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(56) Documents Cited:
GB 2242935 A **GB 2236804 A**
GB 1501473 A **JP 560167897 A**
US 6123618 A

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(54) Abstract Title: **Bladeless fan**

(57) A bladeless fan assembly 1 comprising a nozzle 10 and means for creating an air flow through the nozzle 10. The nozzle comprises in interior passage 20 communicating with a mouth 12, which is arranged to direct airflow from the interior passage 20 over an adjacent surface 14, which may be convex. The nozzle 10 may be an annular, circumferentially continuous plenum, which may be at least 10cm in diameter and at least 5cm long. The nozzle 10 surface may comprise a diffuser which may be at least 5cm or 2/3 of the length of the nozzle 10, and may lie in a plane no more than 15 degrees from the horizontal. The mouth 12 may be at least part circular and the mouth opening may be less than 5mm. The air flow through the nozzle 10 may be created by a motor 30 and an impeller and there may be a duct communicating with the motor 30 and the nozzle 10. The motor 30 may be a DC brushless motor with a mixed flow impeller. The fan 1 may be rotatable about its base 18 and may be mounted on the desk, floor, a wall or a ceiling; and it may include lighting, a clock, or an LCD.

Fig 1

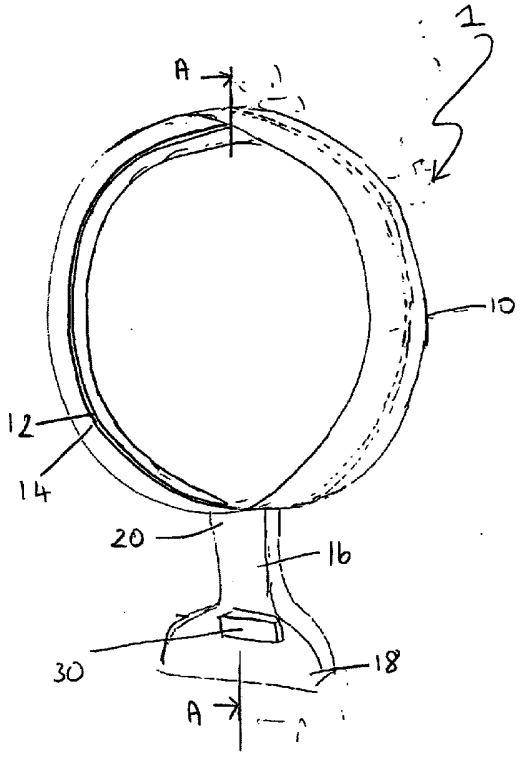

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Fig 1

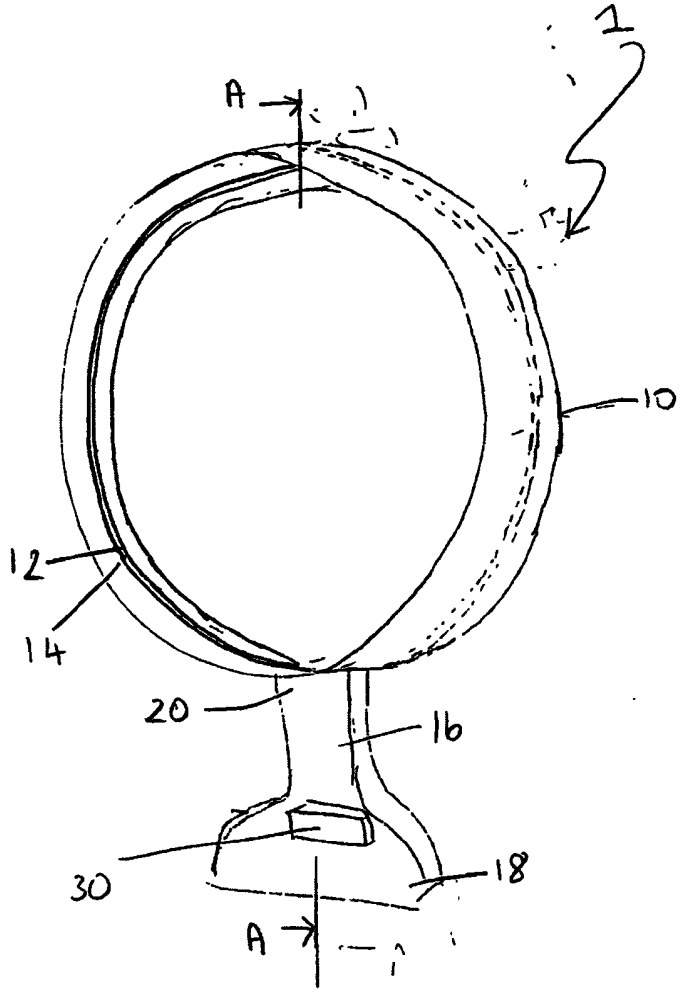


Fig 2.

