozzle 122 – e.g. the screen does not terminate at a centre of the airflow within the nozzle 122. Moreover, but for a small amount of bleed air in some embodiments, the nozzle should completely enclose the stream of conditioned or heated air until the conditioned or heated air reaches the downstream end 122b of the nozzle 122. This prevents premature mixing of the conditioned air with room air. Consequently, the temperature of the air leaving the nozzle is lower and the airflow velocity is higher than for deflector arrangements that, in general, generate some vorticity due to skin friction between the airflow and deflector.

Experiments show that the proportion of room air mixing with the conditioned air stream at a distance of 1 metre from the localized air conditioning device can be reduced from about 2 times the quantity of conditioned air with commercial air deflector arrangements to about 1 times the quantity of conditioned air by using a completely enclosed articulated circular nozzle incorporating an airflow straightener as described herein. Reducing mixing by such a large proportion results in significantly increased comfort sensation at a greater distance from the localised air conditioning device.

In addition, the airflow straightener 123 may comprise multiple elements including one or more screens of filters (e.g. conical mesh screens), vanes, ribs and other devices. These elements may be spaced along the outflow assembly – e.g. such that the veins or ribs align the airflow with the upstream side 123a to direct air onto the upstream side 123a, or may control air leaving the airflow straightener 123 from the downstream side 123b. In addition, the airflow straightener 123 may be positioned closer to the downstream end 122b of the nozzle 122 than to the upstream end 122a. Air flowing through the nozzle accumulates boundary layer turbulence caused by friction with the walls of the nozzle.

The outflow assembly 162 may comprise at least one side opening - each side opening is a hole or gap. A small amount of air bleeds through small gaps and holes in the nozzle panels, in the flexible duct 121, and/or elsewhere in the outflow assembly. This helps reduce condensation forming on the cold outer surface of the nozzle 122.

One issue faced by existing air-conditioner systems is condensation on the outer surface of the nozzle while colder air passes through the inside of the nozzle. Condensation can be minimized by reducing heat transfer through the structure of the nozzle, for example, by applying a layer of insulation material. However, the insulation material increases the thickness of the nozzle and makes it harder to collapse the nozzle for storage when the device is not in use. Another means of reducing condensation is to arrange for the nozzle to be covered by fabric which allows a small amount of conditioned air to pass through holes or gaps in the nozzle structure. While a small proportion of conditioned air leaks through the fabric, it prevents accumulation of moisture, eliminating the condensation problem. Furthermore, any condensation rapidly spreads through the fabric by a wicking, just as oil is drawn up a wick from a reservoir in the case of an oil lamp. This increases the surface area of moisture exposed to the air, helping to promote evaporation of the condensed water.

A suitable substantially circular nozzle can be constructed from a set of rigid frame components or panels, encased within porous fabric arranged such that the nozzle folds into a compact form when the device is not in use.

To that end, the outflow assembly 162 may further comprise a fabric cover (not shown) over each side opening, extending over at least a part of one or both of the nozzle 122 and flexible duct 121. In such embodiments, the fabric cover should be formed from a porous fabric to enable it to wick water away from the nozzle 122. As a result of the small amount of air bleeding through the at least one side opening and thereby through the fabric cover, water condensing on the cold outer surface of the nozzle 122 spreads laterally into the fabric and is evaporated by the bleed air. Particularly where the air bled from the outflow assembly 162 is taken from the heated outflow, but also when it is taken from the conditioned air outflow, it is cooled by transferring heat to the water to evaporate the water. The cooled bleed air sinks slowly (see 166 of Figure 1) and re-enters the return air intake 113 below the nozzle 122.

Though a fabric cover has been proposed, the outflow assembly 162 may alternatively comprise an insulation layer for reducing heat funds are from within the outflow assembly laterally (with respect to a direction of the airflow through the outflow assembly) out of the outflow assembly.

As discussed above, and airflow 130 from the room is also drawn through the room air filter screen 131 adjacent to the condenser 132, passing through the passages between the condenser fins through a plenum 133 to an inlet of the condenser centrifugal fan impeller 134 mounted on the same motor shaft 117 as the evaporator centrifugal fan impeller 116 driven by the motor 135. Air leaving the centrifugal fan impeller 134 enters a duct 137 surrounding the fan and passes out in a substantially vertical direction through the warm air outlet 136. The air-conditioner device 100 also includes a gap 141 through which air is drawn into the air-conditioner device 100 between the duct 118 surrounding the evaporator fan 114 and the duct 137 surrounding the condenser fan 134. Air flowing through gap 141 passes through the electric motor 135 to the inlet of the centrifugal fan impeller 134 to provide cooling for the motor 135.

An alternative means for projecting a stream of conditioned air away from the localised air conditioning device 165 towards a user is shown in Figure 5. Features from the various embodiments disclosed herein may be incorporated into or exchanged for features in other ones of the embodiments, while maintaining the function of the presently described outflow arrangement. With particular reference to Figure 5, the outflow assembly 166 is detachable from the air-conditioner device 165. To facilitate attachment and detachment, the outflow assembly 166 comprises an adapter 171 for attaching to conditioned air outlet 120' (though the heated air outlet may similarly be used). The present outflow assembly 166 is again articulated, to control the direction of the airflow from the air-conditioner 165 towards the user. The adapter 171 supports a nozzle articulation means 172 that enables a user to adjust the direction of the tapered outlet nozzle 173 to change the direction of the conditioned air stream 124 over a wide range of angles. The nozzle articulation means 172 comprises an expandable bellows permitting a wide range of directions for the nozzle 173. The bellows provide sufficient friction to substantially prevent undesirable movement caused by the weight of the nozzle 173 and force of air flowing through the outflow assembly 166, while enabling manual control over the direction of the airflow 124. Other types of nozzle articulation means such as an arrangement of appropriate pivoted nozzle mountings enclosing a flexible duct are possible, have been used for fluid control applications and will be understood by the skilled person in view of present teachings. An inclined or conical mesh screen 174 inside the nozzle substantially reduces velocity fluctuations in the conditioned air stream caused by turbulence and vorticity. Optionally, an additional means of reducing velocity fluctuations can be used such as an open cell foam air flow straightener placed in the conditioned air outlet 120' or adapter 171. In addition, the air-conditioner device may include a cover or deflector (the cover can be shaped for use as a deflector when the outflow assembly is not attached) with the outflow assembly being connectable to the cover or deflector.

