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(54) **CONVERTIBLE VERTICAL TAKE-OFF AND LANDING MINIATURE AERIAL VEHICLE**

UMWANDELBARES MINIATUR-SENKRECHTSTARTLUFTFAHRZEUG

VEHICULE AERIEN MINIATURE CONVERTIBLE A DECOLLAGE ET ATERRISSAGE VERTICAUX

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**Description****I. Technical Field Of The Invention**

**[0001]** The present invention relates generally to aircraft.

**II. Background Of The Invention**

**[0002]** In the past, attempts have been made to combine fixed wing airplanes with helicopters to achieve vertical take-off and landing (VTOL) capabilities. Examples include the Lockheed XfV-1 and the Convair XfY-1 Pogo.

**[0003]** The Pogo, for example, was thirty-one feet (31') long with a twenty-six feet (26') wide delta wing. A large vertical stabilizer above the wing was matched by an equally sized ventral fin below which could be jettisoned for an emergency horizontal landing. The first double transition from vertical flight to horizontal flight and back to a vertical landing by the Pogo was made on November 2, 1954. The Pogo was flown until November 1956. The Lockheed XfV-1 never made a vertical takeoff and landing. The world's first operational vertical/short take-off and landing (VSTOL), the Harrier jump jet, was introduced in the 1960's and was used successfully in several military campaigns.

**[0004]** Fixed wing airplanes and helicopters have completely permeated worldwide commerce and warfare. Presently, they are used to move civilians, soldiers, goods, supplies, etc. to nearly any place in the world. Moreover, fixed wing airplanes and helicopters are used to quickly transport injured persons or organs to and from hospitals. Militaries, law enforcement agencies, and intelligence agencies also use them to chase criminals, target, spy, and gather any other type of information. VTOL and VSTOL aircraft have been used infrequently, for specific military missions, but these types of aircraft have never achieved the widespread success of conventional fixed wing airplanes and helicopters due in part to the difficulty in powering and controlling them.

**[0005]** Smaller unmanned fixed wing airplanes and helicopters have proved useful for surveillance, lethal and non-lethal ordnance delivery, crowd control, targeting etc. However, a relatively small, unmanned aircraft that can transition between vertical flight (like a helicopter) and horizontal flight (like a fixed wing airplane), has not been provided. Thus, the present invention recognizes that there is a need for a relatively small, unmanned aerial vehicle that can transition between a vertical flight mode and a horizontal flight mode and sustain either mode of flight.

**[0006]** US4037807 discloses a flight vehicle having the features of the preamble of claim 1.

**SUMMARY OF THE INVENTION**

**[0007]** In accordance with the invention, there is pro-

vided an aerial vehicle, comprising:

a rotor guard assembly;  
 an upper fuselage segment extending upwardly from the rotor guard assembly;  
 a lower fuselage segment extending downwardly from the rotor guard assembly;  
 at least one rotor rotating within the rotor guard assembly between the upper fuselage segment and the lower fuselage segment; and  
 at least one turning vane flap extending from the rotor guard assembly below the rotor; characterised in that there is at least one grid fin extending radially from the lower fuselage segment below the turning vane flap, the grid fin allowing the aerial vehicle to transition between a vertical flight mode and a horizontal flight mode and in that there are six or more turning vane flaps.

**[0008]** In a preferred embodiment, the aerial vehicle further includes an undercarriage that extends downwardly from the outer periphery of the rotor guard assembly. Also, a powerplant is installed in the lower fuselage segment adjacent to the rotor guard assembly. The power plant has a shaft that extends between the lower fuselage segment and the upper fuselage segment and the rotor is rigidly attached to the shaft.

**[0009]** Preferably, a fuel tank is installed in the upper fuselage segment adjacent to the rotor guard assembly. The fuel tank includes a bladder installed.

**[0010]** The bladder is inflatable to pressurize fuel in the fuel tank. In a preferred embodiment, a fuel line leads from the fuel tank to the powerplant and is routed partially external to the rotor guard assembly. Also, a high pressure line leads from the powerplant to the bladder within the fuel tank and is routed partially external to the rotor guard assembly.

