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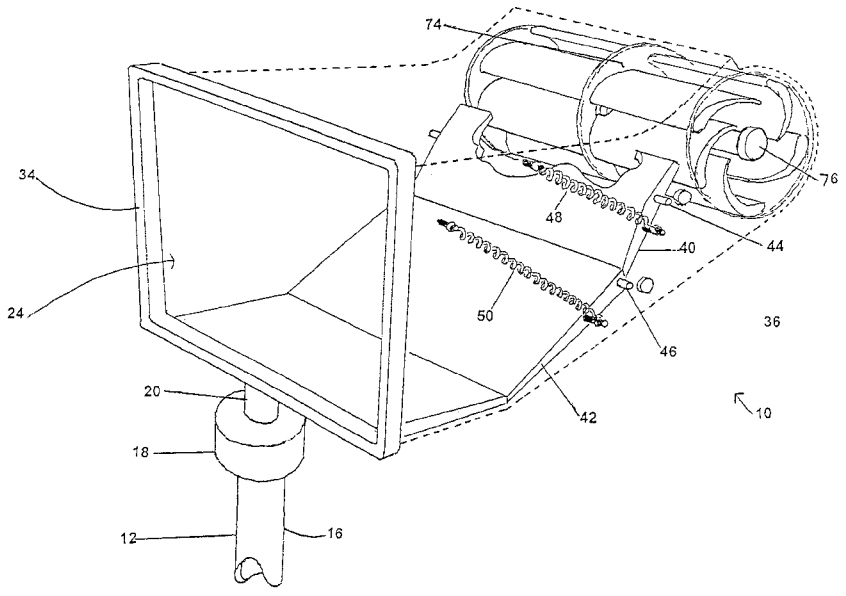
(54) **Title**: ELECTRICAL ENERGY GENERATOR



(57) **Abstract**: A fluid (water or wind) driven generator which includes a funnel of decreasing cross-section into which the fluid flows; a rotor inside the funnel; and a generator which is mounted for rotation concentrically with the rotor.

ELECTRICAL ENERGY GENERATOR

BACKGROUND OF THE INVENTION

[0001] This invention relates to the generation of electrical energy using the movement of a fluid as a motive source.

[0002] "Fluid", as used herein, includes a liquid, e.g. water, and a gas e.g. air.

[0003] A wind-driven electrical energy generator typically includes a turbine which is rotatable about a vertical axis so that its blades, in the form of a propeller arrangement, are directly presented to oncoming wind. These blades can be extensive in size and, when moving, are subjected to substantial stresses which can lead to unpredictable failure of the blades. The size of a large, wind-driven, turbine generator can be visually overwhelming and aesthetically unattractive.

[0004] An object of the present invention is to provide an electrical generator which is of compact form and relatively unobtrusive, and which can be installed and operated, using a suitable fluid as a motive source, under conditions of relative safety.

SUMMARY OF THE INVENTION

[0005] The invention provides apparatus for generating electrical energy which includes support structure, a funnel with a fluid inlet and a fluid outlet which is mounted to the support structure and which is movable relative to the support structure, a rotor inside the funnel between the inlet and the outlet and an electrical generator which is operatively connected to the rotor.

[0006] The funnel may enclose a passage which, at least over part of its length, decreases in cross-sectional area proceeding from the inlet to the outlet.

[0007] The funnel may be mounted to the support structure for pivotal movement about a vertical axis. The mounting arrangement may be adapted to ensure that the fluid inlet is positioned, automatically, to face an oncoming flow of the fluid.

[0008] The rotor may be mounted for rotation about a horizontal axis.

[0009] The funnel may include a force or pressure release mechanism. This feature is particularly beneficial if the rotor is driven by wind but could still be used if the fluid is a liquid. The mechanism may take on any appropriate form. In one embodiment of the invention the release mechanism includes an opening which increases in size as the fluid velocity increases e.g. the mechanism may include at least one flap which is movable by force produced on the flap by the fluid, against a biasing component, to divert the fluid away from the rotor to an increasing extent as the velocity of the fluid increases.

