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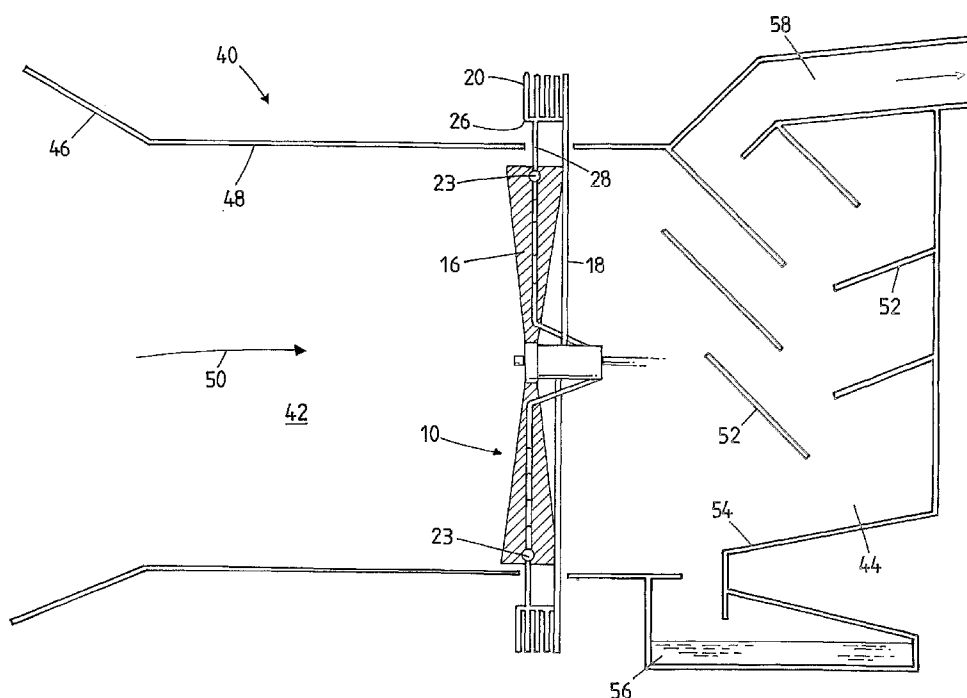
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ance Notes on Codes and Abbreviations" appearing at the begin-
ning of each regular issue of the PCT Gazette.

(54) Title: APPARATUS AND METHOD FOR COOLING OF AIR



(57) Abstract: A wind turbine apparatus (40) for cooling of air having a wind turbine (10) axially connected to a refrigeration compressor (13) arranged to compress refrigerant, means (18) for conducting compressed refrigerant centrifugally outwards, means for causing the compressed refrigerant to lose pressure (23) so as to cool fins (16) of the wind turbine (10), and means for returning spent refrigerant centripetally to the compressor (13).

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TITLE

“APPARATUS AND METHOD FOR COOLING OF AIR”

FIELD OF THE INVENTION

The present invention relates to an apparatus and method for cooling air.

SUMMARY OF THE INVENTION

In accordance with one aspect of the present invention there is provided a wind turbine apparatus for cooling of air characterised by comprising a wind turbine axially connected to a refrigeration compressor arranged to compress refrigerant, means for conducting compressed refrigerant centrifugally outwards, means for causing the compressed refrigerant to lose pressure so as to cool blades of the wind turbine, and means for returning spent refrigerant centripetally to the compressor.

In accordance with a further aspect of the present invention there is provided a method of condensing water from ambient air, which comprises driving, by means of ambient wind, a wind turbine apparatus in accordance with the present invention mounted in a duct by ambient wind so as to cause blades of the wind turbine to be cooled and to thereby cool ambient wind air passing through the duct and the wind turbine, and causing water vapour in the ambient wind air to condense to form liquid water, and collecting the liquid water.

In accordance with a yet further aspect of the present invention there is provided a wind turbine having at least one blade mounted to a compressor housing mounted on a shaft for axial rotation relative to the shaft, and means for conducting compressed refrigerant outward centrifugally and means for returning the refrigerant centripetally through the or each blade with loss of pressure and change of phase from liquid to gas so as to cool the or each blade.

DESCRIPTION OF THE DRAWINGS

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

Figure 1 is a schematic plan view of a wind turbine of the present invention showing a single turbine blade;

Figure 2 is a further schematic plan view similar to Figure 1 showing a plurality of turbine blades;

Figure 3 is a schematic side elevation of a first embodiment of an apparatus to convey air in accordance with the present invention;

Figure 4 is a view similar to Figure 3 showing a second embodiment of an apparatus of the present invention;

Figure 5 is a side elevation of a third embodiment of an apparatus of the present invention;

Figure 6 is a plan view of a further embodiment of a wind turbine of the present invention as used in the third embodiment of apparatus illustrated in Figure 5;

Figure 7 is a side elevation of a fourth embodiment of an apparatus of the present invention;

Figure 8 is a plan view of a yet further embodiment of a wind turbine of the present invention used in the fourth embodiment of apparatus illustrated in Figure 7;

Figure 9 is a schematic side elevation of a compressor used in the air cooling apparatus of the present invention;

Figure 10 is a schematic side elevation of a further embodiment of a compressor used in the air cooling apparatus of the present invention;

Figures 11a, b, c and d are various views of the compressor of Figure 10;

Figure 12 is a schematic side elevation of a yet further embodiment of a compressor used in the air cooling apparatus of the present invention;

Figure 13 is a view similar to Figure 3 showing a fifth embodiment of an apparatus of the present invention;

Figures 14A, 14B and 14C show schematically a scroll refrigerant compressor useful in the present invention in various positions;

Figure 15A is a plan view of an alternative form of scroll compressor useful in the present invention; and

Figure 15B is a side view of the scroll compressor of Figure 15A.

DESCRIPTION OF THE INVENTION

In Figure 1 of the accompanying drawings, there is shown a wind turbine apparatus 10 comprising a central shaft 12 having a compressor 13 comprising a housing 14 mounted thereabout. The compressor housing 14 is arranged to rotate axially relative to the shaft 12. Further, a plurality of turbine blades 16 (only one of which is shown) are mounted to the compressor housing 14. As shown, a tube 18 extends outwardly from the housing 14 to a peripheral cooling coil 20. A convoluted pipe 22 extends from the cooling coil 20 back to the housing 14. There is a constriction 23 at a part in the pipe 22 adjacent the cooling coil 20.

In use, the turbine blade 16 is caused to rotate axially about the shaft 12 by the kinetic energy of ambient wind air. Rotation of the blade 16 causes rotation of the compressor housing 14 and refrigerant in the compressor housing 14 to be compressed so as to undergo a phase change from gas to liquid. The compressed liquid refrigerant flows outwardly driven by the compressor and assisted by centrifugal force along the tube 18 to the cooling coil 20 which acts as a manifold.

As shown, the refrigerant has to travel almost in a complete circle to reach the pipe 22. This enables the compressed refrigerant to be cooled during its residence in the cooling coil 20.

The refrigerant leaves the cooling coil 20 through the constriction 23 which leads into the pipe 22. At this point the refrigerant undergoes a rapid loss of pressure and thus evaporates back to the gaseous phase and causes the blade 16 to be cooled. The spent refrigerant then passes centripetally back to the housing 14 on a low pressure line of the compressor 13.

The cooling of the blade 16 causes ambient wind air to be cooled which has useful effects as will be described.

In Figure 2, there is shown an apparatus 30 similar to that in Figure 1. In Figure 2 there can be seen a plurality of turbine blades 16, a plurality of tubes 18, a cooling coil 20 and a plurality of pipes 22. In this embodiment, the compressed refrigerant passes along the tubes 18 to the cooling coil 20. From the cooling coil 20 the compressed refrigerant passes through a plurality of short tubes 28 to an inner manifold 26. From the inner manifold 26 the compressed refrigerant passes through the constrictions 23 into the tubes 22 as described hereinabove. Thus the compressed refrigerant does not enter the tubes 22 directly and therefore is cooled by its residence in the cooling coil 20 and the tubes 28 and the inner manifold 26.

In Figure 3, there is shown an apparatus 40 which comprises a wind turbine 10. There is also shown a respective inner manifold 26 adjacent an outer end of each blade 16. The compressed liquid refrigerant passes initially from the cooling coil 20 to each inner manifold 26 through short tubes 28. The refrigerant then passes through constrictions 23 into the pipes 22 as described hereinabove.

Further, there is shown in Figure 3, a wind collecting duct 42 and an outlet condensation chamber 44. The duct 42 includes an outer wide portion 46 and an inner relatively narrow portion 48. The combination of the wide portion 46 and the narrow portion 48 increases air velocity in the duct 42.

Ambient wind air blowing in the direction of an arrow 50 flows through the wind turbine 10 so as to cause the latter to rotate such that the blades 16 are cooled. This causes the air temperature to fall below the condensation point or dew point and water vapour to condense from the ambient air to form liquid water. This is enhanced by the presence of baffles 52 which impede the flow of air and induce liquid water to collect thereon. The liquid water flows from the baffles 52 onto a sloping floor portion 54 from which the liquid water flows into a collection trough 56. The cooled air from which water has been removed is exhausted through an upper outlet 58. As

can be seen in Figure 3, the coil 20 is located externally of the duct 42 so that heat lost from the compressed refrigerant is dispersed into the ambient air rather than inside the duct 42.