**[0011]** In a preferred embodiment, an upper cap is installed on the upper fuselage segment. One or more sensors are disposed within the upper cap. The sensor can be an optical sensor, an infrared (IR) sensor, a radio frequency (RF) sensor, a magnetic field sensor, a chemical sensor, an acoustic sensor, a motion sensor, etc. Additionally, one or more cameras can be disposed within the upper cap. The camera can be a video camera, a still camera, a digital video camera, a digital still camera, a color video camera, a black-and-white video camera, a thermal imaging camera, an infrared video camera, a night vision camera, etc.

**[0012]** Preferably, the aerial vehicle also includes a microprocessor within the upper fuselage segment. A transceiver is connected to the microprocessor and extends through the upper cap. In a preferred embodiment, the aerial vehicle further includes a global positioning satellite (G.P.S.) system within the upper fuselage segment. The G.P.S. system is also connected to the microprocessor.

**[0013]** Preferably, the upper fuselage segment and the

lower fuselage segment together define a fuselage defining a longitudinal axis;

the rotor guard assembly surrounds at least a portion of the fuselage in a plane perpendicular to the longitudinal axis;

the rotor rotates within the rotor guard assembly in a plane perpendicular to the longitudinal axis; the turning vane flaps have one end hingedly attached to the rotor guard, the turning vane flaps rotating about a radial axis extending radially from the longitudinal axis; and the grid fin rotates about a central axis extending radially from the longitudinal axis.

**[0014]** The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

### BRIEF DESCRIPTION OF THE DRAWINGS

#### [0015]

(Figure 1 is a side plan view of the aerial vehicle of the present invention;

(Figure 2 is a cross-section view of the aerial vehicle taken along line 2-2 in Figure 1;

Figure 3 is a cross-section view of the aerial vehicle taken along line 3-3 in Figure 1;

Figure 4 is a cross-section view of the aerial vehicle taken along line 4-4 in Figure 1;

Figure 5 is a block diagram of a fuel system; and

Figure 6 is a block diagram of a control system.

### DESCRIPTION OF AN EMBODIMENT OF THE INVENTION

**[0016]** Referring initially to Figure 1, an aerial vehicle is shown and generally designated 10. Figure 1 shows that the aerial vehicle 10 includes an upper fuselage segment 12 and a lower fuselage segment 14 that are connected by a rotor guard assembly 16. In a preferred embodiment, the fuselage segments 12, 14 are hollow tubular members which are open at each end. Preferably, the fuselage segments 12, 14 are made from a graphite epoxy composite, but can be made from any other suitable material well known in the art.

**[0017]** As mentioned above, the lower end of the upper fuselage segment 12 and the upper end of the lower fuselage segment 14 are engaged with the rotor guard assembly 16. Figure 1 further shows that the aerial vehicle 10 includes an undercarriage that, in this non-limiting, exemplary embodiment, comprises six legs 18 that extend downwardly from the outer periphery of the rotor guard assembly 16. The legs 18 are equally spaced around the outer periphery of the rotor guard assembly 16 and are angled with respect to a longitudinal axis 20 defined by the aerial vehicle 10.

**[0018]** It is to be understood that the undercarriage can be fixed or retractable and can be configured to allow the aerial vehicle 10 to alight on surfaces of varying contour.

As described above, the undercarriage is mounted on the outer periphery of the rotor guard assembly 16 and is structurally coupled to the turning vanes, described below, to allow loads on the undercarriage to be transferred to the upper fuselage segment 12 and the lower fuselage segment 14. Preferably, the undercarriage is made from a graphite epoxy composite, but can be made from any other suitable material well known in the art. The undercarriage can also include a quick release mechanism to allow it to drop-off after the aerial vehicle 10 is launched, e.g., for a one-way mission. Moreover, the undercarriage can be designed to absorb impacts caused by landing, e.g., using elastomeric polymers, shock-absorbing foam hinges, shock absorbing feet, etc.