When this arrangement is used for projecting cool conditioned air towards a user, an external fabric cover can be used with appropriate bleed air flow through small holes or slots in the adapter 171, the nozzle articulation means 172, and/or the nozzle 173. Preferably the nozzle outlet should be circular to minimize mixing between the projected air stream and the room air over the greatest possible distance. In some embodiments, the entire nozzle has a circular cross-section. Mixing of the air jet with the surrounding air takes place at the boundary separating the jet from the surrounding air. A substantially circular nozzle generates the least mixing of the air jet with surrounding air because the circumference of the boundary is minimized relative to its cross-section area. Other nozzle outlet shapes are possible, however.

Preferably, such a means for projecting a stream of conditioned air away from the localised air conditioning device can be provided at the warm side 102 of the localised air conditioning device 100 to enable improved ventilation in small rooms and to avoid accumulation of warm air in the room above the localised air conditioning device 100. The nozzle articulation means 172 and the nozzle with internal inclined or conical mesh screen 174 enables the warm air stream to be projected effectively through an open doorway or window with minimal mixing between the projected air stream and the room air. Optionally, an additional means of reducing velocity fluctuations can be used such as an open cell foam air flow straightener placed in the conditioned air outlet 120 or adapter 171.

Preferably, in each instance, the adapter 171 can easily be attached to the casing 142 of the localised air conditioning device 165 at the appropriate locations of the conditioned air outlet or the warm air outlet. Preferably the attachment means is arranged such that the adapter 171 can easily be removed from the casing when it is not needed.

Many modifications will be apparent to those skilled in the art without departing from the scope of the present invention

The reference to any prior art in this specification is not, and should not be taken as, an acknowledgment or any form of suggestion that the prior art forms part of the common general knowledge in Australia

In this specification and the claims that follow, unless stated otherwise, the word "comprise" and its variations, such as "comprises" and "comprising", imply the inclusion of a stated integer, step, or group of integers or steps, but not the exclusion of any other integer or step or group of integers or steps.

References in this specification to any prior publication, information derived from any said prior publication, or any known matter are not and should not be taken as an acknowledgement, admission or suggestion that said prior publication, or any information derived from this prior publication or known matter forms part of the common general knowledge in the field of endeavour to which the specification relates.

Parts

100 Localised air conditioning device
101 Cold side of air conditioning device
102 Warm side of air conditioning device
111 Return air filter screen
113 Return air inlet
114 Evaporator heat exchanger
115 Plenum chamber between evaporator heat exchanger and evaporator fan
116 Evaporator fan impeller
117 Fan motor drive shaft
118 Evaporator fan duct
119 Coarse array of parallel passages or vanes for straightening conditioned air stream
120 Open cell foam in conditioned air outlet to straighten conditioned air stream
122 Nozzle structure made from articulated or folding components
122a Upstream end of 122
122b Downstream end of 122
122c Panels of 122
123 Inclined or conical mesh screen to straighten conditioned air stream
123a Upstream end of 123
123b Downstream end of 123
124 Conditioned air stream leaving the nozzle outlet
125 Frame carrying nozzle
126 Pivot allowing nozzle direction to be changed in horizontal plane
126a Plate of 126, connected to cover
126b Plate of 126, connected to nozzle
126c Pin connecting plates 126a, 126b
127 Pivotable mounting for frame inside conditioned air outlet cover
128 Conditioned air outlet cover
129 Pivot on which conditioned air outlet cover rotates relative to the air conditioner
131 Room air inlet and filter screen
132 Condenser heat exchanger
133 Plenum between condenser heat exchanger and condenser fan
134 Condenser fan impeller
135 Fan motor
136 Condenser fan outlet duct and safety grille
140 Warm air stream from condenser fan outlet
150 Condensate tray beneath evaporator heat exchanger

151	Water chute
152	Middle condensate tray
153	Water overflow pipe
154	Cable drawer / condensate tank
155	Spray wheel motor
156	Water spray wheel
160	Compressor
162	Outflow assembly
163	Open cell foam
165	air-conditioner device
166	outflow assembly
171	Air outlet adapter
172	Extendable bellows section
173	Nozzle
174	Conical or inclined mesh screen

Claims Defining the Invention

1. An outflow assembly configured to control an airflow from an air-conditioner, comprising:
a nozzle having an upstream end and a downstream end, the airflow passing from the upstream end to, and out of, the downstream end; and
an airflow straightener within the nozzle and having an upstream side facing the upstream end and a downstream side facing the downstream end, the airflow passing through the airflow straightener towards the downstream end, wherein the airflow straightener progressively reduces a cross-sectional area of the airflow on the upstream side.

2. The outflow assembly of claim 1, wherein the nozzle tapers towards the downstream end.

3. The outflow assembly of claim 2, wherein the nozzle tapers to reduce the cross-sectional area of the nozzle by about 20%.

4. The outflow assembly of any one of claims 1 to 3, wherein the nozzle has a circular cross-section.

5. The outflow assembly of any one of claims 1 to 4, wherein the nozzle has an expanded condition in which the airflow passes through the nozzle, and a collapsed condition for storage of the outflow assembly.