In Figure 4, there is shown an apparatus 60 similar to that in Figure 3, except that an inlet 62 is lowermost and is provided with flaps 64. In this case, the flaps 64 are only opened, as shown, on the windward side of the apparatus 60. Wind air flows upwardly through the turbine 10 and then through a condensation chamber 66 to exhaust through a top vent 68. Once again liquid water collects on baffles 52 and then flows along a sloping floor 54 to collect in a trough 56.

In Figure 5, there is shown an apparatus 70 similar to that in Figure 4, except that the exhaust vent 68 is provided with an additional wind turbine 72 to reduce pressure in the exhaust vent 68 and enhance removal of exhaust air. Power obtained from the wind turbine is available for any useful purpose.

In Figure 6, there is shown a wind turbine 10 having wind guides 62 with flaps 64 between adjacent pairs of wind guides 62. The flaps 64 are arranged to be opened as shown by the wider oblong shape when the flaps face in the direction of the ambient wind.

In Figure 7, there is shown an alternative form of the apparatus of the present invention.

In this Figure there is shown an apparatus 80 having a funnel 82 at an intermediate level and a downwardly directed deviation device 84. The device 84 is arranged to pivot about a substantially vertical axis so as to orientate itself, in use, into a position which is most effective in directing the ambient wind air through a wind turbine 10. Cooled air can then enter a condensation chamber 86 below the wind turbine 10 and deposit moisture on baffles 88. The deposited moisture can then flow into a collection trough 90. The cooled air depleted of moisture can then pass upwardly to an upper vent 92.

In Figure 8, there is shown a wind turbine 10 similar to that shown in Figure 7. As shown, the device 84 faces the incoming ambient wind. The wind air is directed into the wind turbine 10.

In Figure 9, there is shown a preferred form of compressor 90 of the present invention. The compressor 90 has a central rotating cylindrical hub or housing 92 on which is mounted the blades 16 and refrigerant carrying tubes of the wind turbine 10 as described herein. The compressor 90 includes compressor blades 94 mounted on a drive shaft 96. The blades 94 are arranged to be driven at high speed by a gear train 98 fitted to an inner wall of the hub 92. Used refrigerant returning centripetally to the compressor 90 as described above is recompressed and sent out centrifugally as described above.

In Figure 10 there is shown an alternative form of compressor 100 mounted within a cylindrical hub or housing 102. In this embodiment refrigerant is displaced by a roller 104 mounted eccentrically on a shaft 106 relative to a main shaft 108 of the compressor 100.

As shown in Figures 11a, 11b, 11c and 11d, the compressor 100 operates as follows. The compressor 100 comprises a central shaft 101 having an eccentric 102 mounted thereon. A rotatable housing 103 is mounted about the eccentric 102. A tube 104 leads away from the housing 103 and a pipe 105 leads into the housing 103. A spring biased vane 106 extends through a wall of the housing 103 and contacts an outer surface of the eccentric 102. Rotation of the housing 103 causes refrigerant contained therein to be compressed and exited through the tube 104. Similarly, used refrigerant returns to the housing 103 through the pipe 105. This is facilitated by the vane 106 which is spring biased into engagement with the outer surface of the eccentric 102.

In Figure 12 there is shown a further alternative form of compressor 120 mounted within a cylindrical hub 122. In this embodiment refrigerant is contained in an elastic chamber 124. The chamber 124 is alternately contracted and expanded. This is done

by eccentric discs 126 fixedly mounted on a central shaft 128. Each disc 126 has a circular channel 130 formed on an inner side thereof. A slidable bearing 132 is mounted in each channel 130. A respective rod 134 extends from each bearing 132 to a respective end plate 136 of the chamber 124. Each rod 134 is constrained by a circular guide member 138.

In use, a hub 122 rotates axially about the shaft 128 and the chamber 124 rotates with the hub 122. This movement causes the bearings 132 to slide in the channels 130 and the rods 134 to reciprocate correspondingly in the guide member 138. In this way the chamber 124 is expanded and retracted so alternately compressing and driving out compressed refrigerant through a one way valve 140 and allowing ingress of used refrigerant through a one way valve 142.

In Figure 13, there is shown a wind turbine apparatus 130 which is similar to that shown in Figures 4 and 5. In this embodiment, wind funnels 132 are arranged to direct ambient wind air over a water surface 134. The water may be brackish or fresh water. The wind air then passes upwardly through an upright tube 136 (or a sloping duct on a hillside) to pass through a wind turbine 10 and thence a condensation chamber 138 having baffles 52 and a sloping floor 54 from which water flows into a collection trough 56. Exhaust air is vented through an outlet 58. Absolute humidity of air entering the apparatus 130 increases and the density of the air is therefore lowered. Thus, flow of air due to the wind is augmented by convection as the wet air rises to the wind turbine 10.

It is also envisaged that the refrigeration compressor used in the apparatus of the present inventions could be in the form of a scroll compressor.

This embodiment of the present invention is illustrated in Figures 14A, 14B and 14C of the accompanying drawings.

In Figure 14 there is shown a scroll compressor 150 having a housing 151 having mounted therein a circular plate 152. Further, an internal ring gear 154 mounted on a

wind turbine axial shaft (not shown) extends around the internal periphery of the housing 151. Turbine blades 16 are mounted to the housing 151 and cause wind to effect axial rotation of the housing 151 on a fixed shaft (not shown).

The housing 151 is rotated, in use, by rotation of blades of a wind turbine as described hereinabove.

As indicated above, the scroll compressor 150 is mounted on a bearing on the fixed axial shaft (not shown). One scroll 156 is attached to the housing 151 whilst another 158 is driven by three planetary gears 160 mounted on the housing 151 disposed at the apex of an equilateral triangle. The gears 160 are driven by the ring gear 154. The scroll 158 may be described as a wobbling scroll.

The gears 160 are asymmetrically connected to the plate 152 by means of respective pivotal connections 162. In use the housing 151 is axially rotated by the wind turbine. This causes the planetary gears to be turned by engagement with the fixed ring gear 154. This causes the ring gear 154 to rotate and thereby cause rotation of the planetary gears 160. Rotation of the planetary gears 160 causes the plate 152 to move in a wobbling motion which causes the scroll 158 to move correspondingly.

As shown in Figures 14A to 14C this causes gaps between the two scrolls 156 and 158 to be alternately opened up and closed in a progressive manner. This action leads to compression of refrigerant vapour contained between the scrolls such that the vapour is subjected to increased pressure and is converted to liquid form.

As described hereinabove, the compressed liquid refrigerant is thus urged outwardly of the compressor housing 151 through a tube (not shown) by centrifugal force. Further, as described hereinabove, the spent refrigerant returns through pipes (not shown) to the interior of housing 151 where it enters the gap between the scrolls 156 and 158.

In Figures 15A and 15B there is shown an alternative arrangement of scroll compressor 180 useful in the present invention compared to the scroll compressor of Figure 14. Like reference numerals denote like parts. It should be noted in Figure 15A that only the scroll 158 is shown.

In this embodiment there is a central shaft 182 having mounted thereon a housing 184. The housing is mounted on a bearing on the shaft 182. The shaft 182 may or may not be continuous. A central gear wheel 186 is fixedly mounted about the shaft 182. The gear wheel 186 is connected to three planetary gears 188.

Further, as can be seen in Figure 15B one scroll 156 is fixed to the housing 184 by any suitable means such as an end plate (not shown). The other scroll 158 is mounted on an end plate 190 and is connected to the planetary gears 188 through eccentric pins 192.

The shaft 182 and the gear wheel 186 are fixed in position. The housing 184 is arranged to rotate about the shaft 182 as described hereinabove. The planetary gears 188 engage with the gear wheel 186 and are thereby caused to rotate as the housing 184 rotates. This rotation of the planetary gears 188 causes the scroll 158 to move on the plates 190 by means of the pins 192 such that the scroll 158 undergoes a wobbly motion as described hereinabove.

Modifications and variations as would be apparent to a skilled addressee are deemed to be within the scope of the present invention

CLAIMS

1. A wind turbine apparatus for cooling of air characterised by comprising a wind turbine axially connected to a refrigeration compressor arranged to compress refrigerant, means for conducting compressed refrigerant centrifugally outwards, means for causing the compressed refrigerant to lose pressure so as to cool blades of the wind turbine, and means for returning spent refrigerant centripetally to the compressor.
2. An apparatus according to claim 1, characterised in that the apparatus comprises a central shaft and the refrigeration compressor has a housing which is mounted about the shaft, the compressor housing being arranged to rotate axially relative to the shaft.
3. An apparatus according to claim 2, characterised in that a plurality of turbine blades are mounted on the housing and extend away therefrom.
4. An apparatus according to claim 3, characterised in that tube means extends outwardly from the housing and interconnects with a peripheral coil.
5. An apparatus according to claim 4, characterised in that the coil is disposed externally of the apparatus so as to radiate heat to the ambient air
6. An apparatus according to claim 4 or 5, characterised in that a respective return pipe extends from the coil through one or more turbine blades, the or each return pipe being provided adjacent the coil with a constriction so as to cause the refrigerant to undergo loss of pressure and the turbine blades to be cooled, the spent refrigerant then returning centripetally back to the housing on a low pressure side of the compressor.
7. An apparatus according to any one of the preceding claims, characterised in that there is provided a wind collecting device into which ambient wind air flows, the