**[0019]** As shown in Figure 1, an upper cap 22 is installed on the upper end of the upper fuselage segment 12. A sensor bay, described in detail below, is established within the upper cap 22. A lower cap 24 is disposed on the lower end of the lower fuselage segment 14. As shown the upper cap 22 and the lower cap 24 are hemispherically shaped, but they can be any aerodynamically appropriate shape. It is to be understood that the lower cap 24 provides a smooth fairing off which boattail drag can be significantly reduced when the aerial vehicle is in airplane flight mode, e.g., like a conventional fixed-wing airplane. The lower cap 24 also protects the empennage 26, described in detail below, the lower fuselage segment 14, and the components within the lower fuselage segment 14 and empennage 26 from damage caused by dirt, debris, exhaust gases, impact, etc. The lower cap 24 is preferably made from an energy absorbing material. Thus, if any of the legs 18 are damaged during landing, the lower cap 24 can absorb the impact.

**[0020]** In a preferred embodiment, the aerial vehicle 10 includes plural, preferably six, turning vane flaps 28. The turning vane flaps 28 are equally spaced around the rotor guard assembly 16 and are placed beneath the rotor, described below. As described in detail below, each turning vane flap 28 is hingedly attached to a turning vane within the rotor guard assembly 16. Also, each turning vane flap 28 is aligned with a respective leg 18 extending from the rotor guard assembly 16. Moreover, a respective roll control servo 30, e.g., a rotary electro-mechanical servo-actuator, is connected to each turning vane flap 28 and controls the rotation thereof. Each roll control servo 30 is rigidly attached to the outer periphery of the rotor guard assembly 16 and includes a shaft 32 that is attached to a respective turning vane flap 29. It is to be understood that the roll control servos 30 are issued identical commands so as to roll the aerial vehicle 10. Specifically, each turning vane flap 28 is rotated about its hinged end, through an axis extending radially from the longitudinal axis 20, in order to generate rolling moments around the longitudinal axis 20. Accordingly, the turning vane flaps 28 are designed to counter atmospheric effects and changes in rolling moments due to inertial loading or unloading.

**[0021]** In a preferred embodiment, the turning vane

flaps 28 are fabricated from a structurally stiff material which is strong and light, e.g., a graphite epoxy composite, to allow for rapid transitions and increase the speed and responsiveness of the aerial vehicle 10 during rolling maneuvers. Preferably, the width of each turning vane flap 28 is such that the inner edge of each flap 28 is a greater distance from the central longitudinal axis 20 of the aerial vehicle 10 than the outer periphery of the empennage 26. Otherwise, the below-described grid fins that comprise the empennage 26 might counteract the motion of the aerial vehicle caused by the turning vane flaps 28.

**[0022]** Figure 1 further shows that the aerial vehicle 10 can include a remote control unit 34. As shown, the remote control unit 34 can include plural control buttons 36 and a joy stick 38. Thus, the buttons 36 and the joy stick 38 can be used to control the flight of the aerial vehicle 10.

**[0023]** Referring to Figure 2, the aerial vehicle 10 is shown with the fuselage segments 12, 14, the caps 22, 24, and the rotor guard assembly 16 cross-sectioned to reveal the interior components of the aerial vehicle 10. Figure 2 shows that the rotor guard assembly 16 includes plural upper turning vanes 40 and plural lower turning vanes 42 that extend radially from a generally cylindrical rotor guard hub 44 to a generally cylindrical rotor guard wall 46. As shown, the vanes 40, 42 are integrally formed with the rotor guard hub 44 and the rotor guard wall 46, but it can be appreciated that the vanes 40, 42, the hub 44, and the wall 46 can be formed separately and then attached to each other by a means well known in the art such as chemical welding. The lower end of the upper fuselage segment 12 and the upper end of the lower fuselage segment 14 are disposed within the rotor guard hub 44. Thus, the fuselage segments 12, 14 are supported by the rotor guard assembly 16.