[0010] The electrical generator may take on any suitable form and may be mounted at any appropriate location. In one embodiment of the invention the electrical generator is mounted coaxially with the rotor, preferably inside a volume defined inside the rotor.

[0011] If the apparatus is to be driven by water flow then the funnel would be submerged e.g. in a body of the water. In this event the pressure release mechanism referred to is normally not required.

[0012] The support may be connected to an anchor at a floor of the body of water.

[0013] The inlet to the funnel may carry a screen or a mesh to restrict access of aquatic life (fishes, frogs and the like) into the funnel.

[0014] The electrical generator is preferably mounted for rotation about an axis which is concentric with an axis about which the rotor rotates. The electrical generator may have any suitable construction and may include a permanent magnet structure which is rotatable relative to stator coils mounted on the axis.

[0015] The rotor may also be of any appropriate kind. However it is preferred that the rotor includes a number of blades which have an aerofoil shape. This feature allows the rotor to rotate at a linear speed which is greater than the speed of movement of a fluid, say a water stream, which impinges on the blades.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The invention is further described by way of examples with reference to the accompanying drawings in which:

Figure 1 is a view in perspective, but illustrating aspects of an internal construction, of apparatus according to one form of the invention;

Figure 2 is a side view of the apparatus shown in Figure 1, on an enlarged scale;

Figure 3 is a view in perspective of apparatus according to another form of the invention, suited for use in water; and

Figure 4 is an exploded perspective view of part of a rotor and electrical generator included in the apparatus of Figure 3 on an enlarged scale.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0017] Figures 1 and 2 of the accompanying drawings illustrate apparatus 10 according to one form of the invention for generating electrical energy from wind.

[0018] The apparatus includes support structure 12 which is in the form of a vertically-extending mast 16, a thrust bearing 18 at an upper end of the mast, and a stub axle 20 which extends upwardly.

[0019] The apparatus includes a wind funnel 22 which has a rectangular wind inlet 24 and a wind outlet 26. Internally the funnel defines a passage 30 which decreases in cross-sectional area progressing from the inlet towards the outlet. The stub axle 20 is mounted to a lower end of a rigid support frame 34 which bounds the inlet 24 and the wind funnel extends, in cantilever fashion, to one side of the frame.

[0020] A pressure release arrangement 36 is located on a lower side of the wind funnel. In this instance the release arrangement includes first and second flaps or panels 40 and 42 respectively which are mounted to the funnel for pivotal movement about respective axes 44 and 46. The panels are biased to respective closed positions by means of coil springs 48 and 50.

[0021] As is shown in Figure 2 the panel 40, in its closed position, extends upwardly to define a relatively small duct or escape aperture 54 between an inner surface of the wind funnel 22 and an opposing tip 56 of the panel. Wind incident on the panel surface below the axis 44 can cause the panel to pivot in the direction of an arrow 60, against the biasing action of the spring 48, so that an aperture 62 below the panel is opened to an increasing extent. Similarly, the panel 42 is pivotal, by incident wind, about the axis 46 against the biasing action of the spring 50 thereby to expose an aperture 66, to an increasing extent, which is dependent on the velocity of the incoming wind.

[0022] A rotor 70 is mounted inside the passage close to the outlet 26. The rotor has a number of shaped blades 72 which are mounted to supports 74 which extend from a horizontally aligned hub 76.

[0023] An electrical generator is operatively coupled to the rotor. The generator can be positioned at any suitable location. In one preferred form of the invention the generator, notionally shown by means of a dotted line 80, is positioned inside a hollow section of the hub 76. The generator may be of conventional construction and typically includes magnets, and conductive windings, which are caused to move relative to each other upon rotation of the rotor. This aspect is known in the art and for this reason is not further described herein.