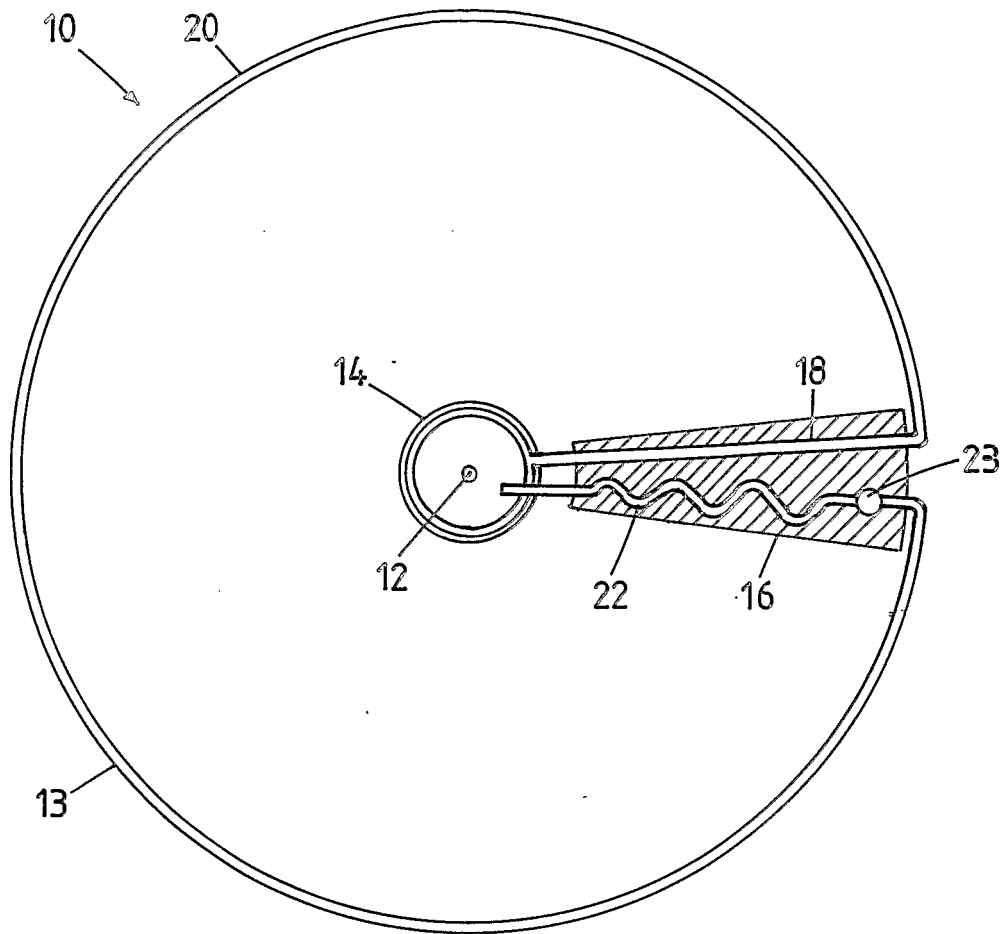
wind collecting device contains the wind turbine and the ambient wind air causes the wind turbine to rotate so as to cause refrigerant to be compressed by the refrigeration compressor and to flow outwardly under centrifugal force and return centripetally to the refrigeration compressor to cause cooling of the blades so as to cause water vapour in the ambient wind air to condense to form liquid water.

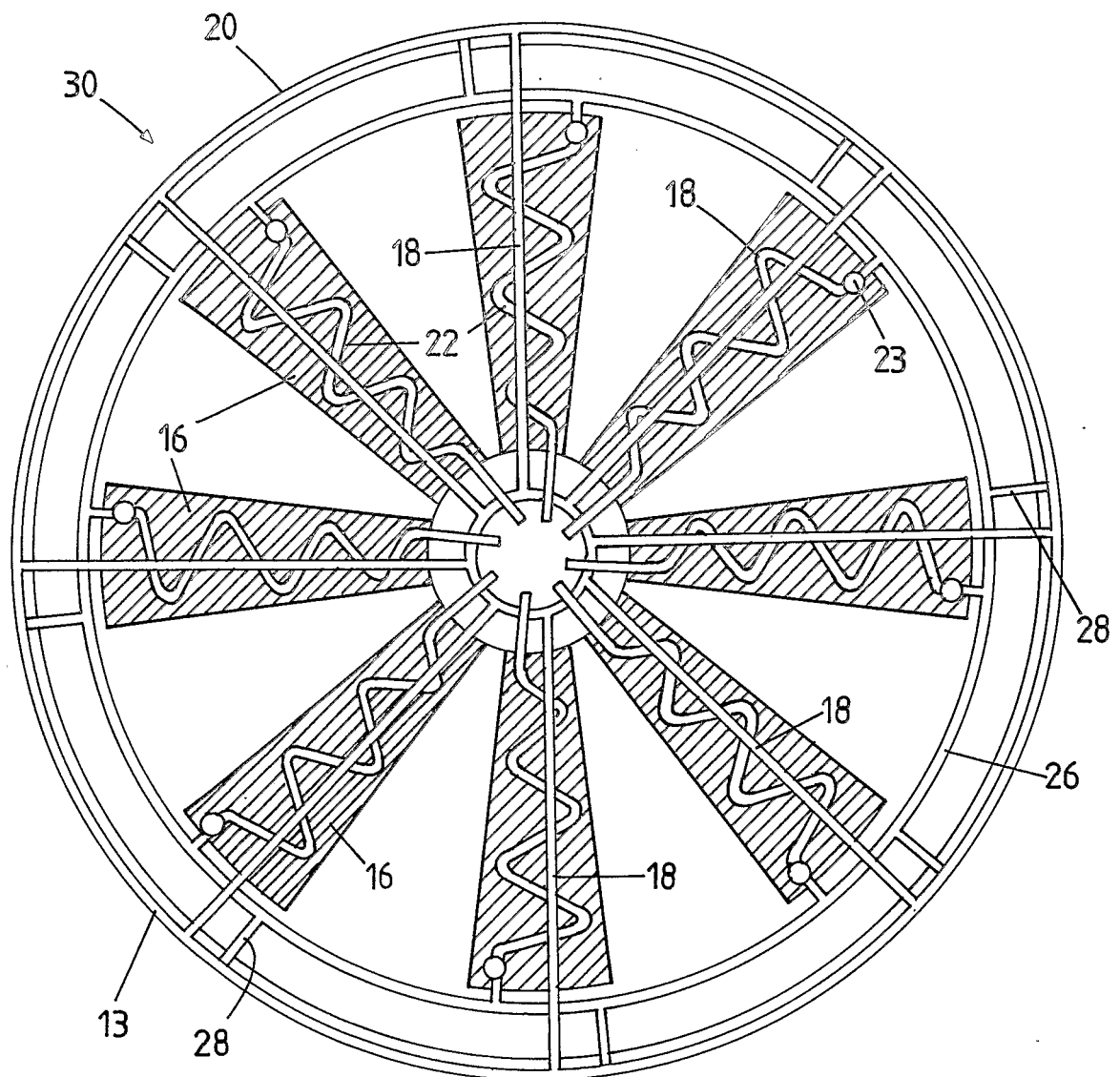
8. An apparatus according to claim 7, characterised in that the wind collecting device comprises an inlet funnel upstream of the wind turbine and an outlet condensation chamber downstream of the wind turbine, and an intermediate portion narrower than the inlet funnel, the intermediate portion containing the wind turbine.
9. An apparatus according to claim 8, characterised in that the condensation chamber comprises a baffle to enhance condensation of water from the ambient air.
10. An apparatus according to claim 8 or 9, characterised in that the outlet condensation chamber is provided with means for collecting liquid water condensed from the ambient wind air.
11. An apparatus according to claims 8 to 10, characterised in that the duct is provided with flaps which are arranged to be opened when facing windward.
12. An apparatus according to any one of claims 8 to 11, characterised in that the outlet condensation chamber has an outlet vent provided with an additional wind turbine to reduce pressure in the outlet vent and enhance removal of exhaust air.
13. An apparatus according to any one of claims 8 to 12, characterised in that the wind turbine has adjacent pairs of wind guides with respective flaps therebetween, the flaps being arranged to be opened when facing in the direction of ambient wind.
14. An apparatus according to any one of claims 8 to 13, characterised in that there is provided a deviation device arranged to pivot about a substantially vertical axis so