**[0024]** It is to be understood that the rotor guard assembly 16 lends safety to the aerial vehicle and observers or objects in close proximity to the aerial vehicle 10. The rotor guard assembly 16 is designed so that lateral strike loads can be absorbed thereby during close-quarters hovering maneuvers. The rotor guard assembly 16 also increases the efficiency of the aerial vehicle 10 in that tip-effects of the rotor, described below, are reduced. It can be appreciated that the rotor guard assembly 16 can be lined with a rub strip to further reduce tip losses and it can be lined with anechoic materials to absorb acoustic energy. Further, the rotor guard assembly 16 can be penetrated and/or perforated for acoustic signature amelioration and accommodation of subsystem components. The rotor guard assembly 16 can also be fabricated from foil-thickness materials or it can have a thickness that is substantial enough to allow the rotor guard assembly 16 to house ancillary payloads.

**[0025]** Figure 2 shows a powerplant 48 installed within the lower fuselage segment 14. It is to be understood that the powerplant 48 can be a micro turbine, a rotary engine, any type of internal combustion engine, or any type of electric motor. In this non-limiting, exemplary em-

bodiment the powerplant 48 is an internal combustion engine. As shown, the powerplant 48 includes a shaft 50 that extends perpendicularly into the rotor guard assembly 16 within the space established between the ends of the fuselage segments 12, 14. A rotor 52 is rigidly attached to the shaft 50 and rotates perpendicularly to the longitudinal axis 20 within the rotor guard assembly 16. It is to be understood that the rotor 52 can have any number of blades and blade chords. Moreover the rotor 52 can be made of any suitable structural material well known in the art. Preferably, the rotor 52 extends from the center of the shaft 50 outward to the inner periphery of the rotor guard wall 46 in order to reduce tip losses which are normally encountered by free rotors. In a preferred embodiment the rotor 52 has a diameter from 101.6mm-754mm (4"- 10"), but it can be as large as 1828mm (six feet) in diameter.

**[0026]** A preferably cylindrical fuel tank 54 is disposed in the upper fuselage segments 12 above the rotor 46. A fuel line 56 leads from the fuel tank 54, through the upper fuselage segment 12, through the rotor guard hub 44, along an upper turning vane 40, along the rotor guard wall 46, along a lower turning vane 42, through the rotor guard hub 44, through the lower fuselage segment 14, and into the powerplant 48.

**[0027]** In a preferred embodiment, the fuel tank 54 includes a sealed bladder 58 that is pressurized by an external gas source, e.g., the exhaust manifold of the powerplant 48, describe below. It is to be appreciated that the bladder 58 ensures consistent flow of pressurized fuel to the powerplant 48. As shown, a pressure line 60 extends from the powerplant 48 to the bladder 58 and is routed thereto much like the fuel line 56 is routed from the fuel tank 54 to the powerplant 48. Preferably, the fuel tank 54 is located as close to the center of gravity of the aerial vehicle 10 as possibly. Thus, as the fuel level within the fuel tank 54 changes during flight, the location of the center of gravity of the aerial vehicle will not significantly change.

**[0028]** As shown in Figure 2, a sensor bay 62 is established within the upper cap 22 and an avionics bay 64 is established within the upper end of the upper fuselage segment 12 beneath the sensor bay 62. Figure 2 shows that a microprocessor 66 is disposed within the avionics bay 64. Moreover, at least one sensor 68 and at least one camera 70 are disposed within the sensor bay 62. A transceiver 72 extends through the upper cap 22. The sensor 68 can be any type of sensor, e.g., an optical sensor, an infrared (IR) sensor, a radio frequency (RF) sensor, a magnetic field sensor, a chemical sensor, an acoustic sensor, a motion sensor, etc. Also, the camera 70 can be any type of camera, e.g., a video camera, a still camera, a digital video camera, a digital still camera, a color video camera, a black-and-white video camera, a thermal imaging camera, an infrared video camera, a night vision camera, etc.

**[0029]** Referring now to Figure 3, in a preferred embodiment the rotor guard assembly 16 includes six upper

turning vanes 40. It is to be understood that the preferred rotor guard assembly 16 also includes six lower turning vanes 42 (Figure 2). Each lower turning vane 42 is aligned with a respective upper turning vane 40.

