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(54) ROTOR VENTILATOR

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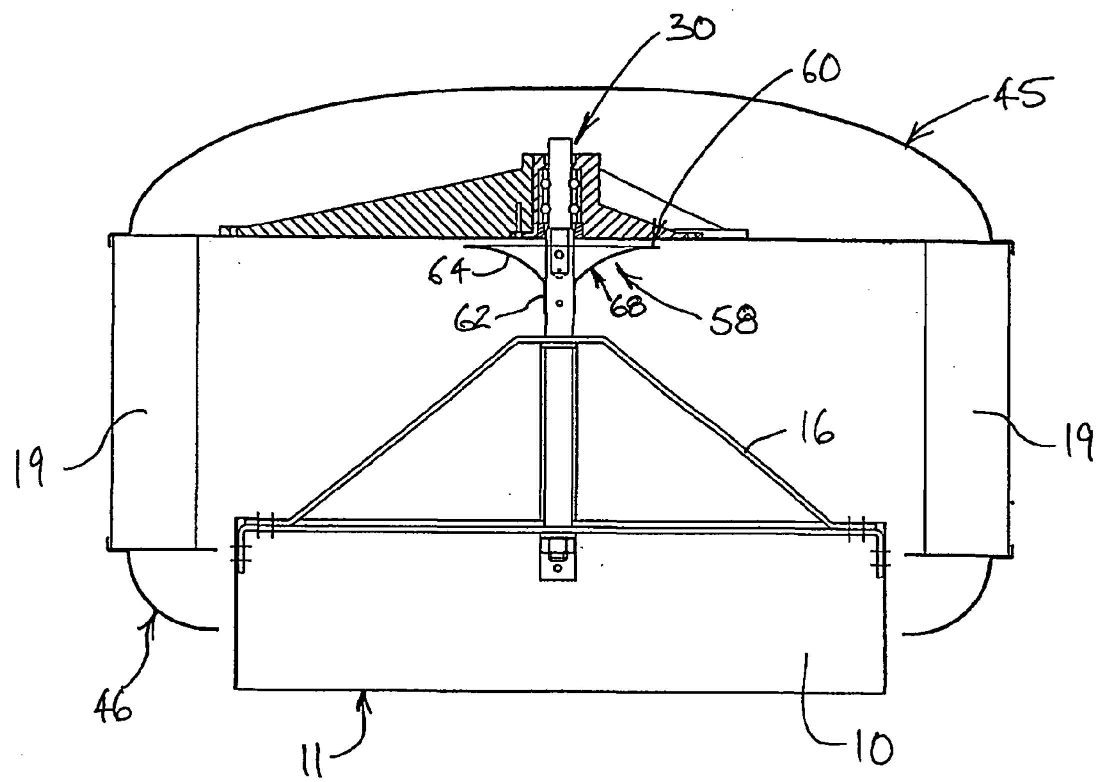
(57) **ABSTRACT**

A rotor ventilator which includes a base to which a shaft is connected to extend upwardly therefrom and a rotor. The rotor is rotatable about the shaft and includes a plate and a plurality of vanes (**19**) extending therefrom. Also included is a bearing means (**30**) for supporting the rotor on the shaft. The bearing means can be a double race assembly and is located at the plate, above the centre of gravity of the rotor. A deflector (**58**) can be located between the base and the plate to deflect gas away from the bearing means.