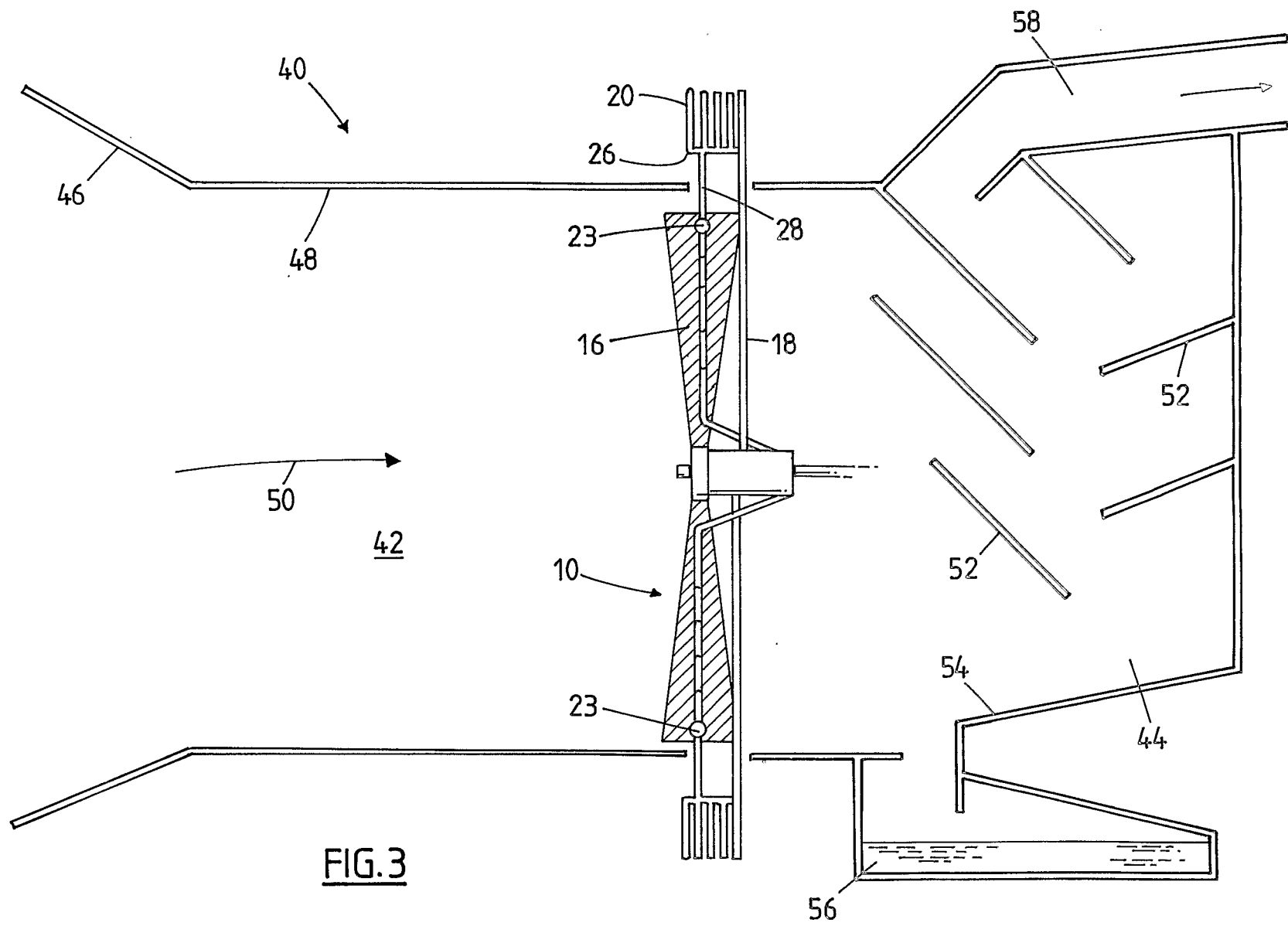
as to orientate itself, in use, into a position which is most effective in directing ambient wind through the wind turbine.

15. An apparatus according to claim 1, characterised in that the refrigeration compressor has a central rotatable housing having blades provided therein, the refrigeration compressor further comprising compressor blades mounted on a drive shaft, the compressor blades being arranged to be driven by a gear train fitted to an inner wall of the housing.
16. An apparatus according to claim 1, characterised in that the housing of the refrigeration compressor comprises a housing containing an eccentrically mounted roller
17. An apparatus according to claim 1, characterised in that the refrigeration compressor comprises a housing containing an elastic chamber containing refrigerant which elastic chamber is arranged to be alternately contracted and expanded.
18. An apparatus according to claim 1, characterised in that the refrigeration compressor comprises a housing containing a scroll compressor.
19. A method of condensing water from ambient air which comprises driving, by means of ambient wind, a wind turbine apparatus in accordance with claim 1, mounted in a duct so as to cause blades of the wind turbine to be cooled and to thereby cool ambient wind air passing through the duct and the wind turbine, and causing water vapour in the ambient wind air to condense to form liquid water, and collecting the liquid water.
20. A wind turbine having at least one blade mounted to a refrigeration compressor housing mounted on a shaft for axial rotation relative to the shaft and means for conducting compressed refrigerant centrifugally outward and means for returning the refrigerant centripetally through the or each blade with loss of pressure and

change of phase of the refrigerant from liquid to gas so as to cool the or each blade.

FIG. 1

FIG. 2



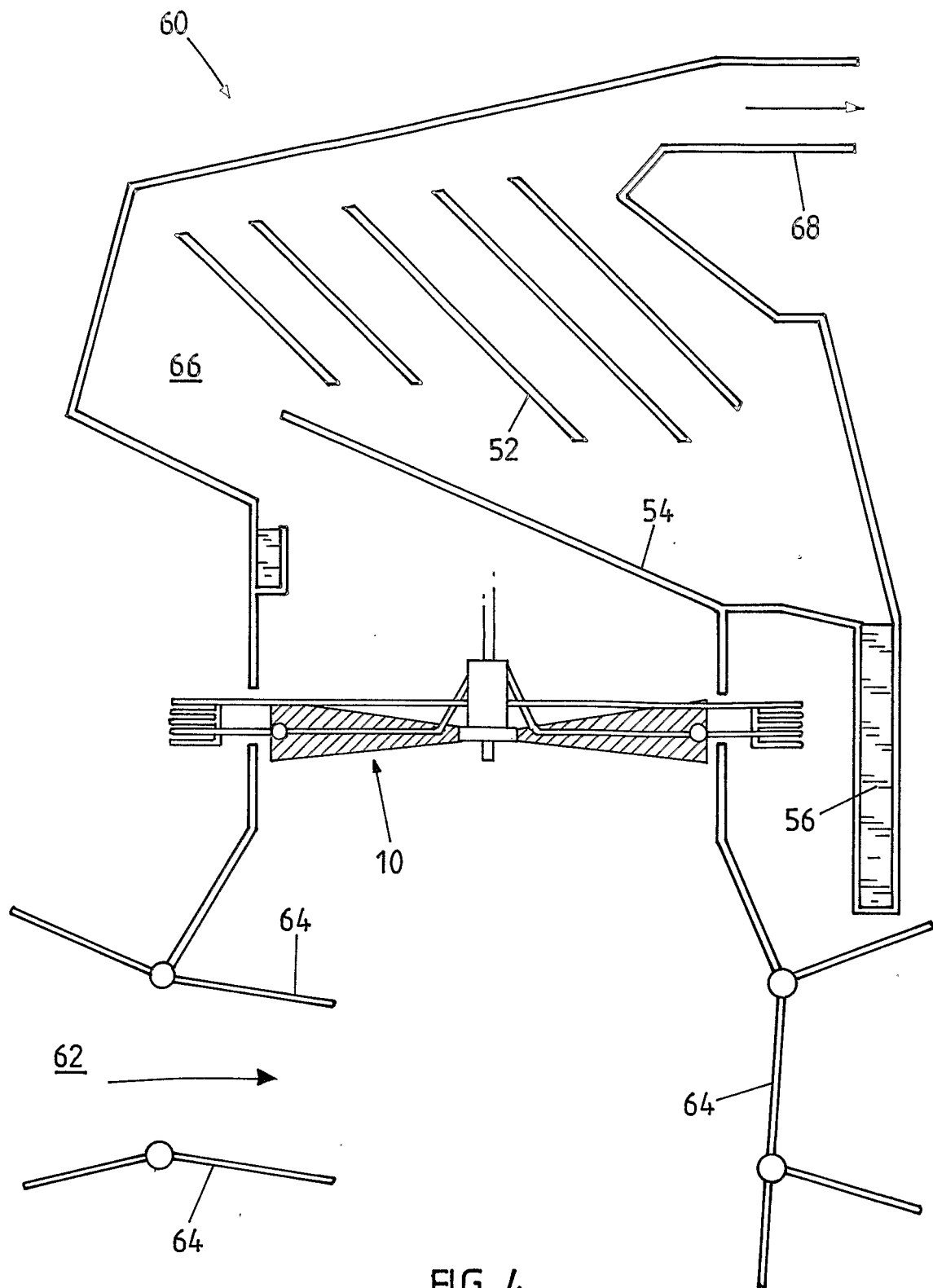
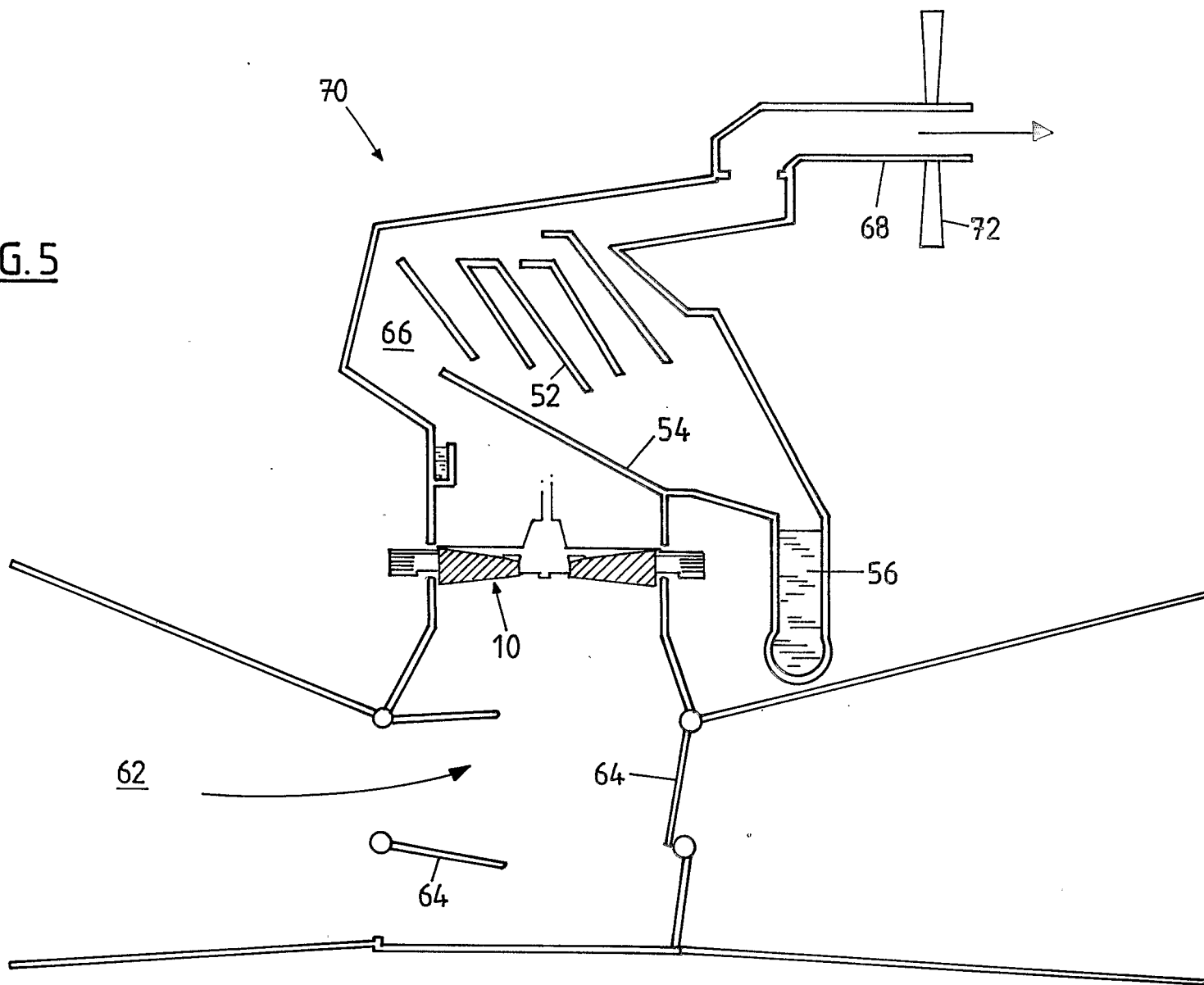