6. The outflow assembly of claim 5, wherein the nozzle is formed from a plurality of interconnected panels, the panels being hinged together to enable the nozzle to move between the expanded condition and the collapsed condition.

7. The outflow assembly of claim 6, wherein there is an even number of panels.

8. The outflow assembly of claim 6 or 7, wherein the nozzle further comprises one or more springs to bias the nozzle in the expanded condition.

9. The outflow assembly of any one of claims 1 to 8, further comprising a flexible duct connecting the nozzle to an outflow of the air conditioner.

10. The outflow assembly of any one of claims 1 to 9, further comprising at least one side opening, each side opening being a hole or gap.

11. The outflow assembly of claim 10, further comprising a fabric cover over the at least one side opening.

12. The outflow assembly of any one of claims 1 to 11, further comprises an insulation layer for reducing heat transfer from within the outflow assembly laterally out of the outflow assembly with respect to a direction of the airflow through the outflow assembly.

13. The outflow assembly of claim 9, wherein the flexible duct is an expandable bellows tube.

14. The outflow assembly of any one of claims 1 to 13, wherein the airflow straightener comprises a screen that progressively reduces the cross-sectional area of air flow on the upstream side of the screen from a periphery of the cross-sectional area of airflow.

15. The outflow assembly of claim 14, wherein a cross-sectional area of the nozzle is circular and the airflow straightener has a conical shape.

16. The outflow assembly of any one of claims 1 to 13, wherein the airflow straightener comprises a screen, the screen being inclined with respect to a direction of the airflow through the nozzle.

17. The outflow assembly of any one of claims 1 to 16, wherein the airflow straightener is positioned closer to the downstream end than to the upstream end.

18. The outflow assembly of any one of claims 1 to 17, wherein the airflow straightener further comprises one or more passages for directing the airflow onto the upstream side or away from the downstream side.

19. The outflow assembly of claim 18, where in the one or more passages are formed by one or more ribs, a honeycomb structure and/or an open cell foam.

20. The outflow assembly of any one of claims 1 to 19, wherein the airflow is a heated airflow.

21. The outflow assembly of any one of claims 1 to 19, wherein the airflow is a conditioned cool airflow.

22. A localised air-conditioning device comprising:

a heat absorbing side comprising:

an air inlet through which a first airflow enters the heat absorbing side;

an evaporator heat exchanger that transfers heat out of the first airflow, to produce a conditioned cool airflow; and

a conditioned cool air outlet through which a conditioned cool airflow leaves the heat absorbing side;

a heat emitting side comprising:

an air inlet through which a second airflow enters the heat emitting side;

a condenser heat exchanger that transfers heat captured by the evaporator heat exchanger into the second airflow, to produce a heated airflow; and

a warm air outlet for directing the heated airflow away from the localised air-conditioning device; and

an outflow assembly according to any one of claims 1 to 21, positioned to receive an airflow from one of the conditioned cool outlet and the warm air outlet, the airflow being one of the conditioned cool airflow and heated airflow.

23. The localised air-conditioning device of claim 22, comprising at least two outflow assemblies according to any one of claims 1 to 21, the at least two outflow assemblies including a first outflow assembly positioned to receive the conditioned cool airflow and a second outflow assembly positioned to receive the heated airflow.

24. The localised air-conditioning device of claim 22 or 23, further comprising a cover that is moveable between an open condition and a closed condition, wherein the outflow assembly has an expanded condition, in which the airflow passes through the nozzle when the cover is in the open condition, and a collapsed condition for storage of the outflow assembly when the cover is in the closed condition.

25. The localised air-conditioning device of claim 24, further comprising a frame connecting the outflow assembly to the cover, the frame comprising a first portion connected to the cover and a second portion connected to the outflow assembly, the first and second portions being movable relative to one another to change a direction of nozzle and thereby change a direction of the airflow passing through the outflow assembly.

26. The localised air-conditioning device of claim 25, further comprising a motor connected to one of the outflow assembly and frame, the motor being operable to change the direction of the nozzle.

27. A localised air conditioning device including:
    (a) a heat emitting side including:
        (i) a room air inlet;
        (ii) a condenser fan;
        (iii) a condenser heat exchanger; and
        (iv) a warm air outlet located on a upper section of the unit for directing hot air in an upward direction; and
    (b) a heat absorbing side including:
        (i) the return air inlet;
        (ii) an evaporator fan;
        (iii) an evaporator;
        (iv) air flow straightening means;
        (v) a conditioned air outlet located in an upper section of the unit; and
        (vi) a nozzle provided with a suitable articulation means for directing the stream of conditioned air from the outlet towards a user; and
    (c) a motor for driving the evaporator fan and the condenser fan,

    wherein the air flow straightening means comprises an appropriate combination of vanes or relatively coarse parallel air passages with minimal flow resistance, open cell plastic foam with minimal flow resistance, and one or more inclined or conical mesh screens with minimal flow resistance, for reducing velocity fluctuations caused by turbulence or vorticity in the airflow.

AMENDED CLAIMS
received by the International Bureau on 21 March 2024 (21.03.2024)

Claims Defining the Invention

1. An outflow assembly configured to control an airflow from an air-conditioner, comprising:
a nozzle having an upstream end and a downstream end, the airflow passing from the upstream end to, and out of, the downstream end; and
an airflow straightener within the nozzle and having an upstream side facing the upstream end and a downstream side facing the downstream end, the airflow passing through the airflow straightener towards the downstream end, wherein the airflow straightener progressively reduces a cross-sectional area of the airflow on the upstream side.

2. The outflow assembly of claim 1, wherein the nozzle tapers towards the downstream end.

3. The outflow assembly of claim 2, wherein the nozzle tapers to reduce the cross-sectional area of the nozzle by about 20%.