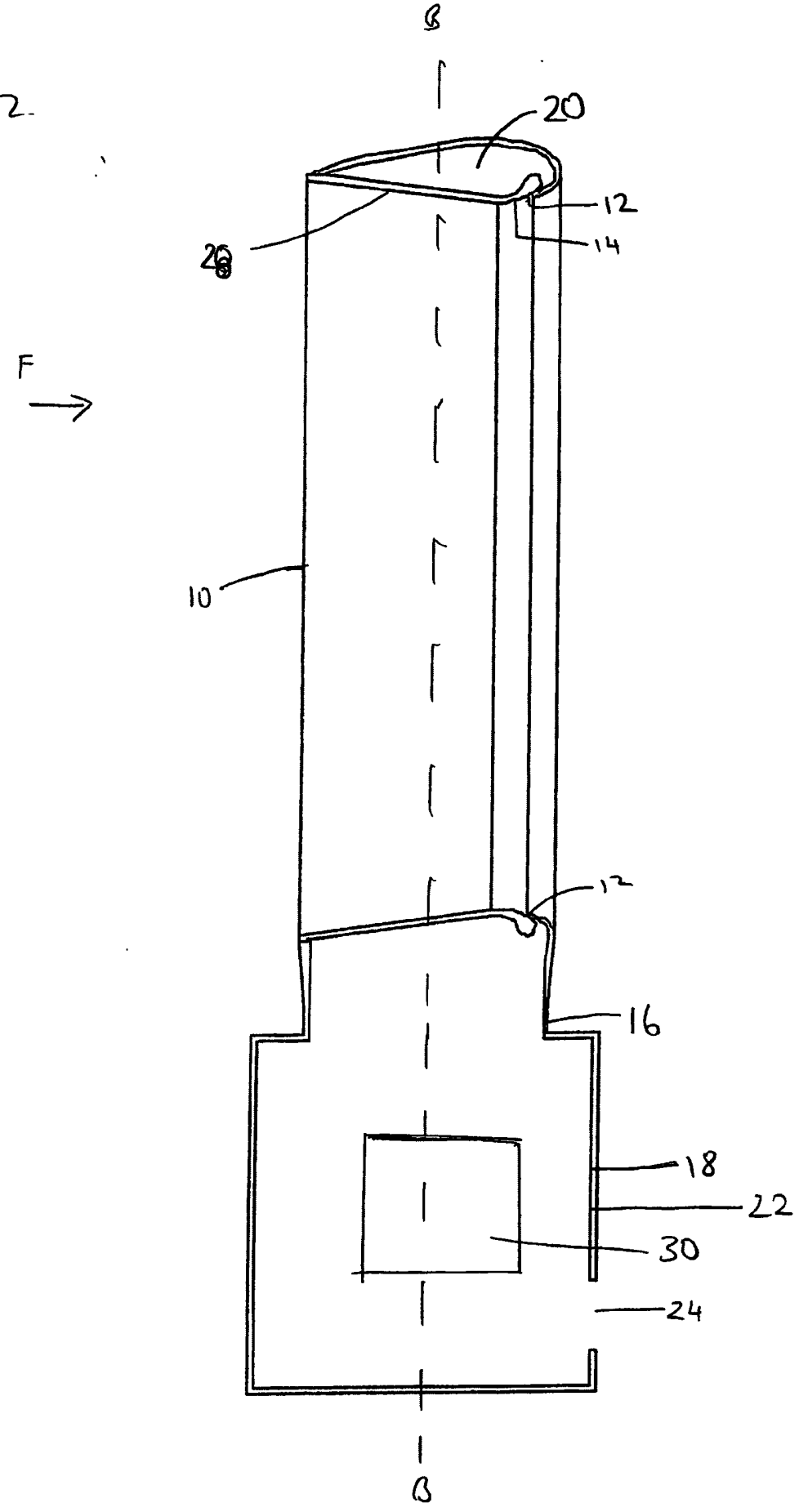


Fig 3