[0024] The wind funnel 22 is freely rotatable about a vertical axis 84 which passes through the mast 16 and so can pivot automatically to ensure that the inlet 24 faces oncoming wind 86. The funnel directs the wind to the aperture 54 and this causes the rotor to rotate. The speed of rotation is directly dependent on the force exerted by the wind. At low wind speeds the funnel acts to "concentrate" the wind and effectively increases the wind speed thereby to cause the rotor to rotate at a higher speed. If the wind force is too high then one or both of the panels 40 and 42 can open to an appropriate extent, under controlled conditions which are determined by the springs 48 and 50. This self-regulating characteristic ensures that the rotor does not rotate at a speed which is so high that the rotor can become damaged. Rotation of the rotor causes the electrical generator to generate electrical energy which can be processed to drive one or more devices, or to charge batteries or accumulators, according to requirement.

[0025] As the rotor is located inside the wind funnel it is, effectively, shielded from external factors. The safety of the apparatus is thereby enhanced. The capability of the funnel to rotate about a vertical axis means that installation problems are reduced for the mast 16 can be located on any suitable structure e.g. a roof, on open ground or the like.

[0026] Figure 3 of the accompanying drawings illustrates apparatus 110 according to one form of the invention for generating electrical energy from a water stream e.g. a current in a river, an ocean, a dam or the like.

[0027] The apparatus includes support structure 112 which is in the form of a vertically extending shaft 116, a thrust bearing 118 at one end of the shaft and a stub axle 120 which is connected to a funnel-shaped structure 122. The arrangement is such that the funnel structure 122 can pivot about the shaft 116.

[0028] The structure 122 has a rectangular inlet 124 and an outlet 126. Internally the funnel structure defines a passage 130 which decreases in cross-sectional area progressing from the inlet towards the outlet. The stub axle 120 is mounted to a lower end of a support frame 134 which bounds the inlet 124 and the structure 122 extends, in cantilever fashion, to one side of the frame.

[0029] The shaft 116 is secured to a sturdy anchor 136, e.g. in the form of a large block of concrete, which rests on a floor 138 below the body of water e.g. on the bottom of an ocean.

[0030] A panel 140 inside the passage 130 is curved from the inlet 124 upwardly to define a relatively narrow zone 142 between an upper edge 144 of the panel and an opposing surface of the funnel structure. The zone 142 defines a small duct or escape aperture which leads to a rotor 170 which is mounted inside the funnel

structure close to the outlet 126. The rotor has a number of shaped blades 172 which are mounted to supports 174 which are centred on a horizontal axis 176.

[0031] Each blade 172 has an aerofoil shape in cross-section with an outer surface 172A which has a convex shape and an inner surface 172B which has a concave shape. Any fluid passing over the outer and inner surfaces creates a pressure difference which tends to "lift" the blade. This movement can occur at a linear speed which is greater than the speed of movement of the fluid. In other words it is possible to cause the rotor to rotate at a speed which is significantly higher than the linear speed of movement of an incident fluid i.e., in this example, of an incoming flow of water which enters the inlet 124.

[0032] An electrical generator 180 is operatively coupled to the rotor. The generator can be positioned at any suitable location.

[0033] The rotor and the electrical generator are centred on a horizontally-extending, hollow, non-rotatable shaft 182, see Figure 4, which is aligned with the axis 176. Outermost supports 174, designated 174A, are located at extremities of the shaft and are mounted on bearings, not shown, so that they are rotatably supported on the structure 122.

[0034] Intervening supports, designated 174B in Figure 3, are not directly coupled to the shaft 182. Each support 174B has a number of apertures 184 which are shaped to receive in a firm and secure manner, the respective rotor blades 172. The supports 174B are positioned at spaced intervals from one another and are held in place by the rotor blades. Extremities of the blades are, as noted, firmly secured to the outwardly positioned supports 174A.