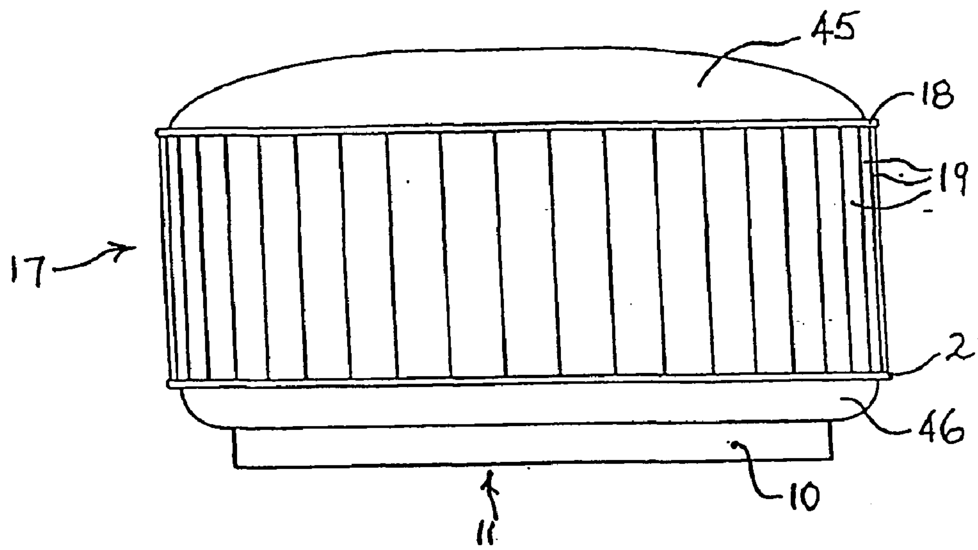


Fig. 1

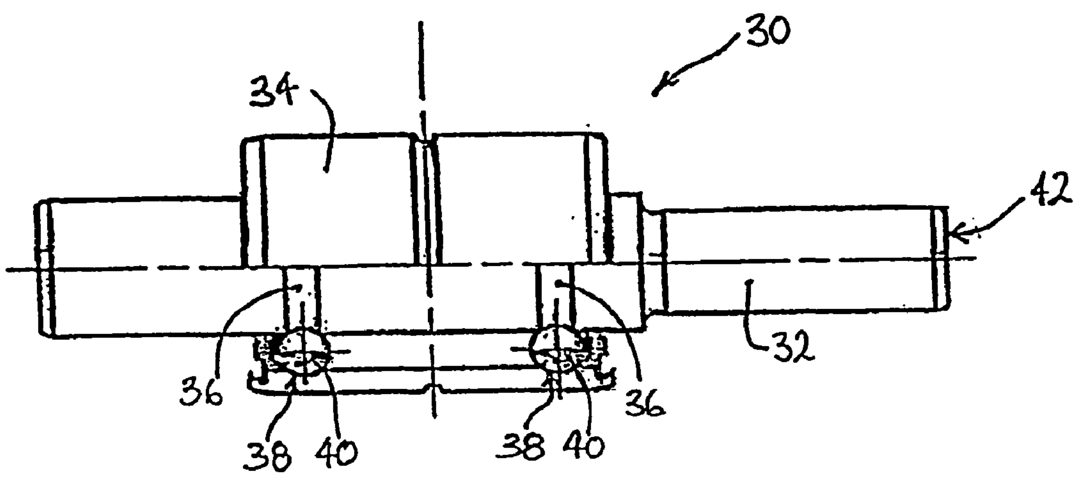


Fig. 6

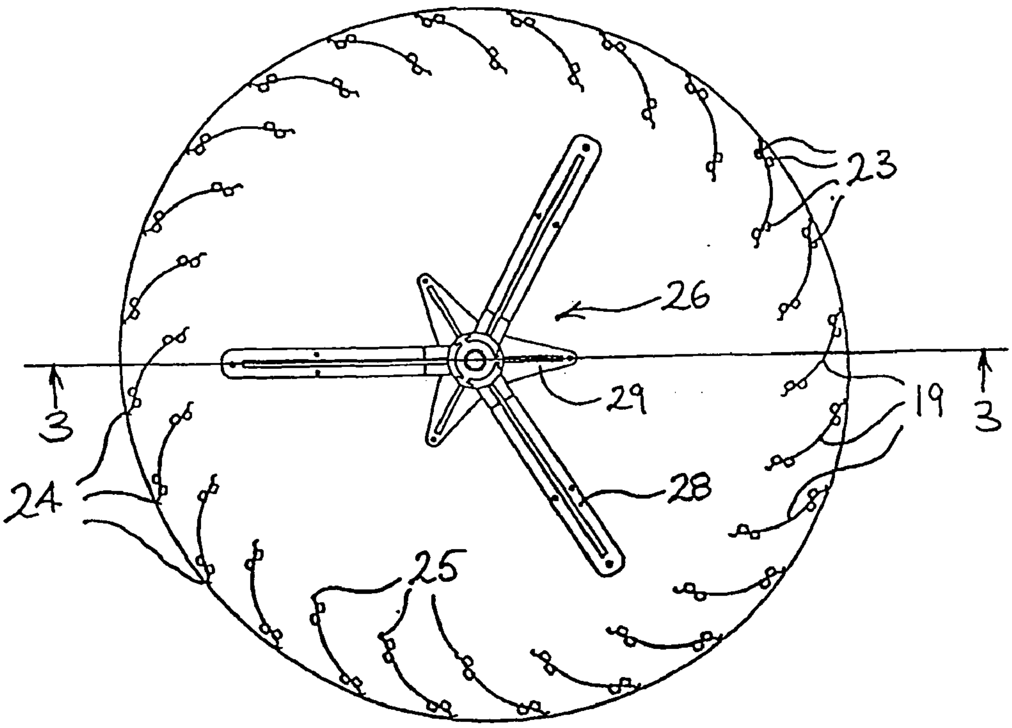

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Fig. 2

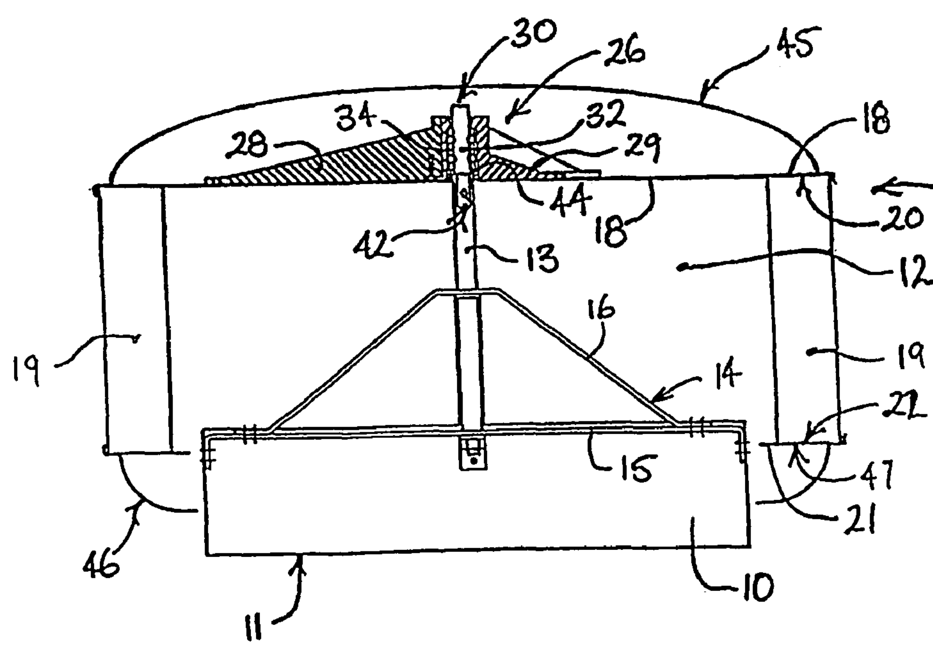
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Fig. 3