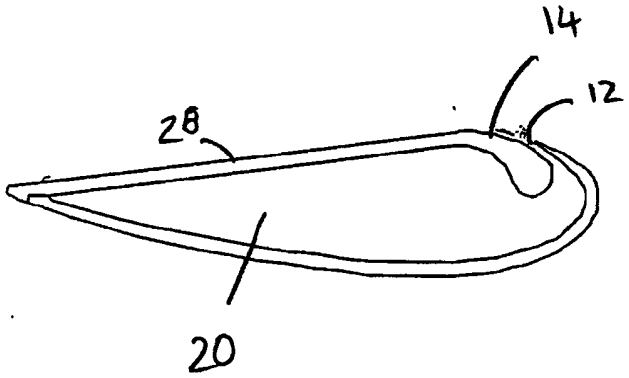
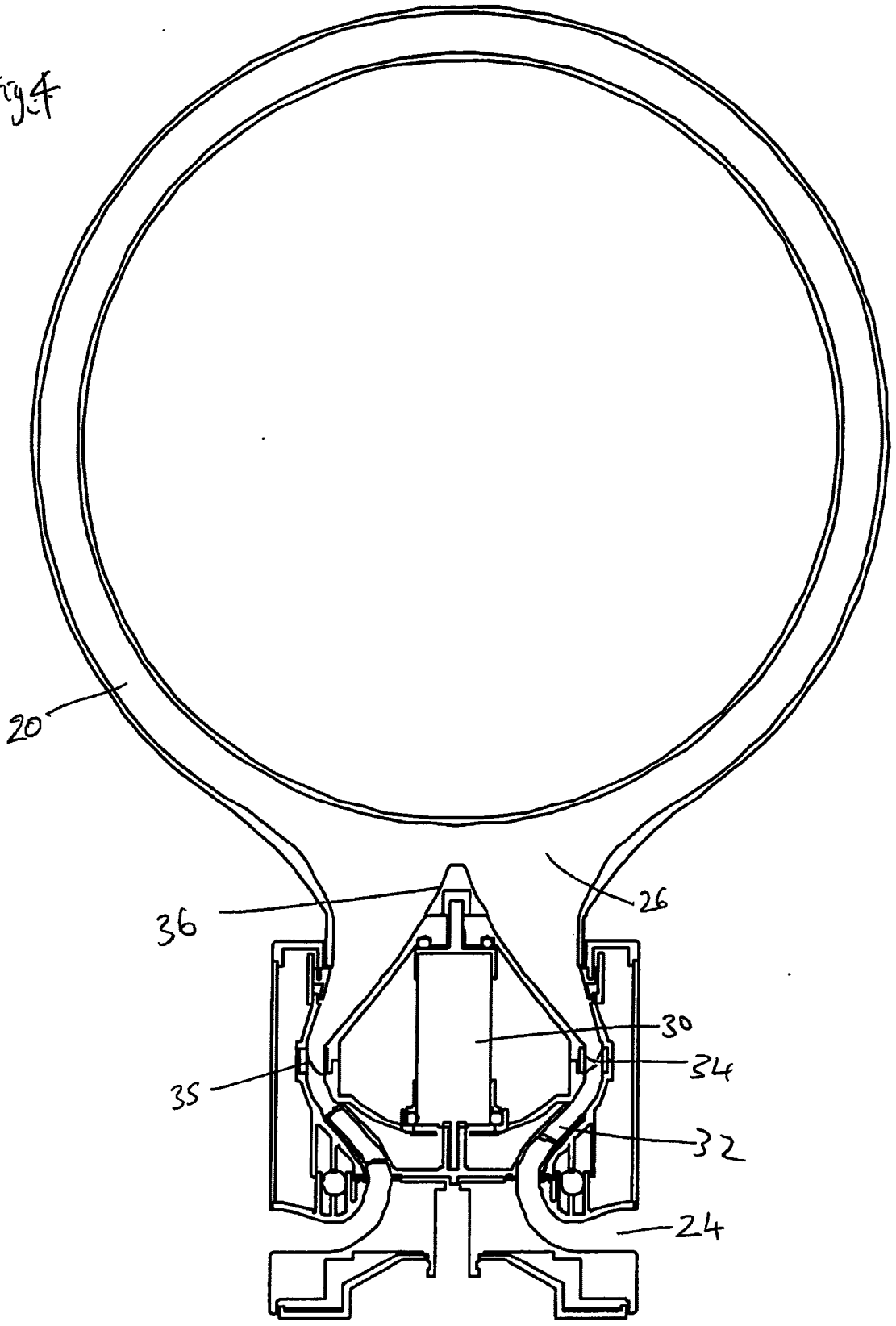