[0035] Figure 4 shows one intermediate support 174B. The support has a large central aperture 186 which is surrounded by bolt holes 188. On each side the support 174B is flanked, respectively, by a stator structure 190, which is fixed in a non-rotatable manner to the shaft 182 and to which are mounted windings 194 (not shown in detail). The stator structure can be positioned inside the aperture 186. On an outer side of the stator structure a magnet assembly 196 is located. The assembly includes a ring 198 which carries a number of rare earth magnets 200 and a locating ring 202 which has apertures 204 into which the magnets 200 are respectively positionable.

[0036] An outer cover 206 is used to secure the ring 198 to the ring 202. The cover has a seal structure and includes cooling vanes 210 which allow fluid to pass around the stator structure for cooling purposes.

[0037] Tabs 212 on the ring 202 allow the magnet assembly to be firmly fixed to one face of the support 174B. A similar assembly is attached to an opposing side of the support. In other respects the generator is of conventional construction and for this reason details of its construction are not further described. A cable 214 from the stator extends through the hollow shaft 182.

[0038] It is apparent from the aforegoing that the support 174B is rotatable together with the magnet structures 196 about the shaft 182. The shaft, as noted, is fixed and the stator structure is firmly mounted to the shaft so that the magnets are rotatable relative, to the windings, together with the rotor.

[0039] In other respects the generator is of conventional construction and, for this reason, details of its construction are not further described.

[0040] The funnel structure 122 is rotatable about a vertical axis 216, centred on the shaft 116, and so can pivot automatically relative to the anchor to ensure that the inlet 124 faces an incoming water stream 218. The funnel structure directs the water stream via the panel 140 to the zone 142 and this causes the rotor to rotate at a speed which is dependent on the force exerted by the water stream and the speed at which the water stream, itself, moves. The funnel structure acts to "concentrate" the water stream and effectively increases the speed of the stream thereby to cause the rotor to rotate at a higher speed.

[0041] Rotation of the rotor establishes relative movement between the stator windings and the permanent magnets. Electrical energy is thereby generated and transmitted via the cable 214 to a user location.

[0042] The rotor is located inside the funnel structure and is effectively shielded from external factors. The safety of the apparatus is thereby enhanced. The capability of the structure to pivot about the vertical axis 216 means that installation problems are reduced, for the anchor can be on any suitable base without undue concern about the rotation of the cable.

[0043] A screen 220 is preferably attached to the inlet 124. The screen has apertures 222 of a particular size to reduce the likelihood that aquatic life such as fishes, frogs or the like can be drawn into the passage 130.

[0044] Two forms of the invention have been described. The first relates to a wind-driven generator. In the second form of the invention the generator is driven by water flow. The features which have been described in connection with the first form of the invention can be used, as appropriate, with the second form of the invention, and vice versa.

CLAIMS

1. Apparatus for generating electrical energy which includes support structure, a funnel with a fluid inlet and a fluid outlet which is mounted to the support structure and which is movable relative to the support structure, a rotor inside the funnel between the inlet and the outlet and an electrical generator which is operatively connected to the rotor.

2. Apparatus according to claim 1 wherein the funnel encloses a passage which, at least over part of its length, decreases in cross-sectional area proceeding from the inlet to the outlet.

3. Apparatus according to claim 1 or 2 wherein the funnel is mounted to the support structure for pivotal movement about a vertical axis so that the fluid inlet is positioned, automatically, to face an oncoming flow of the fluid.

4. Apparatus according to any one of claims 1 to 3 wherein the rotor is mounted for rotation about a horizontal axis.

5. Apparatus according to any one of claims 1 to 4 which includes a pressure release mechanism which includes at least one flap which is movable by force produced on the flap by the fluid, against a biasing component, to divert the fluid away from the rotor to an increasing extent as the velocity of the fluid increases.

6. Apparatus according to any one of claims 1 to 5 wherein the electrical generator is mounted coaxially with the rotor.

7. Apparatus according to any one of claims 1 to 6 wherein the rotor includes a number of blades which have an aerofoil shape which allows the rotor to

rotate at a linear speed which is greater than the speed of movement of the fluid.

8. Apparatus according to any one of claims 1 to 7 wherein the fluid is water and wherein the inlet to the funnel has a screen to restrict access of aquatic life into the funnel.