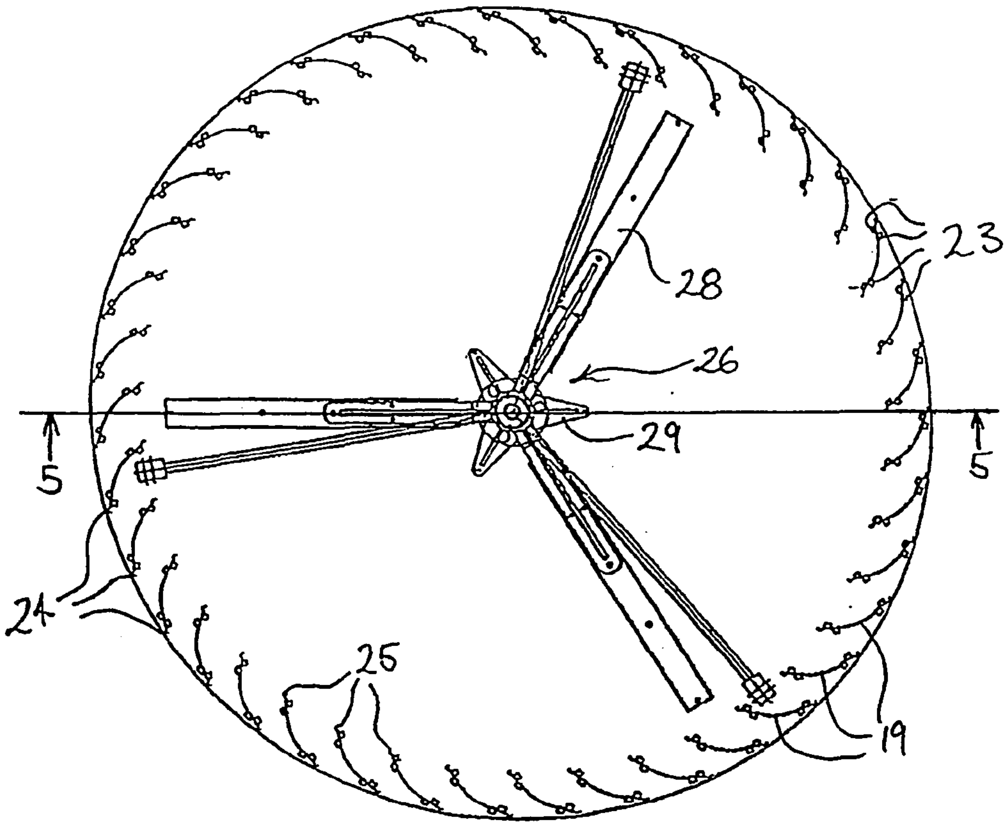

Fig. 4

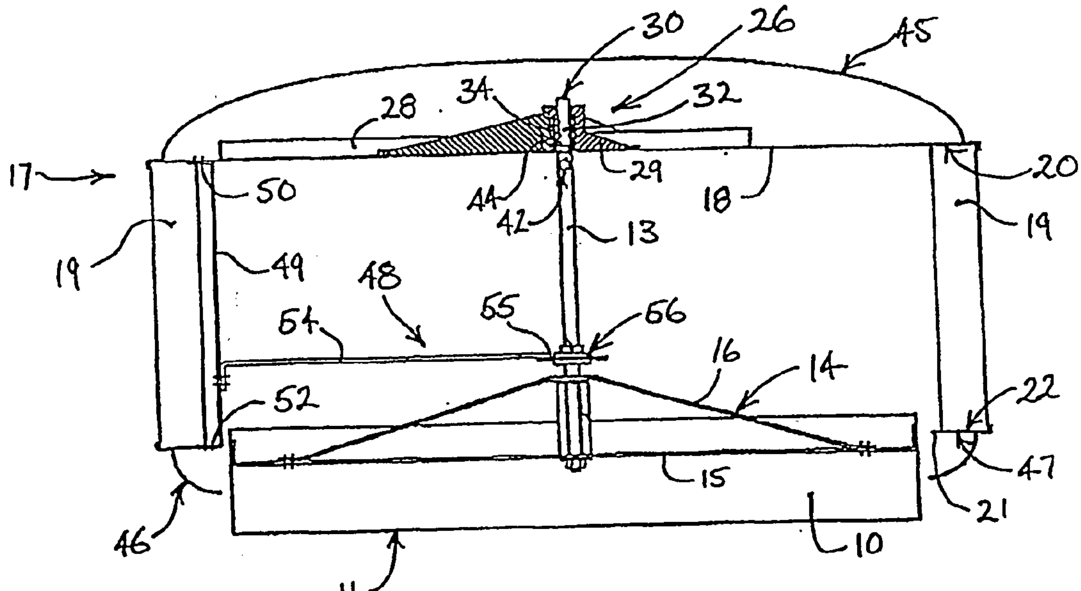
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Fig. 5