FIG. 5



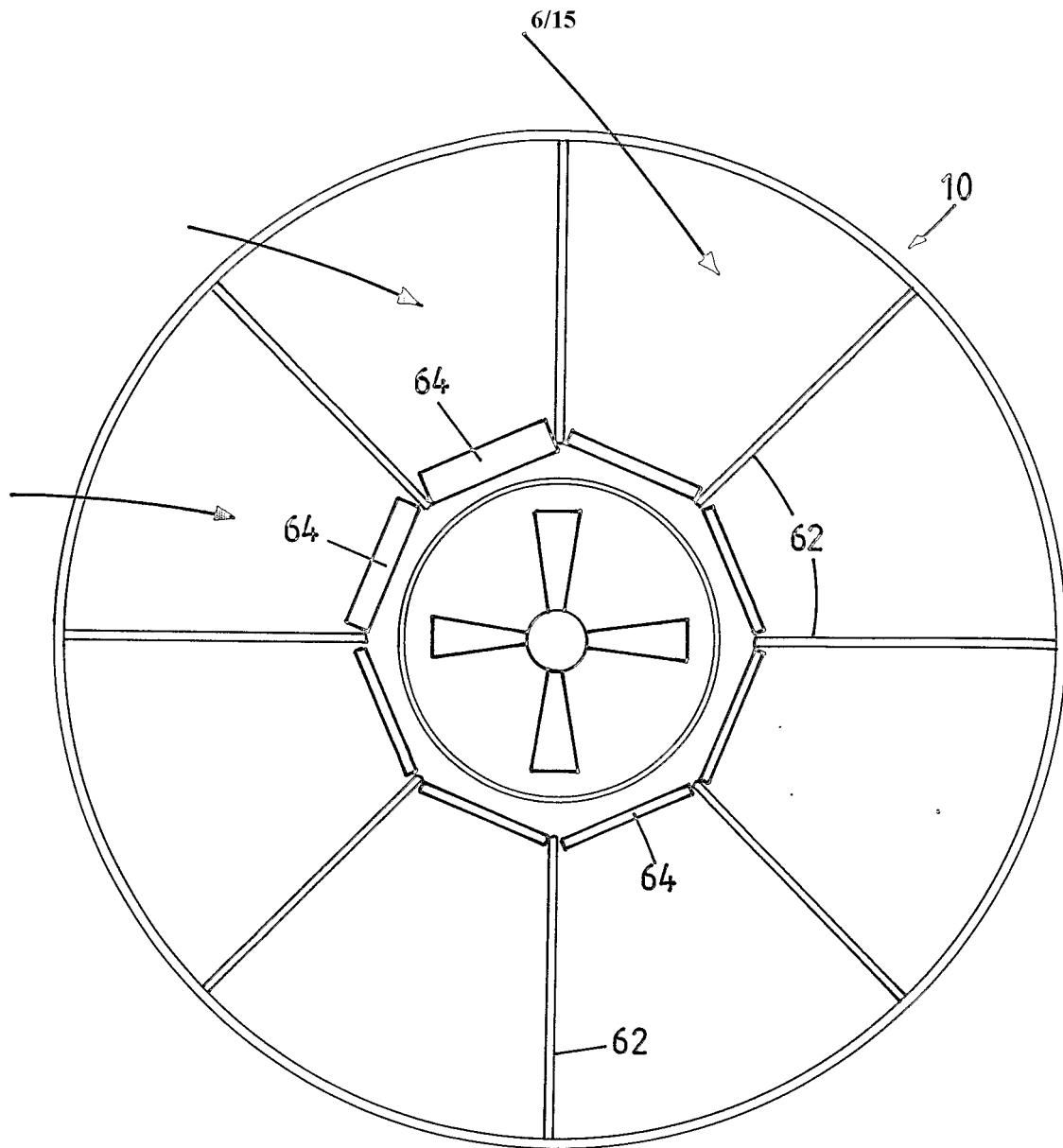
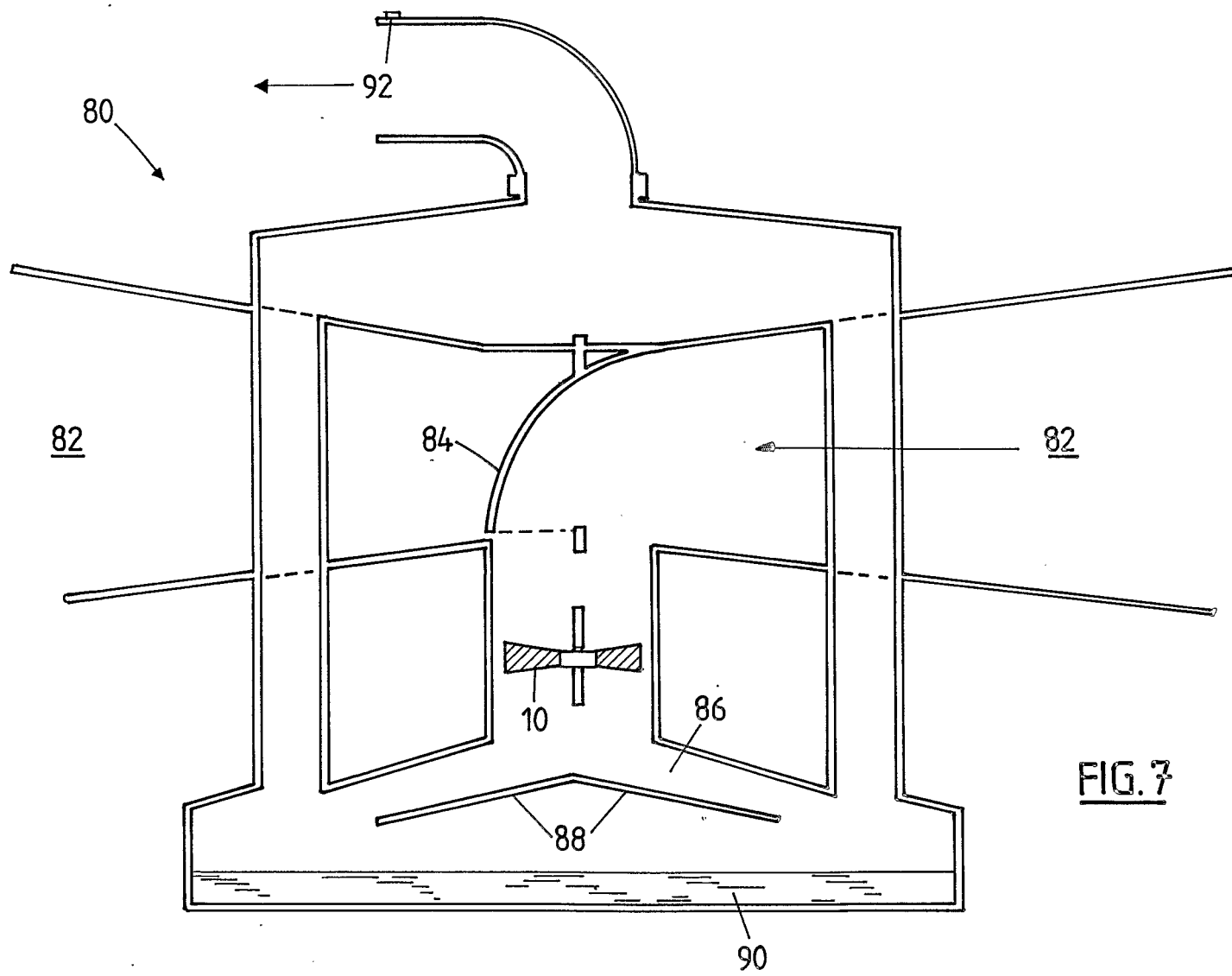