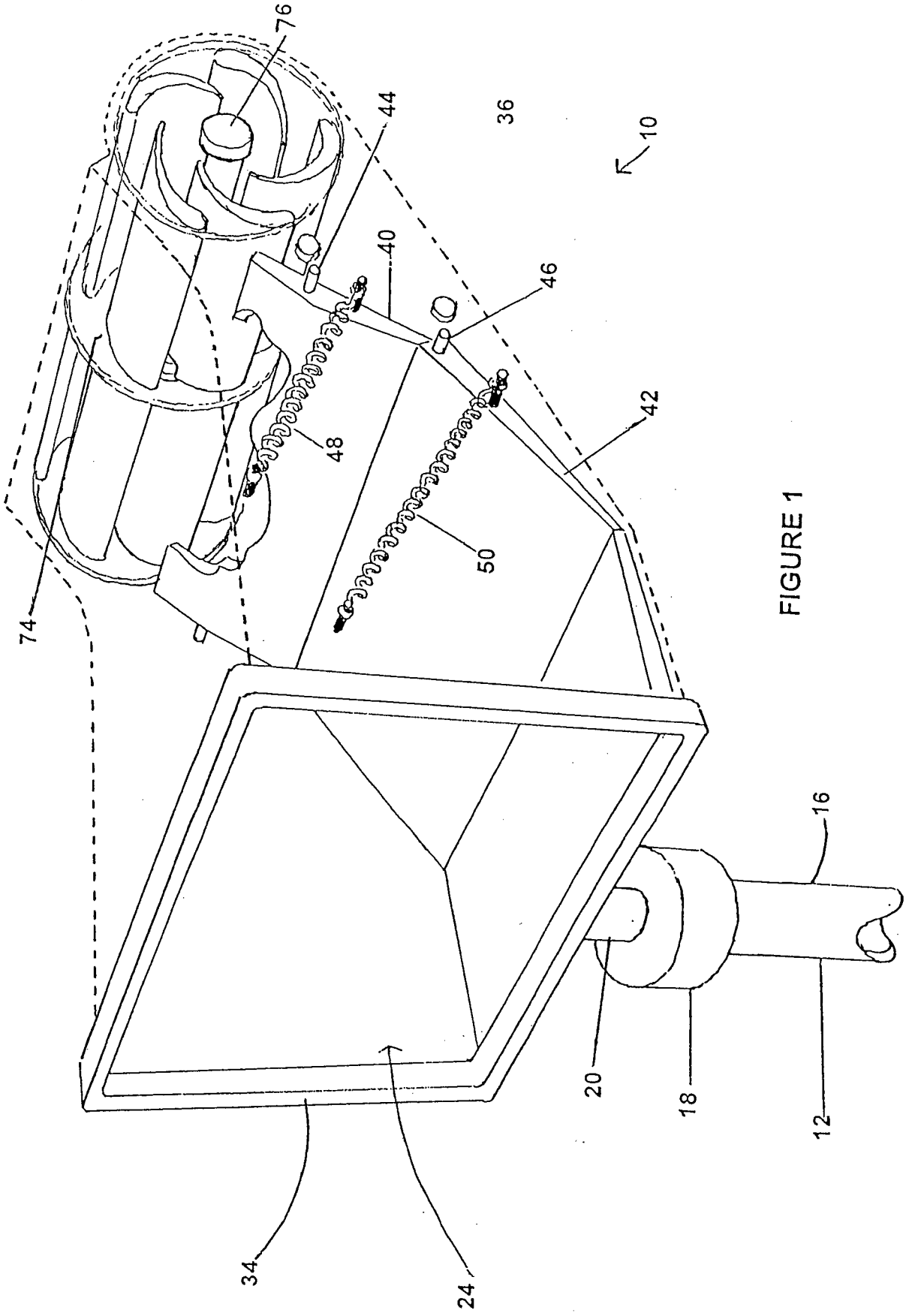