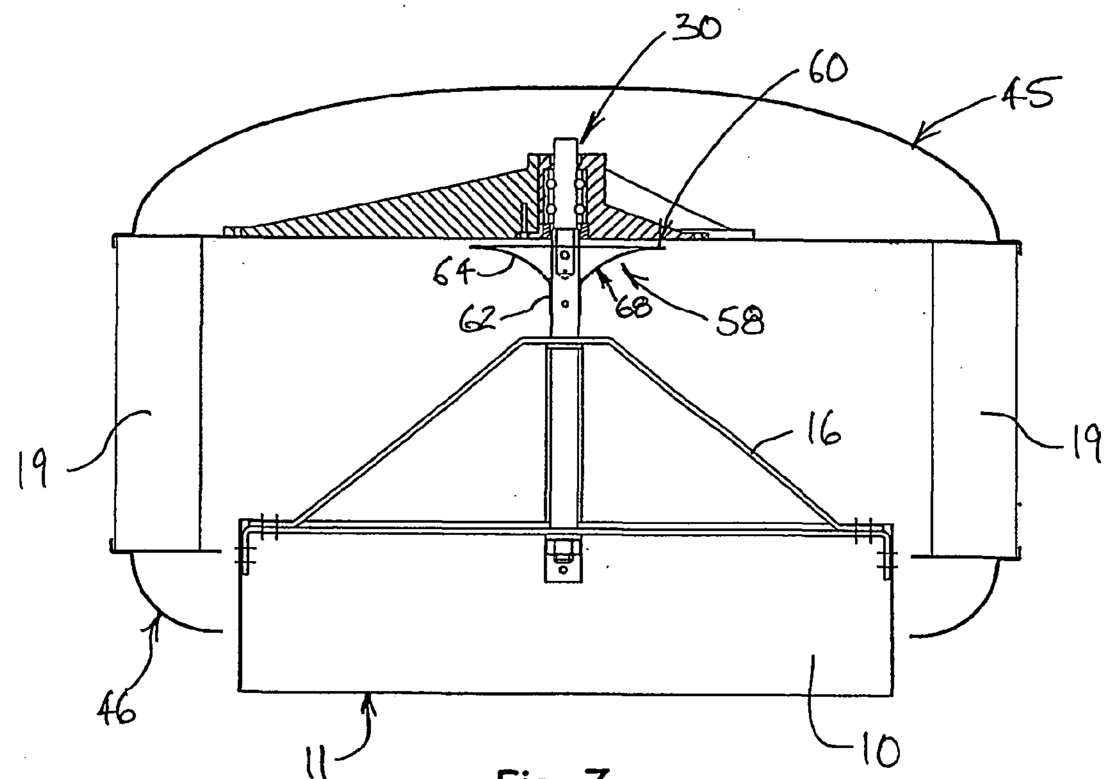

Fig. 7

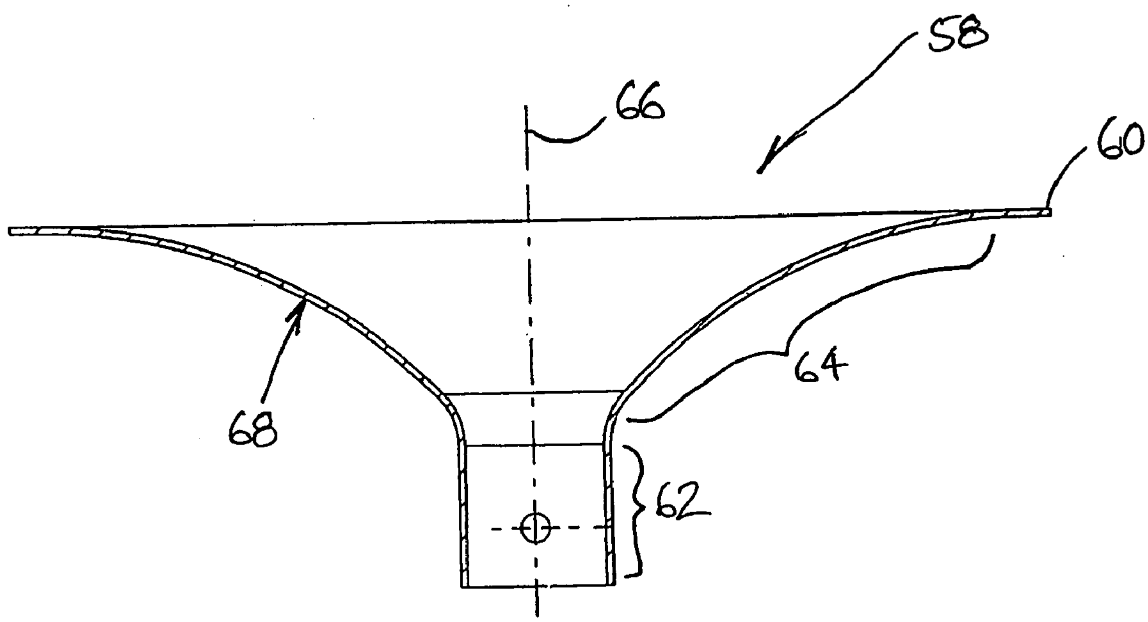

Fig. 8

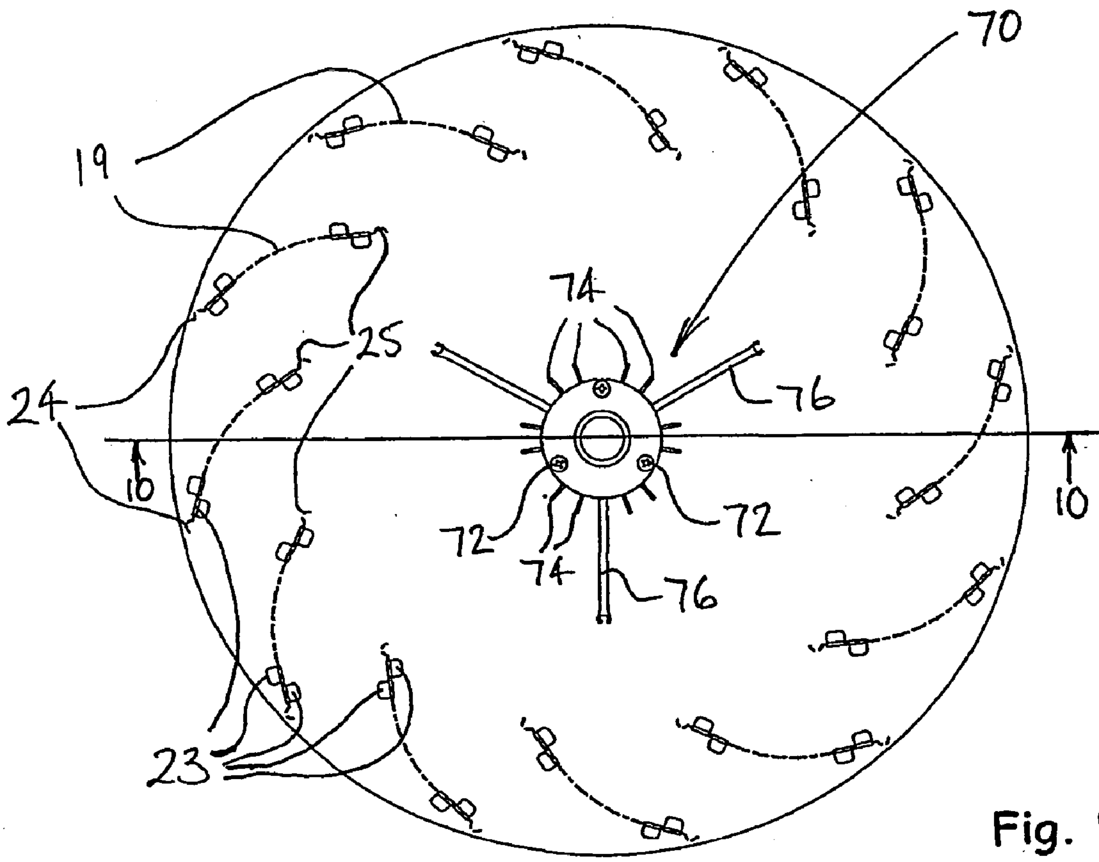

Fig. 9

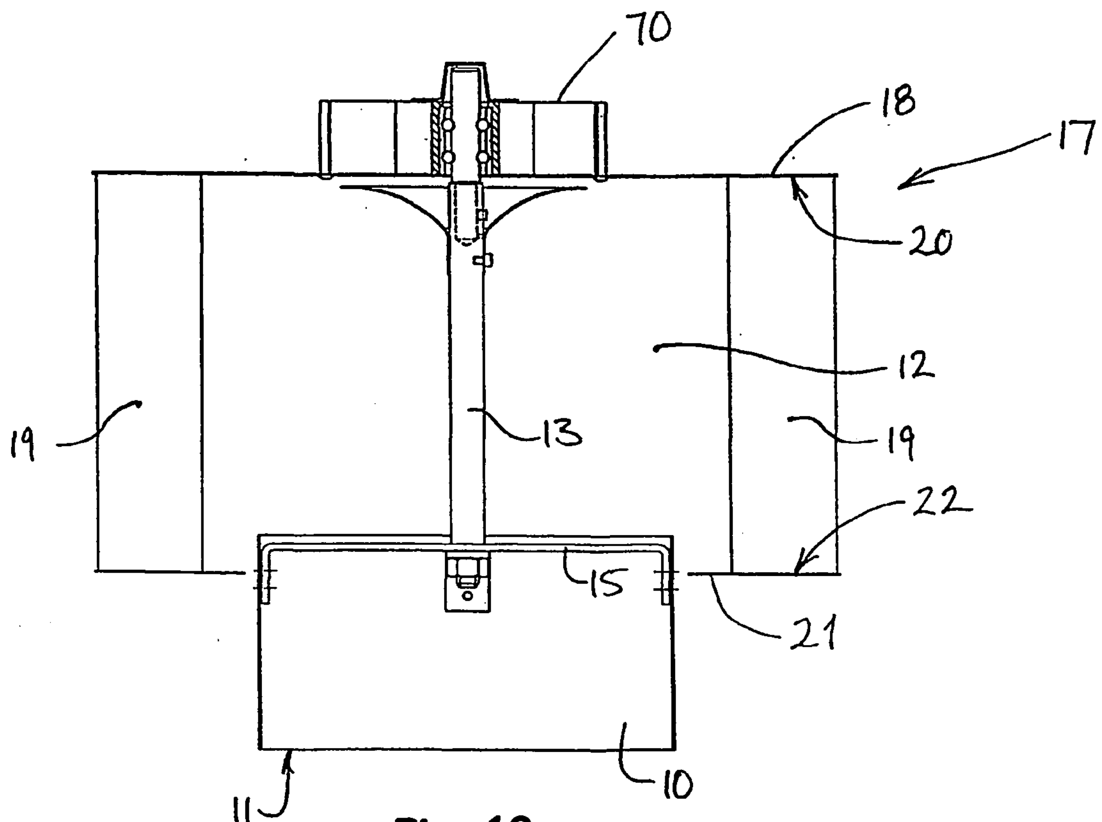

Fig. 10

ROTOR VENTILATOR

FIELD OF THE INVENTION

[0001] The present invention relates to ventilators and in particular to roof-top rotor ventilators.

[0002] The invention has been developed primarily for use as a roof-top rotor ventilator and will be described hereinafter with reference to this application. However, it will be appreciated that the invention is not limited to this particular field of use.

DESCRIPTION OF THE PRIOR ART

[0003] Roof-top rotor exhaust ventilators are utilised to aid in the removal of exhaust air from the building upon which they are employed. Such buildings may include factories, farm sheds or domestic houses.

[0004] The principle behind the roof-top rotor ventilator is that air movement passing the ventilator will cause the ventilator to rotate about its vertical axis. This movement causes the vanes of the ventilator to force air out from within the ventilator, causing the air pressure within the ventilator to be lower than the air pressure within the building in fluid communication with the ventilator. Air within the building is then be moved through the ventilator to be exhausted to the outside of the building.

[0005] The efficiency of a roof top rotor ventilator relies on several factors, though importantly: the initial torque required to rotate the ventilator; the amount of friction resisting the ventilator's rotation; and the vane configuration.

SUMMARY OF THE INVENTION

[0006] In the description and the claims, when the terms "upper", "above" and "lower" are used with respect to the rotor ventilator they refer to a typical in-use orientation of the rotor ventilator, but if the rotor ventilator was used in a sideways, angled or upside down configuration, their orientations may be changed or reversed. Hence, "upper", "above" and "lower" are to be interpreted broadly in this context, and as relative terms.