4. The outflow assembly of any one of claims 1 to 3, wherein the nozzle has a circular cross-section.

5. The outflow assembly of any one of claims 1 to 4, wherein the nozzle has an expanded condition in which the airflow passes through the nozzle, and a collapsed condition for storage of the outflow assembly.

6. The outflow assembly of claim 5, wherein the nozzle is formed from a plurality of interconnected panels, the panels being hinged together to enable the nozzle to move between the expanded condition and the collapsed condition.

7. The outflow assembly of claim 6, wherein there is an even number of panels.

8. The outflow assembly of claim 6 or 7, wherein the nozzle further comprises one or more springs to bias the nozzle in the expanded condition.

9. The outflow assembly of any one of claims 1 to 8, further comprising a flexible duct connecting the nozzle to an outflow of the air conditioner.

10. The outflow assembly of any one of claims 1 to 9, further comprising at least one side opening, each side opening being a hole or gap.

11. The outflow assembly of claim 10, further comprising a fabric cover over the at least one side opening.

12. The outflow assembly of any one of claims 1 to 11, further comprises an insulation layer for reducing heat transfer from within the outflow assembly laterally out of the outflow assembly with respect to a direction of the airflow through the outflow assembly.

13. The outflow assembly of claim 9, wherein the flexible duct is an expandable bellows tube.

14. The outflow assembly of any one of claims 1 to 13, wherein the airflow straightener comprises a screen that progressively reduces the cross-sectional area of air flow on the upstream side of the screen from a periphery of the cross-sectional area of airflow.

15. The outflow assembly of claim 14, wherein a cross-sectional area of the nozzle is circular and the airflow straightener has a conical shape.

16. The outflow assembly of any one of claims 1 to 13, wherein the airflow straightener comprises a screen, the screen being inclined with respect to a direction of the airflow through the nozzle.

17. The outflow assembly of any one of claims 1 to 16, wherein the airflow straightener is positioned closer to the downstream end than to the upstream end.

18. The outflow assembly of any one of claims 1 to 17, wherein the airflow straightener further comprises one or more passages for directing the airflow onto the upstream side or away from the downstream side.

19. The outflow assembly of claim 18, where in the one or more passages are formed by one or more ribs, a honeycomb structure and/or an open cell foam.

20. The outflow assembly of any one of claims 1 to 19, wherein the airflow is a heated airflow.

21. The outflow assembly of any one of claims 1 to 19, wherein the airflow is a conditioned cool airflow.

22. A localised air-conditioning device comprising:

    a heat absorbing side comprising:

        an air inlet through which a first airflow enters the heat absorbing side;

        an evaporator heat exchanger that transfers heat out of the first airflow, to produce a conditioned cool airflow; and

        a conditioned cool air outlet through which a conditioned cool airflow leaves the heat absorbing side;

    a heat emitting side comprising:

        an air inlet through which a second airflow enters the heat emitting side;

        a condenser heat exchanger that transfers heat captured by the evaporator heat exchanger into the second airflow, to produce a heated airflow; and

        a warm air outlet for directing the heated airflow away from the localised air-conditioning device; and

    an outflow assembly according to any one of claims 1 to 21, positioned to receive an airflow from one of the conditioned cool air outlet and the warm air outlet, the airflow being one of the conditioned cool airflow and heated airflow.

23. The localised air-conditioning device of claim 22, comprising at least two outflow assemblies according to any one of claims 1 to 21, the at least two outflow assemblies including a first outflow assembly positioned to receive the conditioned cool airflow and a second outflow assembly positioned to receive the heated airflow.

24. The localised air-conditioning device of claim 22 or 23, further comprising a cover that is moveable between an open condition and a closed condition, wherein the outflow assembly has an expanded condition, in which the airflow passes through the nozzle when the cover is in the open condition, and a collapsed condition for storage of the outflow assembly when the cover is in the closed condition.

25. The localised air-conditioning device of claim 24, further comprising a frame connecting the outflow assembly to the cover, the frame comprising a first portion connected to the cover and a second portion connected to the outflow assembly, the first and second portions being movable relative to one another to change a direction of nozzle and thereby change a direction of the airflow passing through the outflow assembly.

26. The localised air-conditioning device of claim 25, further comprising a motor connected to one of the outflow assembly and frame, the motor being operable to change the direction of the nozzle.

27. A localised air conditioning device according to claim 22, wherein:

the warm air outlet is located on an upper section of the device for directing hot air in an upward direction;

the conditioned air outlet is located in the upper section of the device; and

the device further comprises a motor for driving an evaporator fan and a condenser fan, of the evaporator heat exchanger and the condenser heat exchanger, respectively,

wherein each nozzle is provided with a suitable articulation means for directing the airflow; and

the air flow straightener comprises an appropriate combination of vanes or relatively coarse parallel air passages with minimal flow resistance, open cell plastic foam with minimal flow resistance, and one or more inclined or conical mesh screens with minimal flow resistance, for reducing velocity fluctuations caused by turbulence or vorticity in the airflow.