**[0030]** Figure 4 shows details of the empennage 26. As shown, in this non-limiting, exemplary embodiment, the empennage 26 includes four identical grid fins 74 radially spaced around the lower end of the lower fuselage segment 14. In a preferred embodiment, each grid fin 74 includes plural hollow cells 76 through which air flows during flight of the aerial vehicle 10. As shown, a single respective rotary electro-mechanical servo-actuator 78 is connected to each grid fin 74 via a shaft 80. Opposite servos 78 receive identical signals so that the grid fins 74 are actuated in unified pairs. Each grid fin 74 rotates through an axis that extends radially from the longitudinal axis 20.

**[0031]** It is to be understood that the powerplant 48 rotates the rotor 52 which provides lift for the aerial vehicle 10. With the grid fins 74 aligned with the air flow caused by the rotor 52, the aerial vehicle 10 can take-off vertically and land vertically. During flight, the turning vanes 28 can be rotated in unison about their hinged ends, e.g., in response to a signal from the remote control unit 34, in order to change the direction of air flowing across the turning vane flaps 28 and thus, rotate the aerial vehicle 10 about its longitudinal axis 20. If the aerial vehicle 10 is vertically oriented, this motion is considered yaw. On the other hand, if the aerial vehicle 10 is horizontal, this motion is considered roll.

**[0032]** The grid fins 74 can be used to alter the direction of air flowing therethrough and alter the direction in which the aerial vehicle 10 is traveling. Thus, the grid fins 74 can be used to redirect the aerial vehicle 10 during vertical flight or horizontal flight or completely transition the aerial vehicle 10 between a vertical flight mode and a horizontal flight mode.

**[0033]** Referring to Figure 5, one non-limiting exemplary fuel system is shown and generally designated 100. Figure 5 shows that the fuel system 100 includes the fuel tank 54 (Figure 2) and bladder 58 (Figure 2) that are connected to the powerplant 48 (Figure 2) via the fuel line 56 (Figure 2) and the pressure line 60 (Figure 2).

**[0034]** As shown in Figure 5, the bladder 58 is preferably connected to an exhaust manifold 102 by the pressure line 60. However, it is to be understood that the bladder 58 can be connected to a crankcase 104 as indicated by dashed line 106. Figure 5 shows that the fuel system 100 can include a fuel filter 108 and a fuel regulator 110 installed along the fuel line 56 between the fuel tank 54 and the engine 48. Preferably, the fuel filter 108 is installed between the fuel tank 54 and the fuel regulator 110. The fuel regulator 110 is used to prevent excessive fuel pressure during start-up, idle, or shut-down, and thus, to prevent engine flooding or hydro-lock. Moreover, the fuel filter 108 is used to ensure that the fuel delivered to the powerplant 48 is clean and free of debris that can adversely affect the performance and life span of the

powerplant 48 and the fuel regulator 110.

**[0035]** In general, the fuel filter 108 is situated so that it can be removed, inspected, and, if necessary, replaced during routine maintenance of the aerial vehicle 10. On the other hand, the fuel regulator 110 is not typically replaced on a regular basis and accordingly, is mounted in a location within the upper fuselage segment 12 that is not as easily accessible as the fuel filter 108.

**[0036]** Referring now to Figure 6, one exemplary, non-limiting control system is shown and generally designated 120. Figure 6 shows that the control system 120 includes a microprocessor 122 to which the subcomponents, described below, are attached. As shown, the microprocessor 122 is connected to the grid fin servos 78 (Figure 4) via electrical lines 124 and 126. The grid fin servos 78 are connected in pairs so that opposite pairs of grid fin servos 78 receive the same signals. The microprocessor 122 is also connected to the roll control servos 30 (Figure 1) via electrical line 128. The roll control servos 30 are connected so that all six roll control servos 30 receive identical signals simultaneously.

**[0037]** As shown in Figure 6, the microprocessor 122 is connected to the powerplant 48, e.g., the accelerator 130 and ignition system 132, via electrical lines 134 and 136 in order to control the operation thereof. The microprocessor 122 is also connected to the sensor 68 (Figure 2), the camera 70 (Figure 2), and the transceiver 72 by electrical lines 138, 140 and 142. As shown, the microprocessor 122 can also be connected to a global positioning satellite (G.P.S.) system 144 by electrical line 146.