[0007] According to one aspect of the present invention there is provided a rotor ventilator including:

[0008] a base to which a shaft is connected to extend upwardly therefrom;

[0009] a rotor including a plate and a plurality of vanes extending downwardly therefrom, the rotor being rotatable about the shaft;

[0010] bearing means for rotatably supporting the rotor on the shaft; and

[0011] a deflector located with respect to the shaft and between the base and the plate to deflect gas passing through the rotor ventilator-away from-the bearing means.

[0012] Advantageously, the deflector aids in increasing the working life of the bearing means, by reducing the amount of gas passing through the rotor ventilator from coming into contact with the bearing means. This is particularly advantageous where the gas is either high temperature (eg. >100° C.) or corrosive.

[0013] Preferably, the deflector is located on the shaft adjacent the plate. Preferably, the deflector is coupled about the shaft and includes a flared portion being flared outwardly from a longitudinal axis of the shaft and toward the plate. The flared portion may be concave on a side of the deflector which faces the base. Preferably, the deflector is symmetrical about the longitudinal axis.

[0014] The bearing means may be located on an opposite side of the plate to the deflector.

[0015] Preferably, a heat sink is located about the bearing means. Advantageously, the heat sink aids in increasing the working life of the bearing means by reducing the heat in the bearing means. The heat sink may include at least one heat diffusing fin extending radially with respect to the axis of the shaft.

[0016] According to another aspect of the present invention there is provided a rotor ventilator including:

[0017] a base to which a shaft is connected to extend upwardly therefrom;

[0018] a rotor including a plate and a plurality of vanes extending downwardly therefrom, the rotor being rotatable about the shaft; and

[0019] a double race rotatable bearing assembly for supporting the rotor on the shaft and located at the plate.