Fig.4



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An Appliance

The present invention relates to an appliance, in particular to a fan, for creating an air current comprising a nozzle and means suitable for creating an airflow through the nozzle, wherein the fan assembly is bladeless. Particularly, but not exclusively, the present invention relates to a fan, such as a desk fan, for use in an office or domestic environment.

A number of types of domestic fan are known. A standard fan comprises a single set of blades mounted about a first axis and a drive also mounted about the first axis for powering the single set of blades. Domestic fans are available in a variety of sizes and diameters, for example, a large ceiling fan can be at least 1 m in diameter and is positioned to provide a downward flow of air and cooling throughout a room. Also domestic fans can be freestanding, attached to the floor or mounted on a wall. Fans such as that disclosed in US Design 103476 are suitable for standing on a desk or a table and can provide a directed airflow or air current targeted close to a user. US 2620127 discloses a dual purpose fan suitable for use both mounted in a window or panel and as a portable desk fan.

In a domestic environment it is desirable for appliances to be as small and compact as possible. US 1767060 describes a desk fan with an oscillating function that aims to provide an air circulation equivalent to two or more prior art fans. In a domestic environment it is undesirable for parts to project from the appliance, or for the user to be able to touch any moving parts of the fan, such as the blades. US Design 103476 includes a shroud or cage around the blades. Other types of fan or circulator are described in US 2488467 and US 2433795. The fan of US 2433795 has spiral slots in a rotating shroud instead of fan blades.

Some of the above prior art arrangements have safety features such as a cage or shroud around the louvres or blades to protect a user from injuring themselves on the moving parts of the fan. However, caged blade parts can be difficult to clean and the movement of blades through air can be noisy and disruptive to a user in a home or office environment.

A disadvantage of certain prior art arrangements is that the airflow or circulation produced by the fan is not felt uniformly by the user due to variations across the blade surface or across the outward facing surface of the fan. Uneven airflow can be felt by a user as a series of pulses or blasts of air. A further disadvantage is that the cooling feeling created by the fan diminishes with distance from the user, this means the fan must be placed in close proximity to the user in order for the user to receive the benefit of the fan. However, locating such a fan close to a user is not always possible and locating certain types of known fan close to the user and work space has disadvantages.

Often personal fans or desk fans suitable for use in an office or home environment are dense, and have a bulky shape, with a cage and moving blades for example. This structure means that the fan occupies a significant amount of the user's space and work station area. In the particular case of a fan placed on a desk, or in another position close to the user's work within the working environment, the fan body takes up a significant amount of desk or user space reducing the area available for paperwork, PC or other office equipment. The shape of the fan on or above a desk not only reduces the working area available to a user but can block natural light (or light from artificial sources) from reaching the desk area. A well lit desk area is desirable for close work and for reading. In addition, a well lit area can reduce eye strain and the related health problems that may result after prolonged periods working in reduced light levels.

The present invention seeks to provide an improved fan assembly which obviates disadvantages of the prior art. It is an object of the present invention to provide a fan assembly which, in use, generates air flow at an even rate over the emission output area

of the fan. It is another object to provide an improved fan assembly whereby a user at a distance from the fan feels an improved airflow effect in comparison to prior art fans.

According to the invention, there is provided a fan assembly suitable for creating an air current, the fan comprising a nozzle and means suitable for creating an airflow through the nozzle, wherein the fan assembly is bladeless and the nozzle comprises an interior passage communicating with a mouth, the mouth being adjacent a surface and adapted and arranged in communication with the interior passage so as to direct airflow from the interior passage over the surface. The air flow can be described as having an approximately flat velocity profile across the diameter of the nozzle, the flow rate and profile can be described as plug flow with some regions having a laminar or partial laminar flow.