**[0038]** Accordingly, with the above described control system 120 the microprocessor 122 can be used to control the flight of the aerial vehicle 10 by controlling the operation of the grid fin servos 78, the roll control servos 30, the engine accelerator 130 and ignition system 132 in response to remote control signals from the remote control unit 34. Or, the microprocessor 122 can control the flight of the aerial vehicle 10 in response to a pre-programmed flight plan. The microprocessor 122 can also send and receive information via the transceiver 72. This information can be control signals from the remote control unit 34, sensor signals, video or stills from the camera 70, or any other information relevant to the flight of the aerial vehicle 10.

**[0039]** With the configuration of structure and method described above, it can be appreciated that the aerial vehicle 10 can take off and land vertically. Moreover, during flight the aerial vehicle 10 can hover while vertical and transition between a vertical flight mode and a horizontal flight mode.

**[0040]** While the particular CONVERTIBLE VERTICAL TAKE-OFF AND LANDING MINIATURE AERIAL VEHICLE as herein shown and described in detail is fully capable of attaining the above-described objects of the invention, it is to be understood that it is the presently preferred embodiment of the present invention and thus, is representative of the subject matter which is broadly contemplated by the present invention, that the scope of

the present invention fully encompasses other embodiments which may become obvious to those skilled in the art, and that the scope of the present invention is accordingly to be limited by nothing other than the appended claims, in which reference to an element in the singular is not intended to mean "one and only one" unless explicitly so stated, but rather "one or more." All structural and functional equivalents to the elements of the above-described preferred embodiment that are known or later come to be known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the present claims. Moreover, it is not necessary for a device or method to address each and every problem sought to be solved by the present invention, for it is to be encompassed by the present claims. Furthermore, no element, component, or method step in the present disclosure is intended to be dedicated to the public regardless of whether the element, component, or method step is explicitly recited in the claims.

## Claims

1. An aerial vehicle (10) comprising:
  - a rotor guard assembly (16);
  - an upper fuselage segment (12) extending upwardly from the rotor guard assembly (16);
  - a lower fuselage segment (14) extending downwardly from the rotor guard assembly (16);
  - at least one rotor (52) rotating within the rotor guard assembly (16) between the upper fuselage segment (12) and the lower fuselage segment (14); and
  - at least one turning vane flap (28) extending from the rotor guard assembly (16) below the rotor (52); **characterised in that** there is at least one grid fin (74) extending radially from the lower fuselage segment (14) below the turning vane flap (28), the grid fin (74) allowing the aerial vehicle (10) to transition between a vertical flight mode and a horizontal flight mode, and **in that** there are six or more turning vane flaps (28).
2. The aerial vehicle of claim 1, further comprising:
  - an undercarriage (18) extending downwardly from the outer periphery of the rotor guard assembly (16).
3. The aerial vehicle of claim 2, further comprising:
  - a powerplant (48) installed in the lower fuselage segment (14) adjacent to the rotor guard assembly (16), the power plant (48) having a shaft (50) extending between the lower fuselage segment (14) and the upper fuselage segment (12), the rotor (52) being rigidly attached to the shaft (50).
4. The aerial vehicle of claim 3, further comprising:
  - a fuel tank (64) installed in the upper fuselage segment (12) adjacent to the rotor guard assembly (16).
5. The aerial vehicle of claim 4, wherein the fuel tank (64) includes a bladder installed therein, the bladder being inflatable to pressurize fuel in the fuel tank.
6. The aerial vehicle of claim 5, further comprising:
  - a fuel line (56) leading from the fuel tank (64) to the powerplant, the fuel line being routed at least partially external to the rotor guard assembly (16).
7. The aerial vehicle of claim 6, further comprising:
  - a high pressure line (60) leading from the powerplant (48) to the bladder within the fuel tank (64), the high pressure line being routed at least partially external to the rotor guard assembly (16).
8. The aerial vehicle of claim 7, further comprising; an upper cap (22) installed on the upper fuselage segment (22).
9. The aerial vehicle of claim 8, further comprising:
  - at least one sensor (68) disposed within the upper cap (22).
10. The aerial vehicle of claim 9, wherein the sensor (68) is at least one of the following: an optical sensor, an infrared (IR) sensor, a radio frequency (RF) sensor, a magnetic field sensor, a chemical sensor, an acoustic sensor, and a motion sensor.
11. The aerial vehicle of claim 10, further comprising:
  - at least one camera disposed within the upper cap (22).
12. The aerial vehicle of claim 11, wherein the camera is at least one of the following: a video camera, a still camera, a digital video camera, a digital still camera, a color video camera, a black-and-white video camera, a thermal imaging camera, an infrared video camera, and a night vision camera.
13. The aerial vehicle of claim 12, further comprising:
  - at least one microprocessor (66) within the upper fuselage segment (12).