FIG. 6



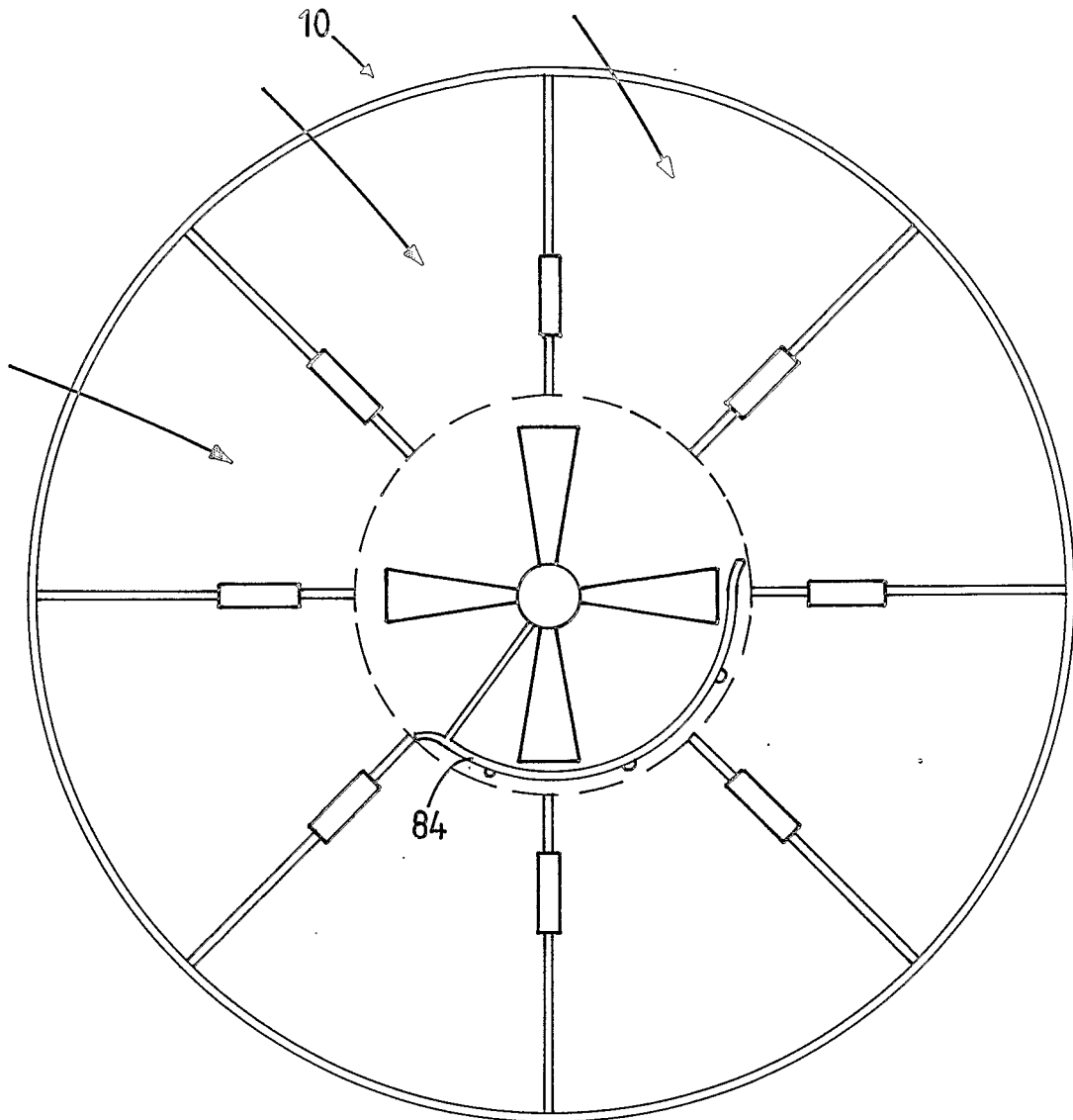


FIG. 8

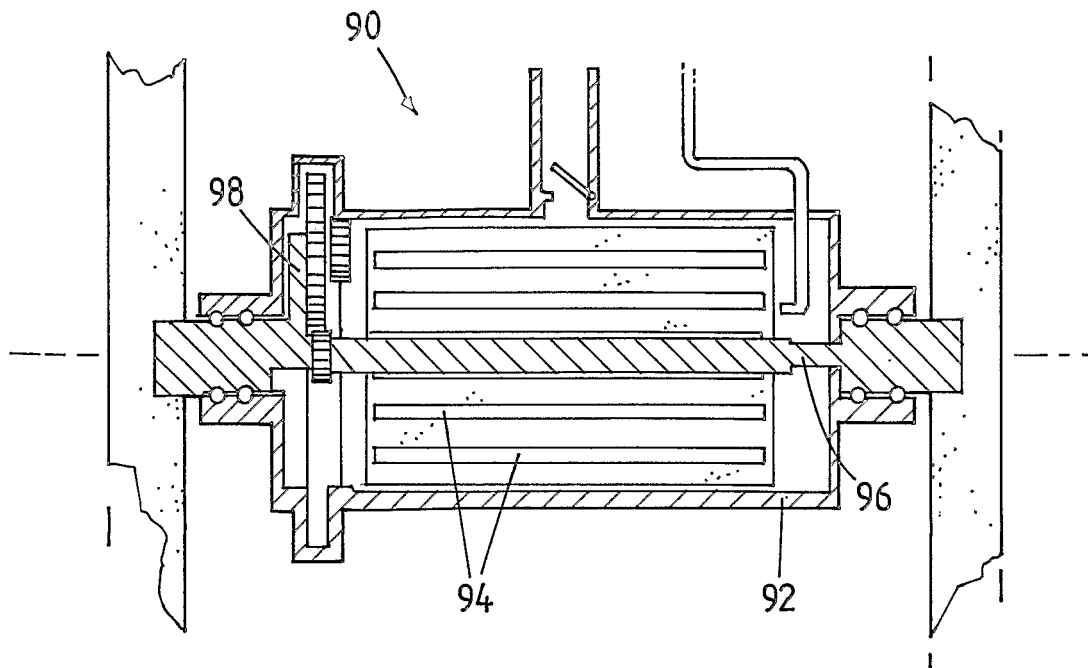


FIG. 9

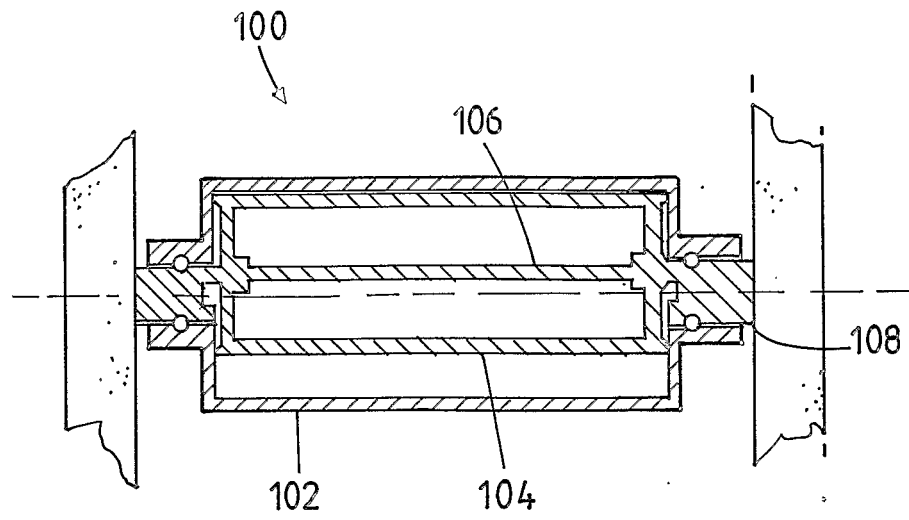