Advantageously, by this arrangement, an air current and a flow of cooling air is created without requiring a bladed fan i.e. airflow is created by a bladeless fan. This arrangement leads to lower noise emissions due to the absence of the sound of a fan blade moving through the air, and a reduction in moving parts and complexity.

Preferably, the surface is a convex surface, more preferably, the surface is a Coanda surface. A Coanda surface is a known type of surface over which fluid flow, exiting an output orifice close to the surface, exhibits the Coanda effect. The fluid tends to flow over the surface closely, almost 'clinging to' or 'hugging' the surface. A description of the features of a Coanda surface and the effect of liquid flow over a Coanda surface can be found in articles such as Reba, Scientific American, Volume 214, June 1963 pages 84 to 92. This arrangement creates a fan where the stream of air exiting through the mouth of the fan follows the profile of the surface. The air flow and the direction of the air flow at the nozzle exit causes entrainment of the air surrounding the nozzle mouth and acts as an air amplifier, drawing additional air flow through the fan opening than without the Coanda surface. The airflow emitted through the opening is increased by at least 15% in comparison to that of a prior art device, the invention provides a fan with

greater efficiency than prior art devices and a fan allowing more flexibility in the design and layout of the apparatus than with previous fans.

Preferably the nozzle comprises a circumferentially continuous plenum. A continuous plenum allows smooth, unimpeded fluid flow within the fan and reduces frictional losses and noise. In this arrangement the nozzle part can be manufactured as a single piece, reducing the complexity of the apparatus and thereby reducing manufacturing costs.

The shape of the nozzle is not constrained by the requirement to include space for a bladed fan. In a preferred embodiment the nozzle is annular. In a further preferred embodiment the mouth is circular. By providing a circular nozzle mouth and opening air flow can be emitted towards a user over a broad area. The air flow from the nozzle mouth and air entrained from around the mouth mix to provide a uniform cooling surface of air for the user. In an annular arrangement a central space is delimited by the circular fan shape. Advantageously, an illumination source in the room or at the desk fan location or natural light can reach the user through the central space.

In a further preferred embodiment the mouth is part circular. This arrangement can provide for a reduced airflow in certain situations or a direction to the airflow.

Preferably the nozzle is at least 10 cm in diameter, more preferably the nozzle is at least 25cm in diameter. This provides an outlet for emission of air over a broad area, suitable for cooling the upper body and face of a user when working at a desk, for example.

Preferably the nozzle has a length of at least 5 cm and preferably the nozzle surface comprises a diffuser surface. By this arrangement a Coanda surface is defined with the desired flow properties to guide fluid over the surface and provide a uniform or close to uniform air flow at the user. Preferably, the length of the diffuser is at least 66% of the nozzle length, preferably at least 50 mm. In a preferred arrangement the mouth opening is less than 5mm, more preferably 1mm. In the preferred arrangement the diffuser

surface lies in a plane at an angle of no more than 15 degrees from the horizontal, more preferably no more than 7 degrees from the axis. By this angular arrangement of the diffuser surface and the aerofoil-type shaping of the nozzle and surface the amplification properties of the nozzle and mouth shape are enhanced whilst minimising noise and frictional losses.

In the preferred fan arrangement the assembly includes a motor, an impeller and a duct communicating with the motor and the nozzle. This arrangement provides some design flexibility and freedom of arrangement of the fan in a user's working or home environment. More preferably the motor is a DC brushless motor, this arrangement reduces frictional losses from motor brushes and also reduces carbon debris from brushes in a traditional motor. Reducing carbon debris and emissions is advantageous in a clean or pollutant sensitive environment such as a hospital or around those with allergies.

Preferably the fan includes a rotatable part, allowing the fan to rotate or pivot about a base portion, or other portion, of the fan. This enables the fan to be directed towards or away from a user as required. In preferred embodiment the fan is desk mountable, in an alternative preferred arrangement the fan assembly may be floor, wall or ceiling mountable.