FIGURE 1

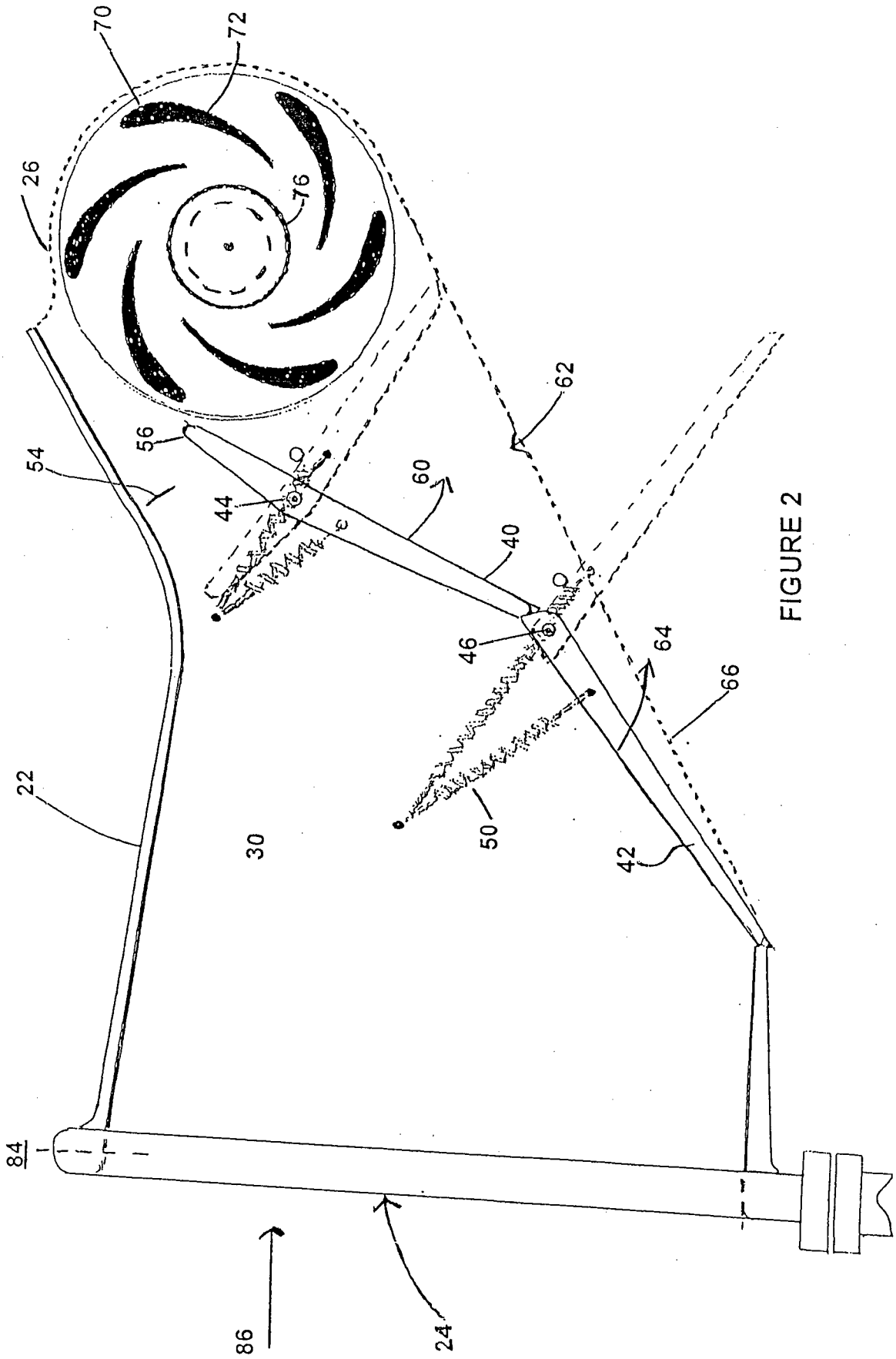