Figure 1

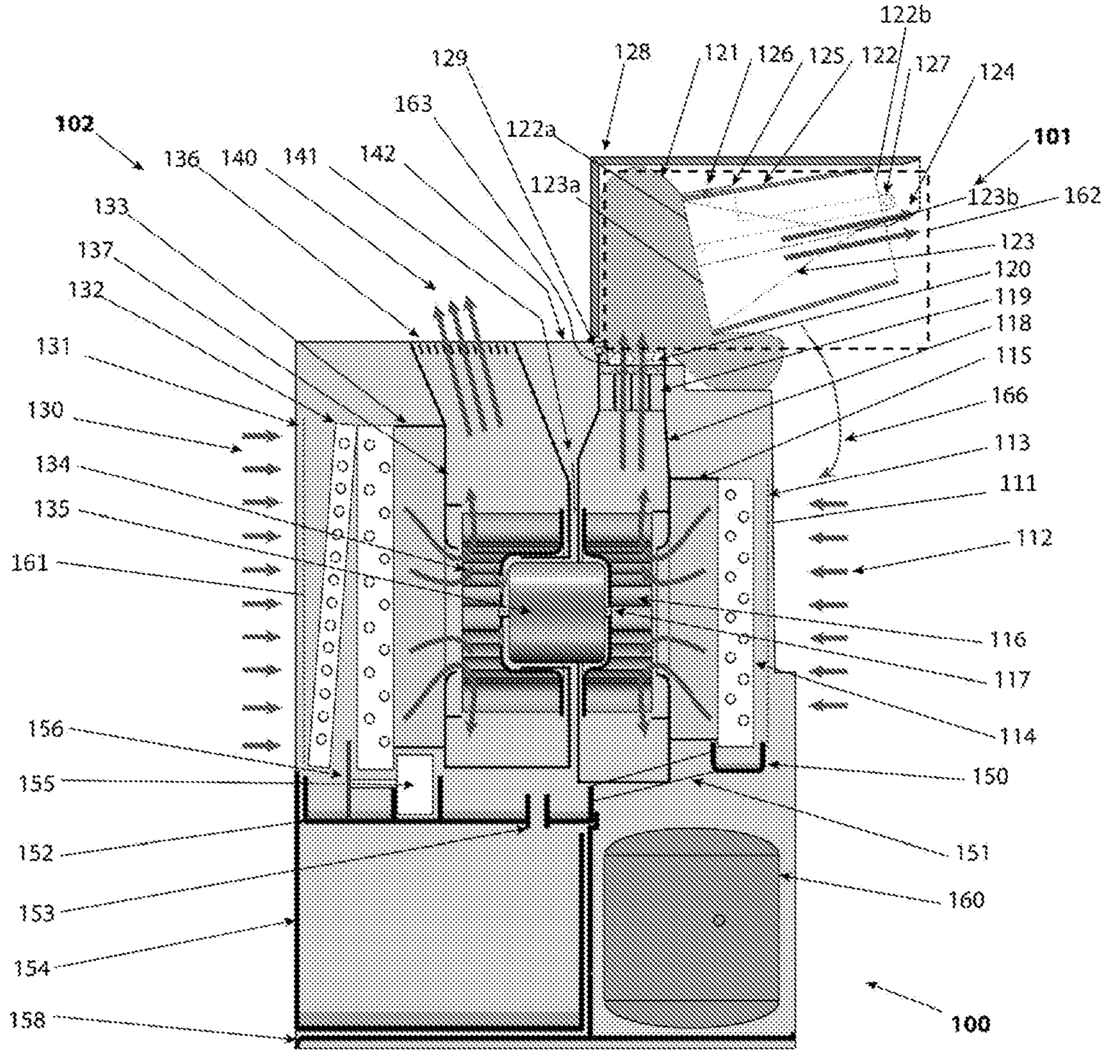
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Figure 2a