[0020] Preferably, the rotatable bearing assembly includes:

[0021] a bearing including a central bore and two internal axially spaced bearing races;

[0022] a central shaft extending longitudinally through the bore, with a space being defined between the bearing and the shaft, the shaft including two external axially spaced bearing races, with the shaft races being aligned with the races on the bearing;

[0023] a plurality of ball bearings captively engaged between respective aligned races; and

[0024] a low friction seal located at one end of the bearing and projecting radially inwards towards the shaft.

[0025] Preferably, the bearing assembly is located above the plate.

[0026] Preferably, a second radially inwardly projecting seal is located at another end of the bearing.

[0027] Preferably, a support means is rotatably mounted at one end to the shaft and mounted at another end to the rotor. The one end of the support means may include a bearing unit for rotatable mounting on the shaft, and may be intermediate the plate and base.

[0028] Preferably, an end of each vane is mounted to the plate-by tab fastening means including at least one tab projection for receipt in a corresponding slot in the plate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] Preferred embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

[0030] **FIG. 1** is a side elevation of a first preferred embodiment of a rotor ventilator according to the present invention;

[0031] **FIG. 2** is a plan view of the rotor ventilator of **FIG. 1** with the dome removed;

[0032] **FIG. 3** is a cross-sectional side elevation of the rotor ventilator of **FIG. 1**, taken on line **3-3**;

[0033] **FIG. 4** is a plan view of an alternate embodiment of a rotor ventilator with the dome removed;

[0034] **FIG. 5** is a sectional side elevation of the rotor ventilator of **FIG. 4**, taken on line **5-5**;

[0035] **FIG. 6** is a part sectional side elevation of a bearing for use with the present invention;

[0036] **FIG. 7** is the cross-sectional side elevation of the rotor ventilator of **FIG. 3**, including a deflector;

[0037] **FIG. 8** is a cross-sectional side elevation of the deflector illustrated in **FIG. 7**;

[0038] **FIG. 9** is a plan view of the rotor ventilator of **FIG. 1** with the dome removed, and including a heat sink; and

[0039] **FIG. 10** is a cross-sectional side elevation of the rotor ventilator illustrated in **FIG. 9**, taken on line **10-10**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0040] Referring to the drawings, where like reference numerals are used to denote similar or like parts, FIGS. **1** to **3** and **6** show a preferred embodiment of a rotor ventilator according to the invention including a base in the form of a hollow cylindrical base element **10** for mounting on a roof, wall, ceiling, floor, etc. The base element **10** allows gas to pass through its opening **11** and into the interior **12** of the rotor ventilator. The type of gas to pass through the ventilator is typically hot air, but may also be corrosive exhaust gases. A shaft **13** is connected to extend upwardly therefrom. A bracket **14** is typically employed for added transverse stability of the shaft and to mount the shaft to the base element **10**. The bracket **14** includes lower frame brace **15** and upper frame brace **16**. Each frame brace **15** and **16** is configured to ensure air flow through the base element **10** into the rotor ventilator interior **12** is not substantially impeded.

[0041] Also included is a rotor **17** which is rotatable about the shaft **13**. The rotor **17** which has a plate **18** and a plurality of vanes **19** extending downwardly therefrom. An end **20** of each vane **19** is mounted to the plate **18**. For added stability of the vanes when the rotor **17** is rotating, the rotor ventilator can also include a second plate in the form of an annulus **21** mounted to the other ends **22** of the vanes.

[0042] For mounting the vanes **19** between the plate **18** and annulus **21**, each end **20** and **22** of each vane **19** has four projecting tabs **23**, though in alternative embodiments each end **20** and **22** may have different numbers of tabs **23**. When the vanes **19** are manufactured, the tabs **23** are in planar alignment with their respective vanes **19**. These projecting tabs **23** are then employed to mount an end **20** and **20** of each vane to the plate **18** and annulus **21** respectively. To achieve the mounting, the plate **18** and annulus **21** have slots which correspond to the projecting tabs **23**. To mount the ends **20** of the vanes **19** to the plate **18**, the tabs **23** are passed through their corresponding slots on the plate **18** and then folded laterally onto the plate to be in the mounted position seen in **FIGS. 2 and 4**. This secures the end **20** of the vane **19** to the plate **18**. Similarly, to secure the ends **22** of the vanes **19** to the annulus **21**, projecting tabs **23** on the end **22** are passed through corresponding perforations on the annulus **21** and are then folded over on the annulus in a similar fashion to the folding of tabs **23** on the end **20**. This secures the end **22** of the vanes **19** to the annulus **21**.

[0043] This method of mounting the vanes to the plate **18** and annulus **21** requires no additional fastening means, such as rivets or screws, to mount the vanes **19** to the plate **18** and annulus **21**. This has the advantages of reducing the overall weight of the rotor and reducing manufacturing time and cost for manufacturing rotor ventilators.

[0044] As external air moves past the vanes **19** of the rotor, the leading edge **24** of each of the vanes **19** will catch the passing air, causing the rotor to rotate. In the case of the embodiments of the invention shown in FIGS. **1** to **5**, the rotor would be caused to rotate in a clockwise direction, when viewed from above, by air movement past the rotor ventilator. The movement of the vanes **19** through the surrounding air causes the gas within the rotor ventilator to be exhausted therefrom. This is achieved by trailing edge **25** cutting through the gas present in the interior **12** of the rotor ventilator, and forcing this gas out from the rotor ventilator between the vanes **19**. This reduces the gas pressure in the interior **12** of the rotor ventilator. Thus higher pressure gas is drawn up into the ventilator through the opening **11** of the base element **10** and subsequently exhausted from the rotor ventilator.

[0045] The rotor ventilator also includes bearing means in the form of a support structure **26** for supporting the rotation of the rotor **17** on the shaft **13**. The support structure **26** is typically mounted on top of the plate **18**, to place the bearing point of the rotor **17** on the shaft **13** well above the centre of gravity of the rotor **17**, while still keeping the support structure **26** in the rotor ventilator.

[0046] There are several advantages of having the support structure **26** on top of the plate **18**. The position of the support structure **26** above the plate **18** means that the centre of gravity of the rotor **17** is well below the bearing point of the support structure **26** on the shaft **13**. Therefore, the rotor basically hangs from the support structure. This allows for greater stability of the rotor ventilator in use because the rotor will have reduced transverse movement which would otherwise occur if the bearing point was below the centre of gravity. If the bearing point was below the centre of gravity, the rotor would overbalance, causing lateral stress on the bearing point. It then follows that in turn there is less working stress upon the support structure.