14. The aerial vehicle of claim 13, further comprising:

at least one transceiver (72) connected to the microprocessor (66) and extending through the upper cap (22).

15. The aerial vehicle of claim 14, further comprising:

at least one global positioning satellite system within the upper fuselage segment (12) and connected to the microprocessor (66).

16. The aerial vehicle of any preceding claim, wherein the upper fuselage segment (12) and the lower fuselage segment (14) together define a fuselage defining a longitudinal axis;

the rotor guard assembly (16) surrounds at least a portion of the fuselage in a plane perpendicular to the longitudinal axis;

the rotor (52) rotates within the rotor guard assembly (16) in a plane perpendicular to the longitudinal axis; the turning vane flaps (28) have one end hingedly attached to the rotor guard (16), the turning vane flaps (28) rotating about a radial axis extending radially from the longitudinal axis; and the grid fin rotates about a central axis extending radially from the longitudinally axis.

#### Patentansprüche

1. Luftfahrzeug (10), das aufweist:

eine Rotorschutzbaugruppe (16);  
ein oberes Rumpfsegment (12), das sich von der Rotorschutzbaugruppe (16) nach oben erstreckt;  
ein unteres Rumpfsegment (14), das sich von der Rotorschutzbaugruppe (16) nach unten erstreckt;  
mindestens einen Rotor (52), der sich innerhalb der Rotorschutzbaugruppe (16) zwischen dem oberen Rumpfsegment (12) und dem unteren Rumpfsegment (14) dreht; und  
mindestens eine Drehflügelklappe (28), die sich von der Rotorschutzbaugruppe (16) unterhalb des Rotors (52) erstreckt;

**dadurch gekennzeichnet, dass** mindestens eine Gitterseitenflosse (74) vorhanden ist, die sich radial vom unteren Rumpfsegment (14) unterhalb der Drehflügelklappe (28) erstreckt, wobei die Gitterseitenflosse (74) dem Luftfahrzeug (10) den Übergang zwischen einer vertikalen Flügelweise und einer horizontalen Flugweise gestattet, und **dadurch**, dass sechs oder mehr Drehflügelklappen (28) vorhanden sind.

2. Luftfahrzeug nach Anspruch 1, das außerdem aufweist:

ein Fahrwerk (18), das sich vom äußeren Umfang der Rotorschutzbaugruppe (16) nach unten erstreckt.

3. Luftfahrzeug nach Anspruch 2, das außerdem aufweist:

ein Triebwerk (48), das im unteren Rumpfsegment (14) benachbart der Rotorschutzbaugruppe (16) installiert ist, wobei das Triebwerk (48) eine Welle (50) aufweist, die sich zwischen dem unteren Rumpfsegment (14) und dem oberen Rumpfsegment (12) erstreckt, wobei der Rotor (52) starr auf der Welle (50) befestigt ist.

4. Luftfahrzeug nach Anspruch 3, das außerdem aufweist:

einen Treibstoffbehälter (64), der im oberen Rumpfsegment (12) benachbart der Rotorschutzbaugruppe (16) installiert ist.

5. Luftfahrzeug nach Anspruch 4, bei dem der Treibstoffbehälter (64) eine Blase einschließt, die darin installiert ist, wobei die Blase aufblasbar ist, um den Treibstoff im Treibstoffbehälter unter Druck zu setzen.