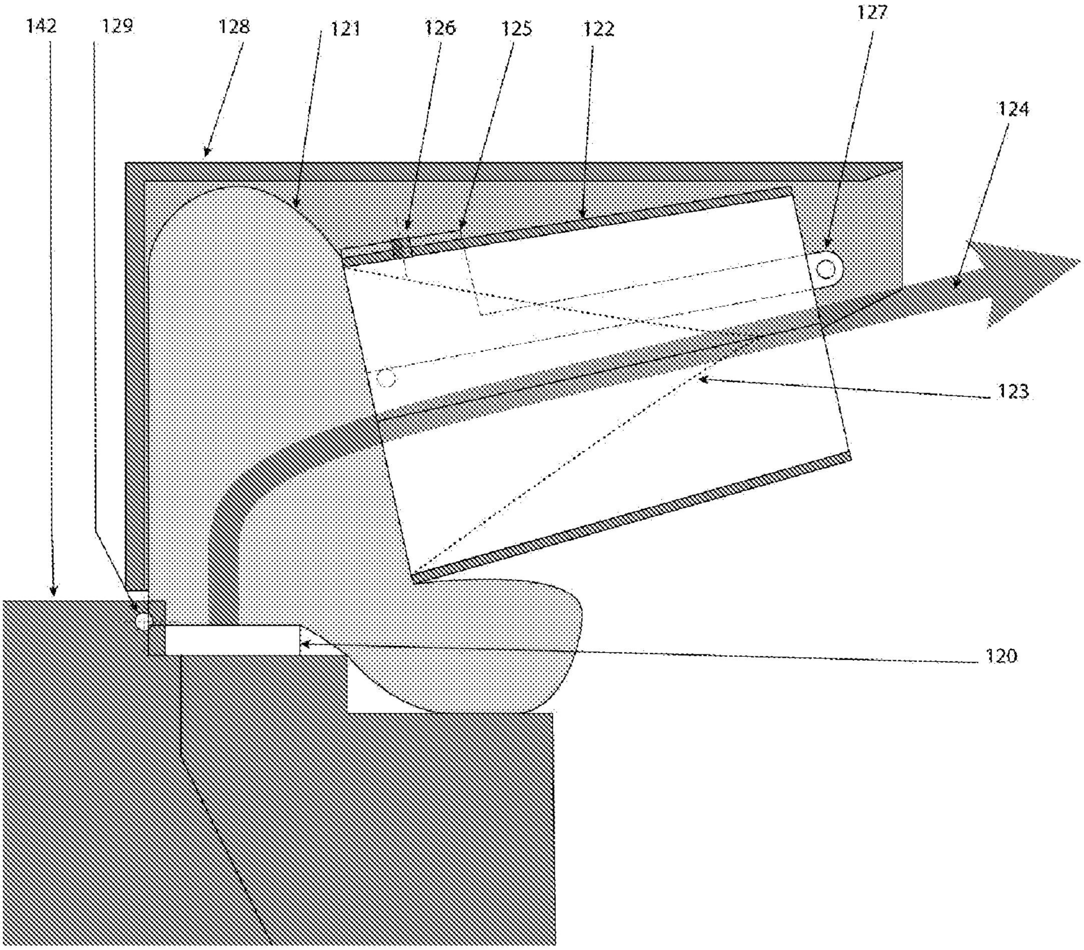


Figure 2b

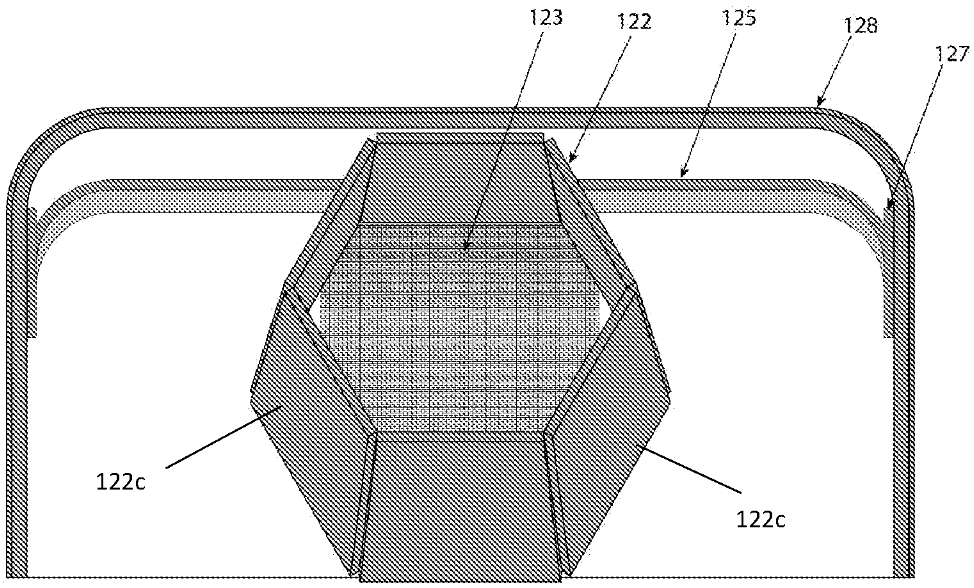


Figure 3