[0047] Another advantage of having the support structure **26** on top of the plate **18** is when the rotor ventilator is used to exhaust corrosive and/or high temperature (ie over 100° C.) gases. Since the support structure **26** is above the plate

18, the support structure will not come into contact with the exhaust gases, since they are exhausted below the plate **18**, via the vanes **19**.

[**0048**] In alternate embodiments, the support structure is located in such a position to ensure the centre of gravity of the rotor **17** is below the support structure **26**.

[**0049**] The support structure includes a fixture **27** for secure mounting to the plate **18**. In the embodiment shown in **FIGS. 2 and 3**, the fixture **27** has three relatively long radially spaced support arms **28** and three relatively short radially spaced support arms **29**. These arms **28** and **29** are used to stably secure the support structure to the plate **18**. The arms are typically riveted to the plate **18**, but may be welded or screw fastened, for example.

[**0050**] The support structure **26** also includes a bearing assembly in the form of a double race ball bearing unit **30**. As seen in **FIG. 6**, the double race ball bearing unit **30** includes a central shaft **32**, and an outer casing **34** which rotates on the central shaft **32**. The central shaft **32** and outer casing **34** have corresponding ball bearing races **36** and **38** between which are tracked a plurality of ball bearings **40** to support the configuration.

[**0051**] The double race ball bearing unit **30** is securely centrally located within the fixture **27**, such that the central shaft **32** is in axial alignment with the central axis of the plate **18**. When the double race ball bearing unit is secured within the fixture **27**, the outer casing is fixed relative to the fixture **27**, while the central shaft **32** is free to rotate with respect to the outer casing **34**.

[**0052**] To allow the rotational mounting of the rotor **17** about the shaft **13**, an end **42** of the central shaft **32** is mounted to an end **44** of the shaft **13** such that shafts **13** and **32** are coaxially aligned and fixed together.

[**0053**] The rotor ventilator typically includes a dome **45** placed on top of the rotor ventilator to both cover the support structure **26** and reduce resistance to air movement about and around the rotor ventilator. Also typically, a skirt **46** is mounted to the lower side **47** of the annulus **21** to also aid in reducing resistance of air movement around the rotor ventilator.

[**0054**] The above embodiment of the rotor ventilator was described with respect to rotor ventilators having a diameter of approximately 700 mm and a height of approximately 460 mm. For ventilators of this size and smaller, the double race ball bearing unit **30** is generally all that is required to maintain transverse stability of the rotor **17** in use. Only having to provide a rotor ventilator with one bearing unit provides significant advantages for ease of-manufacture and reduced costs of manufacture of rotor ventilators of this size, given that only a single bearing unit is required to allow the rotor to efficiently and stably rotate.

[**0055**] Furthermore, the double race ball bearing unit **30** for use in the invention is unknown for the provision of reduced friction rotational bearing for rotor ventilators. Double race ball bearing units of the type employed in the invention were developed for use in wet environments in motors and the like and therefore employ the use of high friction seals to ensure no water, etc has access to the ball bearings and bearing races. A non-inventive person skilled in the relevant art would therefore not consider the use of such a double race ball bearing unit in a rotor ventilator application such as the rotor ventilator of the present invention.

[**0056**] The inventors have surprisingly found that by replacing the high friction seals with low friction, non/low contact seals, the double race bearing unit **30** becomes suitable for use as the ball bearing unit in rotor ventilators and provides several advantages in comparison with single race ball bearing units.

[**0057**] One example of an advantage in using a double race ball bearing unit is that double race ball bearing units are more laterally stable and stronger than single race ball bearing units. Therefore, in the case of the embodiment of the smaller rotor ventilator illustrated in **FIG. 3**, one double race ball bearing unit is all that is required to maintain sufficient lateral stability of the rotor **17**. This would not be sufficiently achieved with one single race ball bearing unit. Another example is that the increased stability and strength of the double race ball bearing unit **30** means it is possible to position the ball bearing unit **30** above the plate **18** and still maintain sufficient lateral stability in certain conditions.

[**0058**] Referring now to **FIGS. 4 and 5**, where like reference numerals are used to denote similar or like parts, another embodiment of the rotor ventilator is shown that is relatively larger than the rotor ventilator described above. An additional support means in the form of an intermediate bearing **48** is employed to improve transverse stability of the larger rotor in use. The intermediate bearing **48** includes a structural member **49**, which has ends **50** and **52**. End **50** is mounted to the plate **18**, while end **52** is mounted to the annulus **21**. A structural arm **54** extends laterally from the structural member **49** toward the shaft **13**. The end **55** of arm **54** is connected to a spider bearing **56** which is rotationally mounted to the shaft **13**.

[**0059**] **FIG. 7** illustrates a deflector **58** in use in a rotor ventilator. The deflector **58** is located on the shaft, between the plate **18** and the base **10**. The deflector is immediately adjacent the plate **18**, being as close as possible to the plate **18**, with enough clearance such that its upper edge **60** does not come into contact with the plate **18** when in use. The deflector includes a narrow portion **62** coupled to the shaft **13**, and a flared portion **64** being flared outwardly from a longitudinal axis of the shaft **13** and toward the plate **18**. As is evident in **FIG. 8**, the flared portion **64** is symmetrical about its axis **66**, and concave on its side **68** which faces the base **10**.

[**0060**] As will be apparent to the skilled addressee, the deflector **58** advantageously deflects gas entering the interior **12** of the ventilator toward the vanes **19** and away from the bearing unit **30**. This is particularly useful when the exhaust gas is of the kind that can affect the bearing unit **30**, and the bearing unit greases. For example, high humidity exhaust gases can detrimentally affect clay based bearing greases by solidifying them, while high temperature exhaust gases of 100° C. or more may reduce viscosity of the bearing grease, such that it flows out of the bearing unit **30**.