FIG.10

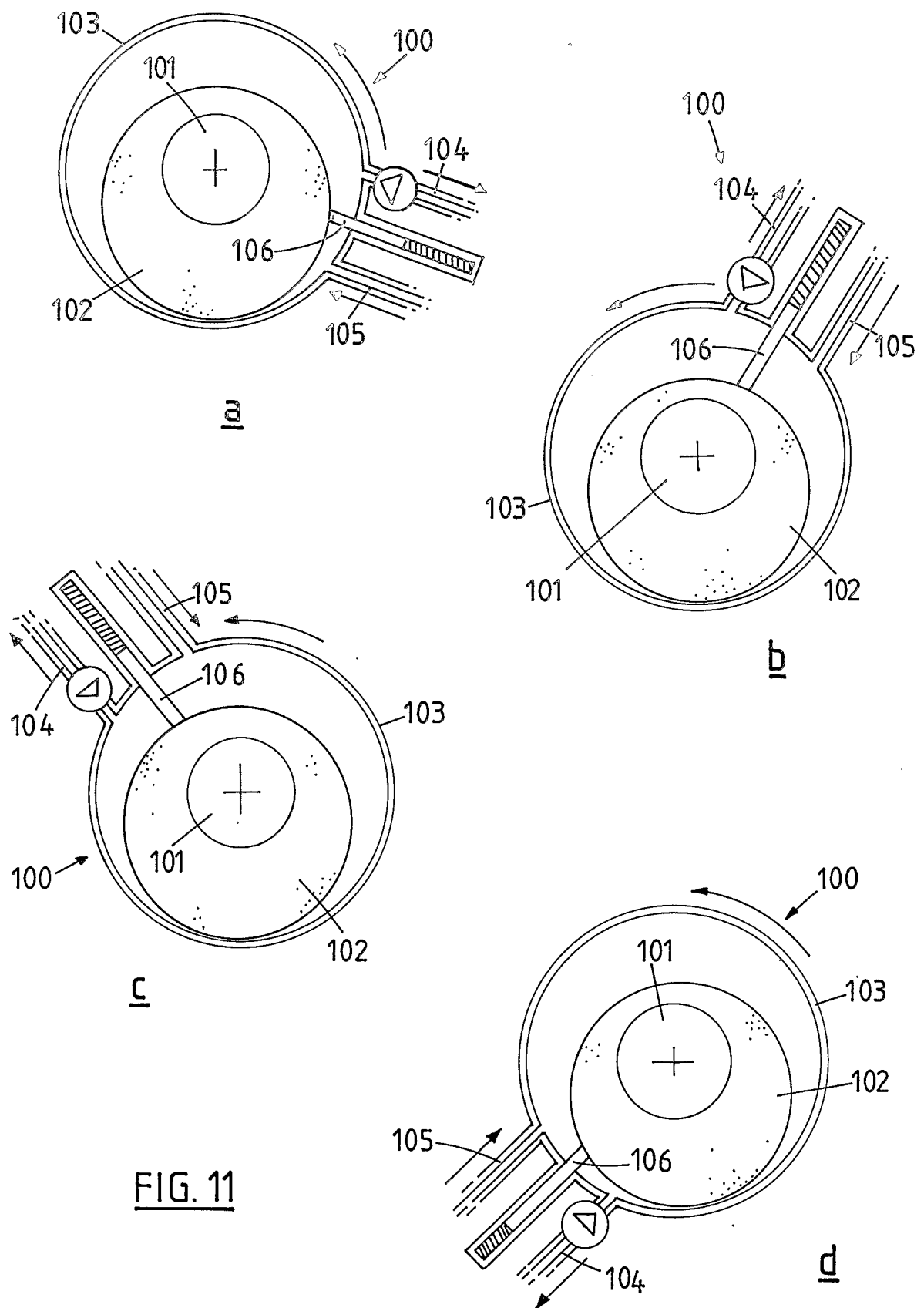


FIG. 11

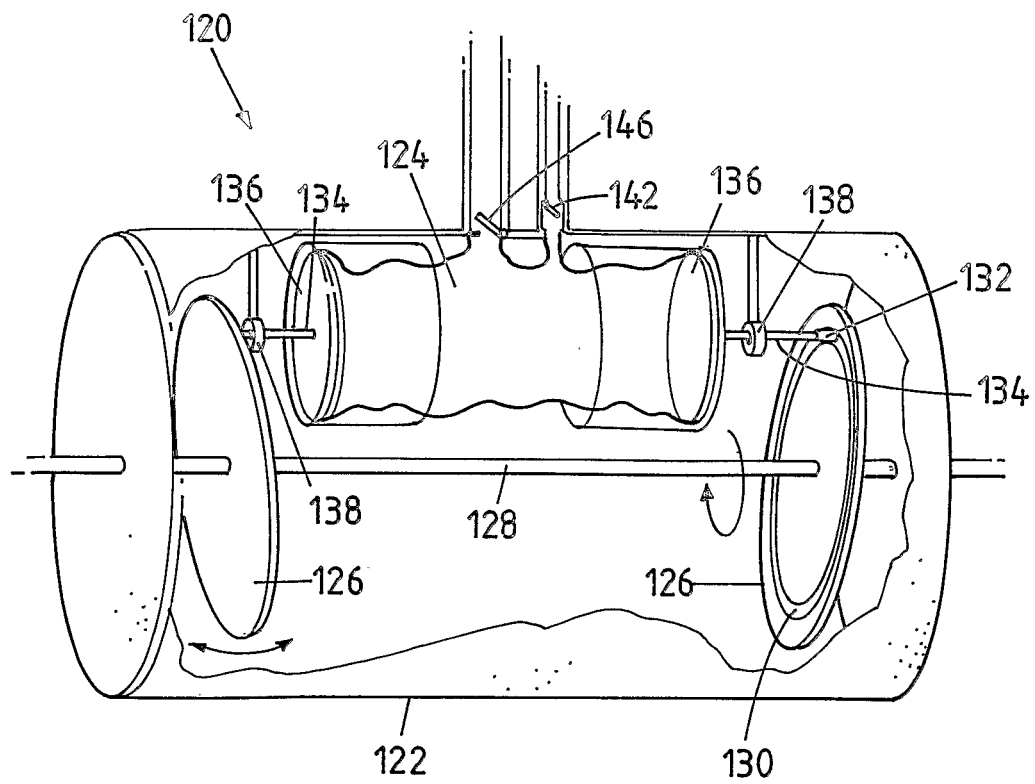
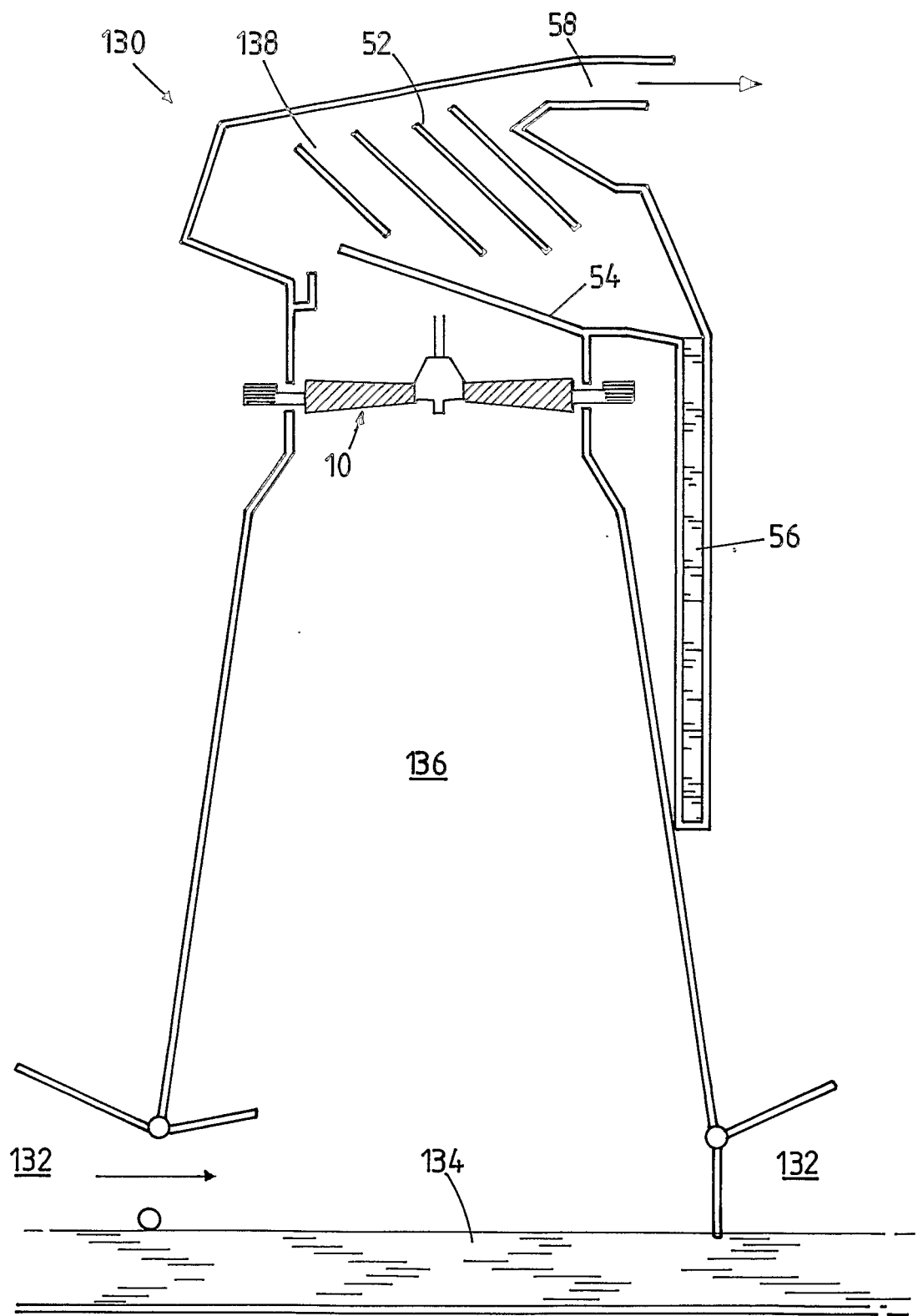