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

Figure 1 is a perspective and schematic view of the fan assembly according to the invention;

Figure 2 is a side sectional view through the fan assembly of Figure 1 at line A-A;

Figure 3 is an enlarged side sectional detail of the nozzle of the fan assembly of Figure 1; and

Figure 4 is a sectional view of the fan assembly according to the invention, taken along line B-B in Figure 2 and viewed from direction F of Figure 2.

A fan assembly according to the invention is shown in Figure 1. The fan assembly 1 of Figure 1 is shown comprising a nozzle 10, means suitable for creating airflow through the nozzle, the nozzle 10 comprising an interior passage 20 communicating with a mouth 12, the mouth 12 adjacent a surface 14 and adapted and arranged in communication with the interior passage 20 so as to direct airflow from the interior passage 20 over the surface 14. The fan is suitable for creating an air current in a room.

Referring firstly to Figures 1 and 2, the fan assembly 1 includes an annular nozzle 10 having an interior passage 20 and a mouth 12. The nozzle is supported by a neck portion 16 and a base 18. Base 18 includes a motor housing 22 having an air inlet 24 and motor means 30 capable of producing an airflow. The neck 16 and base 18 include hollow portions or passageways or ducts allowing fluid communication from the motor means 30 to the interior passage 20 of nozzle 10.

In the embodiment shown, and with reference to Figure 3 the nozzle 10 comprises a circumferentially continuous plenum. The diameter of the nozzle is 300mm. The shape of the nozzle 10 is annular and the mouth 12 is circular. The mouth comprises has a gap or spacing of 1mm between the lips or sides of the mouth or surfaces. The mouth 12 is adjacent a surface 14. The surface 14 is substantially convex and acts to assist the flow of air in the fan assembly.

The nozzle 10 further comprises a diffuser portion 28. The diffuser includes a surface to further assist the flow of air in the fan assembly. Diffuser surface 28 and overall nozzle profile are based on aerofoil shape, in the preferred embodiment the diffuser 28 should be two thirds the length of the overall nozzle, specifically 84mm when the length of the overall nozzle is 111mm. In the embodiment shown here the angle of the surface of the diffuser region is 7 degrees to the horizontal for maximum efficiency of airflow.

In the preferred embodiment, and as shown on Figure 4, a DC brushless motor 30 such as the motor available from Moog Components Group, Part number BN12-28AF-01LH is used to create an airflow through the nozzle. A mixed flow fan 32 is located upstream of the motor. A diffuser 34 comprising a fixed, stationary disc having spiral blades 35 is positioned downstream of the brushless motor 30. The spiral blades 35 of the diffuser 34 act to recover some pressure from the motor 30. A secondary diffuser 36 is located downstream of the motor and acts to recover some of the static pressure lost in the motor housing and through the motor 30. The secondary diffuser 36 is cone shaped and acts to guide the air flow exiting the motor 30. The diffuser 36 has a gradually changing cross section to act to reduce the pressure loss experienced by the airflow on entering the neck of the nozzle 10 and the interior passage 20 and chamber from the motor exhaust.

With reference to Figure 4 the operation of the fan will be described. The fan assembly includes a flow passage having an inlet 24 and a flow passage outlet 26. Air flow directed into the flow passage and the interior passage 20 flows into the annular nozzle 10 and is constricted through the mouth 12. The band of air obeys and flows and adheres by the Coanda effect such that it follows the profile of the convex surface 14 and the diffuser 28. The resultant flow of air creates a low pressure area at the inlet 24 and the result is the inducing of a high flow of air through in the interior passage 20 of the nozzle 10 and out of the mouth 12. The high flow rate causes entrainment of air from the region around the mouth 12 and the nozzle 10 resulting in amplification of the wind and air emitted from the fan as compared to air flow from a fan without the convex, or other, surface adjacent the emitting mouth 12.

The invention is not limited to the detailed description given above. Variations will be apparent to the person skilled in the art. For example, the fan could be of a different height or diameter, the fan need not be located on a desk, but could be free standing, wall mounted or ceiling mounted. The fan shape could be adapted to suit any kind of situation or location where a cooling flow of air is desired. A portable fan could have a

smaller nozzle, say 5cm in diameter. The means for creating an airflow through the nozzle can be a motor or other air emitting device, such as an air blower or vacuum source. The mouth opening may be modified to maximise air flow, the mouth may have a spacing from 0.5mm up to 3mm wide.