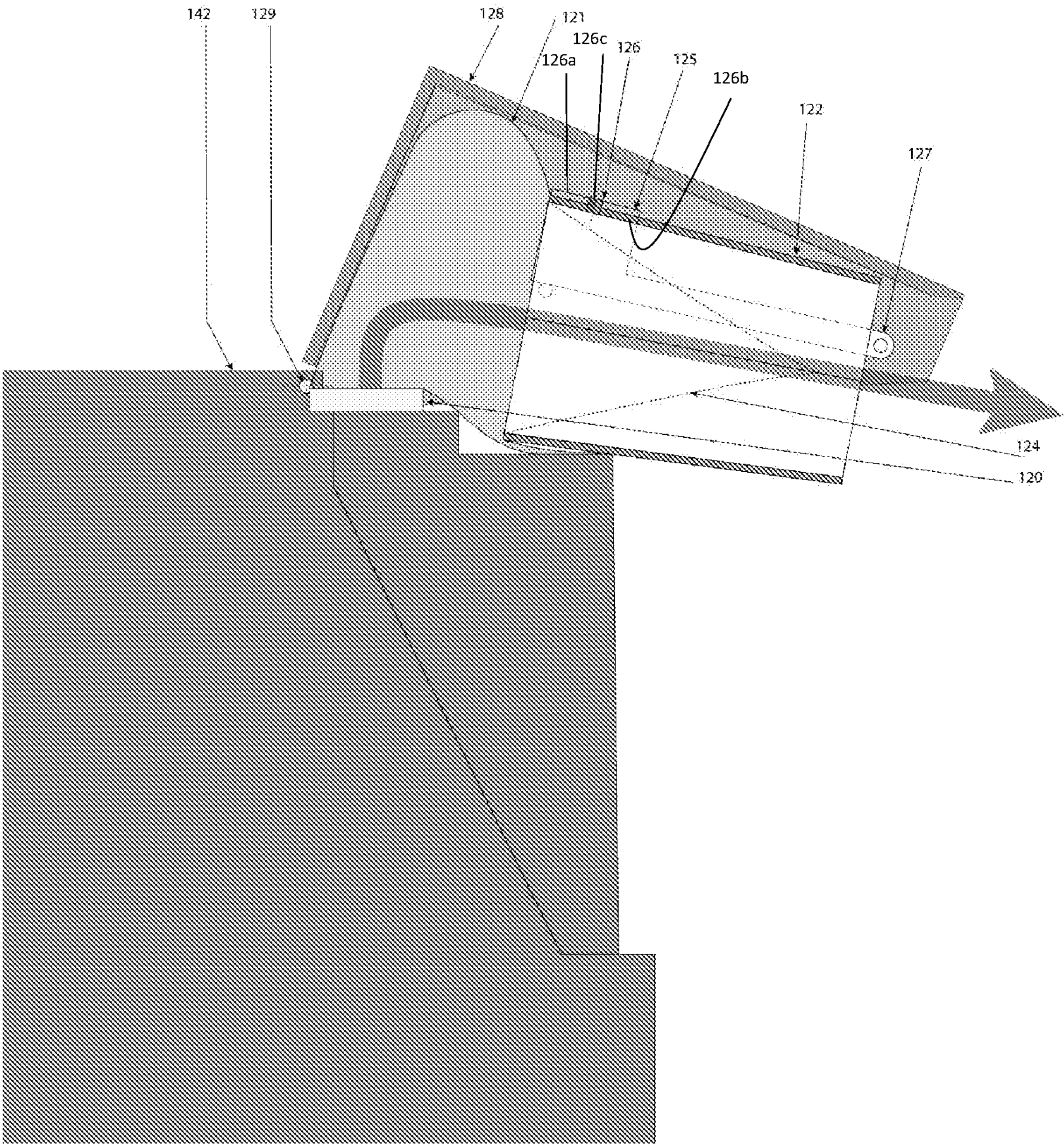


Figure 4

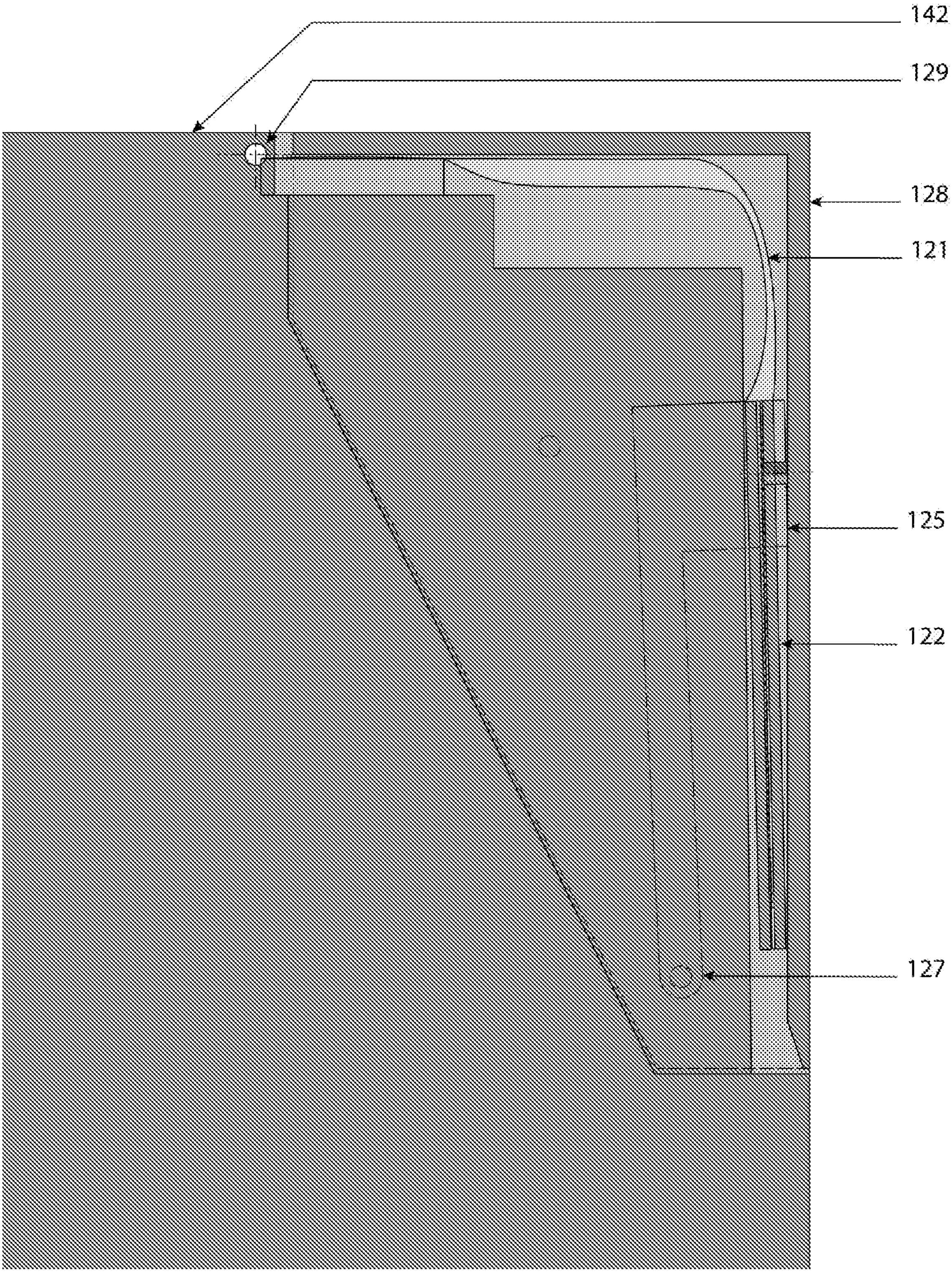
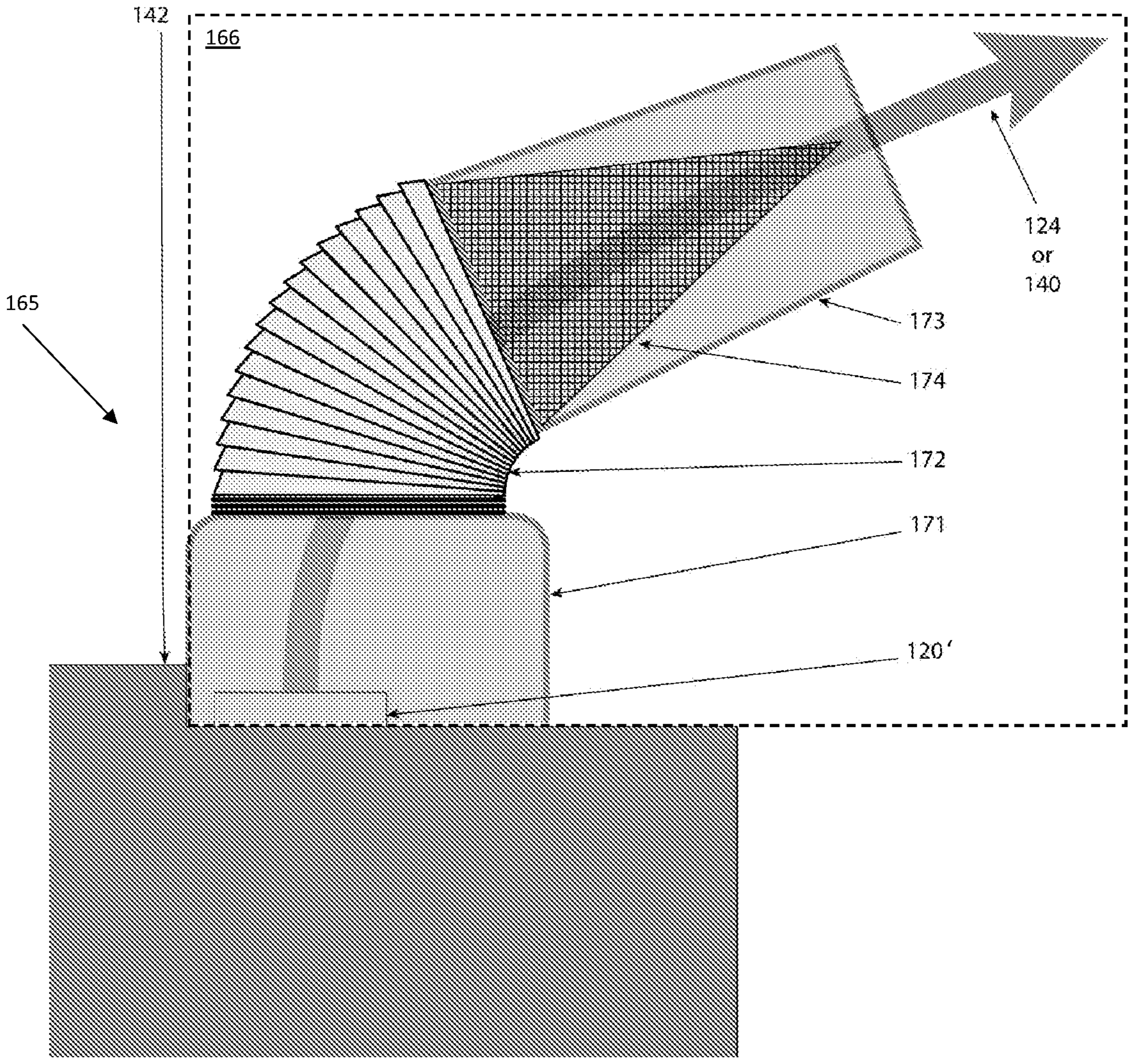