[**0061**] Also, conventional rotor ventilators are typically configured to withstand normal exhaust gas temperatures of 60-70° C. High temperature exhaust gases of 100° C. or greater can detrimentally affect known rotor ventilators severely affecting their working life. However, with the configuration of the rotor ventilator of the present invention including the deflector **58**, the resultant ventilator can withstand such higher temperatures for even greater working times when compared with conventional rotor ventilators.

[**0062**] Different materials may also be used in construction of various components of the rotor ventilator for different exhaust environments. For example, in high temperature environments, the deflector and other components, such as the shaft **13**, are typically constructed from aluminium, since aluminium has been found to reflect radiation and also acts as a heat sink, thereby minimising the effects of radiation. The aluminium components may also be powder coated to reduce the formation of an oxide layer on the components. For corrosive exhaust environments, the deflector **58** and other components are typically constructed from stainless steel. However, stainless steel can also be used for the shaft in high temperature environments because it minimises heat conduction to the plate **18** and thus to the bearing assembly. In lower heat, but high corrosion environments, the bearing housing and some other components may also be formed from a polymer (ie. that has no tendency to corrode).. Ceramic and glass may also be used for some components.

[**0063**] In high temperature environments, the rotor ventilator may also employ the use of a heat sink in the form of a bearing jacket **70**, as illustrated in **FIGS. 9 and 10**. The bearing jacket **70** is coupled to the plate **18** by screws **72**, and located about the bearing unit **30**. As will be apparent to the skilled addressee, in this configuration of the invention, the dome **45** is removed in use to expose the bearing jacket **72** to its surrounding environment. Therefore, when for example the ventilator is attached externally to a roof, the bearing jacket **72** is exposed to air which moves past the ventilator.

[**0064**] The bearing jacket **72** usually substantially consists of aluminium, due to its aforementioned heat radiative properties. The bearing jacket **72** includes six pairs of minor fins **74** and three major fins **76**. The fins **74** and **76** aid in the release of heat from the bearing jacket **72** by increasing the surface area of the bearing jacket **72** in contact with the surrounding atmosphere. The bearing jacket **72** therefore aids in drawing heat away-from the bearing unit **30**, which is useful when the rotor ventilator is employed in high heat environments.

[**0065**] In use, a hole is made in, for example, the roof of a building where improved ventilation is required. The base element **10** is typically fixedly attached to the roof in such a way that positions the shaft **13** in a substantially vertical position and allows free rotation of the rotor **17** about the shaft **13**. Therefore, when air passes the rotor ventilator and causes rotation of the rotor **17** as described above, air exhausted from the interior **12** of the rotor ventilator is replaced by air from below the roof. This air is then subsequently exhausted, and improved ventilation is achieved.

[**0066**] Although the invention has been described with reference to particular examples, it will be appreciated by those skilled in the art that the invention may be embodied in many other forms.

The claims defining the invention are as follows:—

1. A rotor ventilator including:

a base to which a shaft is connected to extend upwardly therefrom;

a rotor including a plate and a plurality of vanes extending downwardly therefrom, the rotor being rotatable about the shaft;

bearing means for rotatably supporting the rotor on the shaft; and

a deflector located with respect to the shaft and between the base and the plate to deflect gas passing through the rotor ventilator away from the bearing means.

2. A rotor ventilator according to claim 1 wherein the deflector is located on the shaft adjacent the plate.

3. A rotor ventilator according to claim 1 or **2** wherein the deflector is coupled about the shaft and includes a flared portion being flared outwardly from a longitudinal axis of the shaft and toward the plate.

4. A rotor ventilator according to any one of the preceding claims wherein the flared portion is concave on a side of the deflector which faces the base.

5. A rotor ventilator according to claim 3 or **4** wherein the deflector is symmetrical about the longitudinal axis.

6. A rotor ventilator according to any one of the preceding claims wherein the bearing means is located on an opposite side of the plate to the deflector.

7. A rotor ventilator according to any one of the preceding claims including a heat sink about the bearing means.

8. A rotor ventilator according to claim 7 wherein the heat sink includes at least one heat diffusing fin extending radially with respect to the axis of the shaft.

9. A rotor ventilator according to any one of the preceding claims wherein the bearing means includes a rotatable bearing assembly having:

a bearing including a central bore and two internal axially spaced bearing races;

a central shaft extending longitudinally through the bore, with a space being defined between the bearing and the shaft, the shaft including two external axially spaced bearing races, with the shaft races being aligned with the races on the bearing;

a plurality of ball bearings captively engaged between respective aligned races; and

a low friction seal located at one end of the bearing and projecting radially inwards towards the shaft.

10. A rotor ventilator including:

a base to which a shaft is connected to extend upwardly therefrom;

a rotor including a plate and a plurality of vanes extending downwardly therefrom, the rotor being rotatable about the shaft; and

a double race-rotatable bearing assembly for supporting the rotor on the shaft and located at the plate.

11. A rotor ventilator according to claim 10 wherein the rotatable bearing assembly includes:

a bearing including a central bore and two internal axially spaced bearing races;

a central shaft extending longitudinally through the bore, with a space being defined between the bearing and the shaft, the shaft including two external axially spaced bearing races, with the shaft races being aligned with the races on the bearing;

a plurality of ball bearings captively engaged between respective aligned races; and

a low friction seal located at one end of the bearing and projecting radially inwards towards the shaft.

12. A rotor ventilator according to claim 10 or **11** wherein the bearing means is located above the plate.

13. A rotor ventilator according to claim 11 or **12** including a second radially inwardly projecting seal located at another end of the bearing.

14. A rotor ventilator according to any one claims 10 to 13 including a support means rotatably mounted at one end to the shaft and mounted at another end to the rotor.

15. A rotor ventilator according to claim 14 wherein the one end of the support means includes a bearing unit for rotatable mounting on the shaft.

16. A rotor ventilator according to claim 14 or **15** wherein the support means is intermediate the plate and base.

17. A rotor ventilator according to any one of claims 10 to 16 including a deflector located with respect to the shaft and between the base and the plate to deflect gas passing through the rotor ventilator away from the bearing assembly.

18. A rotor ventilator according to any one of claims 10 to 17 wherein an end of each vane is mounted to the plate by tab fastening means including at least one tab projection for receipt in a corresponding slot in the plate.

* * * * *