Other shapes or fan construction could be envisaged such as a nozzle comprising an oval, or 'racetrack' shape, a single strip or line or block shape could be used. The fan assembly provides access to the central part of the fan as there are no blades, this means additional features such as lighting or a clock or LCD display could be provided in the central portion, or elsewhere, on the fan.

Other features could include a pivotable or tiltable base on the fan assembly for ease of movement and adjustment of the position of the fan for the user.

CLAIMS

1. A fan assembly suitable for creating an air current comprising a nozzle and means suitable for creating an airflow through the nozzle, wherein

the fan assembly is bladeless; and

the nozzle comprises an interior passage communicating with a mouth, the mouth being adjacent a surface and adapted and arranged in communication with the interior passage so as to direct airflow from the interior passage over the surface

2. A fan assembly as claimed in claim 1, wherein the surface is a convex surface.

3. A fan assembly as claimed in claim 1 or claim 2, wherein the surface is convex.

4. A fan assembly as claimed in any of claims 1, 2 or 3, wherein the nozzle comprises a circumferentially continuous plenum.

5. A fan assembly as claimed in any preceding claim, wherein the nozzle is annular.

6 A fan assembly as claimed in any preceding claim, wherein the mouth is circular.

7. A fan assembly as claimed in any one of claims 1 to 5 wherein the mouth is part circular.

8. A fan assembly as claimed in any preceding claim, wherein the nozzle is at least 10 cm in diameter.

9. A fan assembly as claimed in any preceding claim, wherein the nozzle is at least 25 cm in diameter

10. A fan assembly as claimed in any preceding claim, wherein the nozzle has a length of at least 5cm.

11. A fan assembly as claimed in any preceding claim, wherein the nozzle surface comprises a diffuser.

12. A fan assembly as claimed in claim 11, wherein the length of the diffuser is at least 2/3 or 66% of the length of the nozzle.

13. A fan assembly as claimed in claim 12, wherein the length of the diffuser is least 50mm.

14. A fan assembly as claimed in any preceding claim, wherein the mouth opening is less than 5 mm.

15. A fan assembly as claimed in any preceding claim, wherein the mouth opening is 1 mm.

16. A fan assembly as claimed in any preceding claim, wherein the diffuser surface lies in a plane arranged at an angle of no more than 15 degrees from the horizontal axis.

17. A fan assembly as claimed in any preceding claim, wherein the diffuser surface lies in a plane arranged at an angle of no more than 7 degrees from the horizontal axis.

18. A fan assembly as claimed in any preceding claim wherein the means suitable for creating an airflow through the nozzle comprises a motor and an impeller and the assembly further comprises a duct communicating with the motor and the nozzle.

19. A fan assembly as claimed in claim 18, wherein the motor is a DC brushless motor having a mixed flow impeller.

20. A fan assembly as claimed in any preceding claim, wherein the assembly includes a rotatable part.

21. A fan assembly as claimed in claim 19, wherein the assembly is rotatable about a base portion.

22. A fan assembly as claimed in any preceding claim, wherein the fan assembly is desk mountable.

23. A fan assembly as claimed in any of claims 1 to 21, wherein the fan assembly is floor mountable.

24. A fan assembly as claimed in any of claims 1 to 21, wherein the fan assembly is wall mountable.

25. A fan assembly as claimed in any of claims 1 to 21, wherein the fan assembly is arranged to hang from a ceiling.

26. A fan assembly as claimed in any preceding claim, the fan assembly further including lighting means.

27. A fan assembly substantially as hereinbefore described with reference to the accompanying drawings.

Application No: GB0717155.6 **Examiner:** Mark Boylin

Claims searched: 1 to 27 **Date of search:** 19 December 2007

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, 4-6, 18, 22 and 23 at least	JP 56167897 A Tokyo Shibaura Electric - Abstract and figures
A	-	US 6123618 A Jetfan Australia
A	-	GB 1501473 A Carbonnages
A	-	GB 2242935 A S & C Thermofluids
A	-	GB 2236804 A Robins

Categories:

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

Field of Search:

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

F1E

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

F04D; F04F

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

EPODOC, OPTICS, TXTE, WPI

International Classification:

Subclass	Subgroup	Valid From
F04D	0025/08	01/01/2006

Subclass	Subgroup	Valid From
F04F	0005/00	01/01/2006