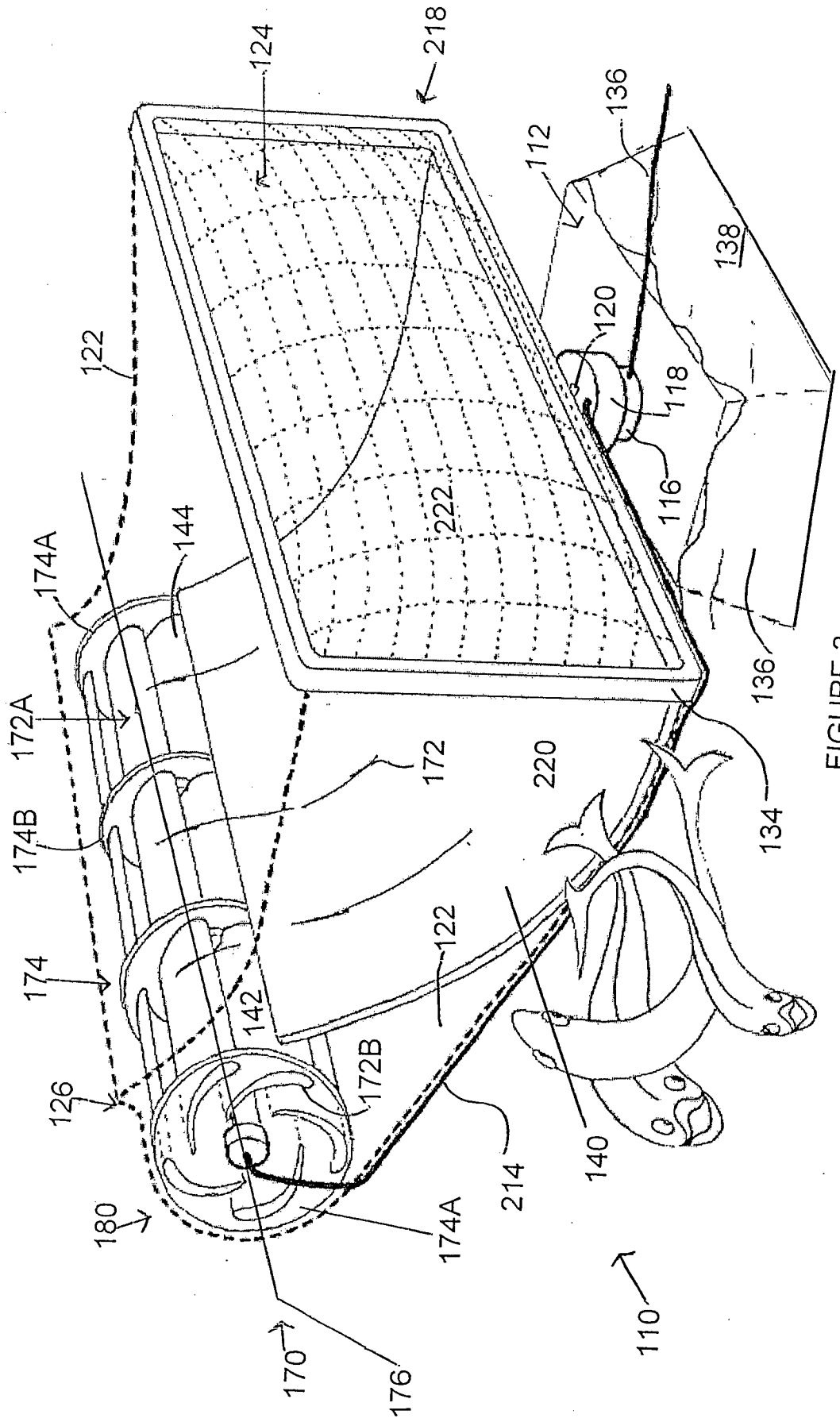