FIG. 12

**FIG. 13**

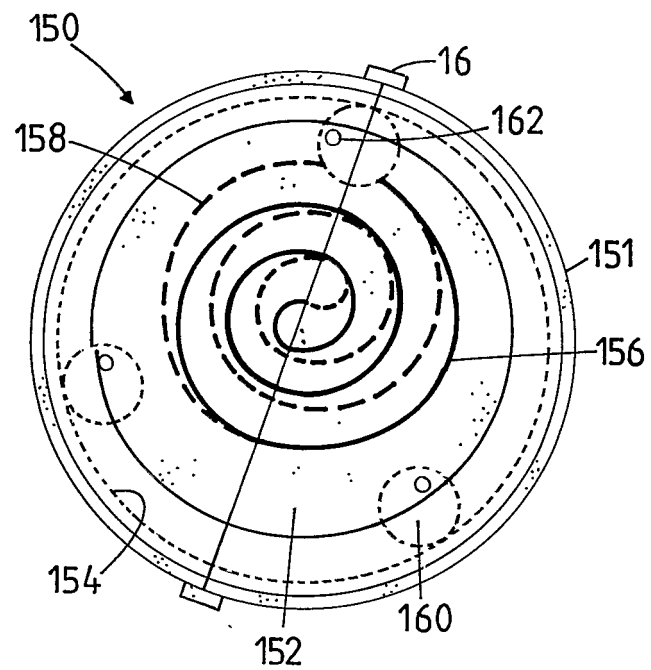


FIG. 14a

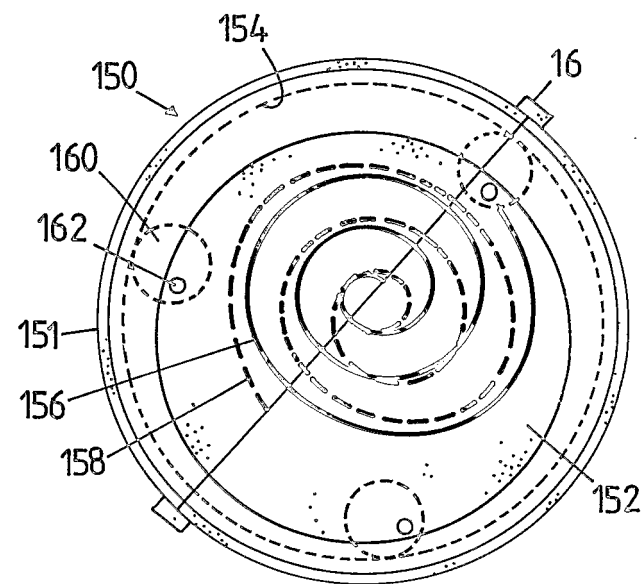


FIG. 14b

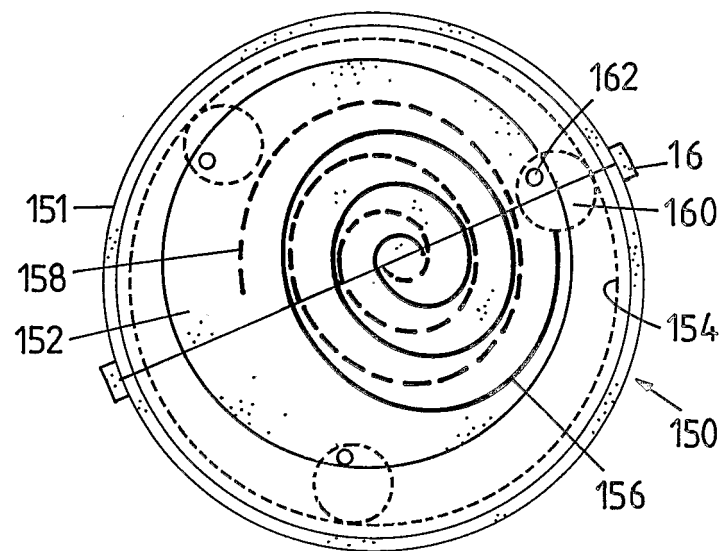


FIG. 14c

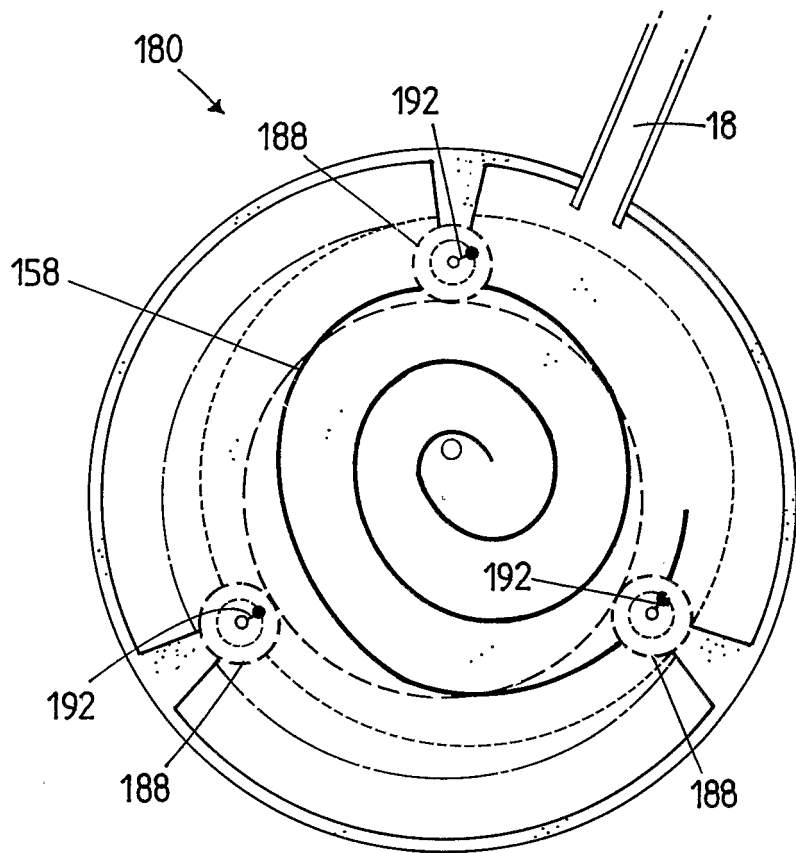


FIG. 15a

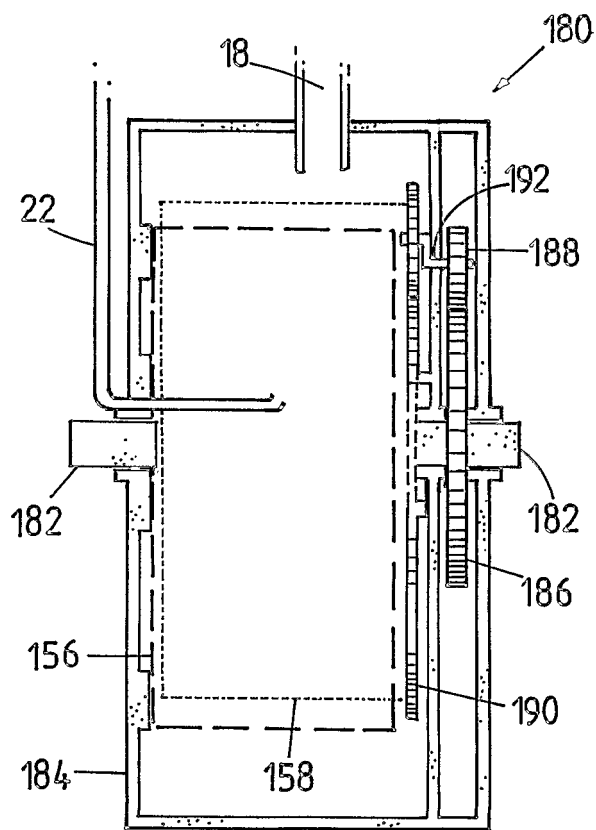



FIG. 15b

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2005/001219

A. CLASSIFICATION OF SUBJECT MATTER		
Int. Cl. ⁷ : F25B 27/00; F25D 17/06; B01D 5/00; F03D 9/00		
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) WPAT, USPTO, ESP@CE: wind, turbine, refrigeration, compress		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 1987/006652 A1 (BAKRAN M S A) 05 November 1987 Claim 3	1-5,7,16-18,20 19
Y		
A	DE 10155560 A1 (PALME K) 17 July 2003 Whole Document	
A	FR 2833044 A1 (PARENT M H N) 06 June 2003 Whole document	
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INTERNATIONAL SEARCH REPORT

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4433552 A (SMITH) 28 February 1984 Whole document	19
A	GB 2117656 A (SMYTH CN) 19 October 1983 Whole document	

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU2005/001219

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Patent Document Cited in Search Report		Patent Family Member	
WO	8706652	FR	2556784
		US	4318019
		US	4262210
		DE	3402035
DE	10155560		
FR	2833044		
US	6308521		
US	4433552		
GB	2117656		
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.			
END OF ANNEX			