Figure 5



INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2023/051098

A. CLASSIFICATION OF SUBJECT MATTER

F24F 13/08 (2006.01) F24F 1/022 (2019.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PATENW: IPC/CPC Marks- F24F5/LOW, F24F13/LOW, F24F13/08/LOW, F24F2013/088, F24F2221/38, B05B1/30, B05B1/34 with Key Words- NOZZLE?, SPOUT?, STRAIGHTNER?, FUNNEL+, CROSS_SECTION+, DIAMETER, REDUC+, DECREAS+, AIR_FLOW, COLLAPS+, FOLD+ and like words

GOOGLE PATENTS: Word search with various combinations of- 1) Foldable/Collapsible, "Airflow Control", Nozzle 2) "Airflow Nozzle", Turbulence/Diffuse

Applicant/Inventor name search in DOCDB, DWPI and Internal Databases of IP Australia

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

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

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
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- "E" earlier application or patent but published on or after the international filing date
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Date of the actual completion of the international search	Date of mailing of the international search report
9 January 2024	09 January 2024

Name and mailing address of the ISA/AU	**Authorised officer**
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INTERNATIONAL SEARCH REPORT

International application No. **PCT/AU2023/051098**

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2009/007430 A1 (MONTAZ, EDMOND) 15 January 2009 para [0015], [0019], [0021]; figs 1, 2	
A	JP 2013036689 A (PANASONIC CORP) 21 February 2013 abstract; figs 1-3	
A	WO 2022/127950 A1 (PRIHODA S.R.O.) 22 June 2022 abstract; fig 1	
A	US 5097672 A (TAKENAKA ET AL.) 24 March 1992 abstract; figs 1, 2	
A	JP 2015215102 A (NIHON SEKKEI INC ET AL.) 03 December 2015 abstract; figs 1, 5	

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2023/051098**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
WO 2009/007430 A1	15 January 2009	WO 2009007430 A1	15 Jan 2009
		EP 2162683 A1	17 Mar 2010
		FR 2918721 A1	16 Jan 2009
		FR 2918721 B1	11 May 2012
JP 2013036689 A	21 February 2013	JP 2013036689 A	21 Feb 2013
		JP 5845400 B2	20 Jan 2016
WO 2022/127950 A1	22 June 2022	WO 2022127950 A1	23 Jun 2022
		CA 3199139 A1	23 Jun 2022
		CN 116670444 A	29 Aug 2023
		EP 4259984 A1	18 Oct 2023
US 5097672 A	24 March 1992	US 5097672 A	24 Mar 1992
		EP 0423340 A1	24 Apr 1991
		EP 0423340 B1	03 May 1995
		JP H02140548 A	30 May 1990
		JP H0678838 B2	05 Oct 1994
		JP H02287045 A	27 Nov 1990
		JP H07104027 B2	08 Nov 1995
		JP H02302550 A	14 Dec 1990
		JP H07104024 B2	08 Nov 1995
		WO 9005879 A1	31 May 1990
JP 2015215102 A	03 December 2015	JP 2015215102 A	03 Dec 2015
		JP 6381276 B2	29 Aug 2018

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.