FIGURE 2


124
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172B
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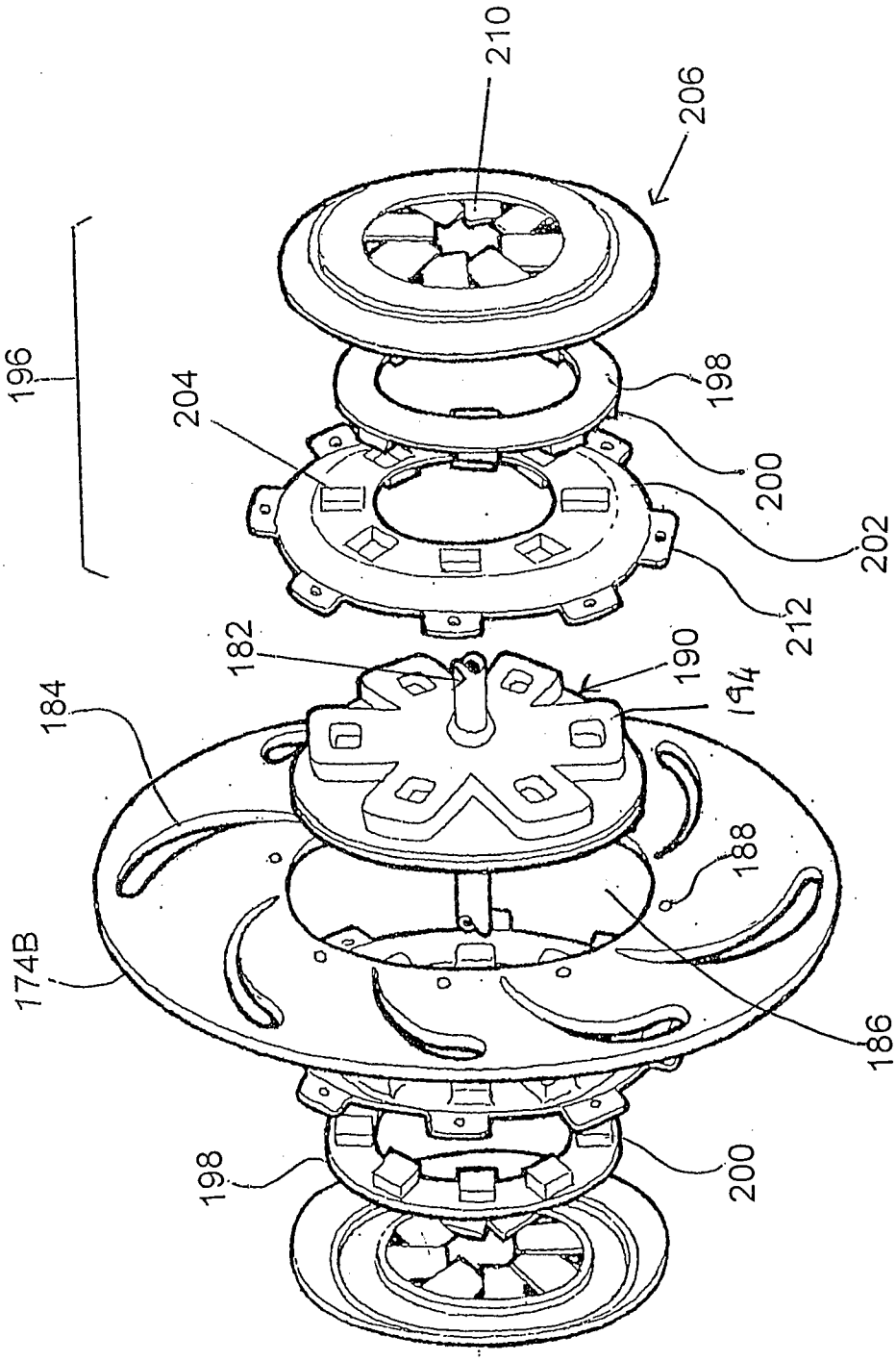
FIGURE 3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174B
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FIGURE 4