6. Luftfahrzeug nach Anspruch 5, das außerdem aufweist:

eine Treibstoffleitung (56), die vom Treibstoffbehälter (64) zum Triebwerk führt, wobei die Treibstoffleitung mindestens teilweise außerhalb der Rotorschutzbaugruppe (16) geführt wird.

7. Luftfahrzeug nach Anspruch 6, das außerdem aufweist:

eine Hochdruckleitung (60), die vom Triebwerk (48) zur Blase innerhalb des Treibstoffbehälters (64) führt, wobei die Hochdruckleitung mindestens teilweise außerhalb der Rotorschutzbaugruppe (16) geführt wird.

8. Luftfahrzeug nach Anspruch 7, das außerdem aufweist:

eine obere Kappe (22), die auf dem oberen Rumpfsegment (12) installiert ist.

9. Luftfahrzeug nach Anspruch 8, das außerdem aufweist:

- mindestens einen Sensor (68), der innerhalb der oberen Kappe (22) installiert ist.
10. Luftfahrzeug nach Anspruch 9, bei dem der Sensor (68) mindestens einer der folgenden ist: ein optischer Sensor; ein Infrarotsensor; ein Hochfrequenzsensor; ein Magnetfeldsensor; ein chemischer Sensor; ein akustischer Sensor; und ein Bewegungssensor. 5
11. Luftfahrzeug nach Anspruch 10, das außerdem aufweist:
- mindestens eine Kamera die innerhalb der oberen Kappe (22) angeordnet ist. 15
12. Luftfahrzeug nach Anspruch 11, bei dem die Kamera mindestens eine der folgenden ist: eine Videokamera; eine Standbildkamera; eine Digitalvideokamera; eine Digitalstandbildkamera; eine Farbvideokamera; eine Schwarzweißvideokamera; eine Wärmebildkamera; eine Infrarotvideokamera; und eine Nachtsichtkamera. 20
13. Luftfahrzeug nach Anspruch 12, das außerdem aufweist:
- mindestens einen Mikroprozessor (66) innerhalb des oberen Rumpfsegmentes (12). 25
14. Luftfahrzeug nach Anspruch 13, das außerdem aufweist:
- mindestens ein Sende-Empfangs-Gerät (72), das mit dem Mikroprozessor (66) verbunden ist und sich durch die obere Kappe (22) erstreckt. 30
15. Luftfahrzeug nach Anspruch 14, das außerdem aufweist:
- mindestens ein Globales Positionierungssystem innerhalb des oberen Rumpfsegmentes (12) und mit dem Mikroprozessor (66) verbunden. 35
16. Luftfahrzeug nach einem der vorhergehenden Ansprüche, bei dem das obere Rumpfsegment (12) und das untere Rumpfsegment (14) zusammen einen Rumpf definieren, der eine Längsachse definiert; die Rotorschutzbaugruppe (16) mindestens einen Teil des Rumpfes in einer Ebene senkrecht zur Längsachse umgibt; der Rotor (52) sich innerhalb der Rotorschutzbaugruppe (16) in einer Ebene senkrecht zur Längsachse dreht; die Drehflügelklappen (28) ein Ende aufweisen, das gelenkig am Rotorschutz (16) befestigt ist, wobei 40

sich die Drehflügelklappen (28) um eine radiale Achse drehen, die sich radial von der Längsachse erstreckt; und wobei sich die Gitterseitenflosse um eine Mittelachse dreht, die sich radial von der Längsachse erstreckt. 45

## Revendications

- 10 1. Véhicule aérien (10), comprenant:
- un ensemble de protection de rotor (16);  
un segment de fuselage supérieur (12) s'étendant vers le haut depuis l'ensemble de protection de rotor (16);  
un segment de fuselage inférieur (14) s'étendant vers le bas depuis l'ensemble de protection de rotor (16);  
au moins un rotor (52) tournant à l'intérieur de l'ensemble de protection de rotor (16) entre le segment de fuselage supérieur (12) et le segment de fuselage inférieur (14); et  
au moins un volet de pale (28) s'étendant depuis l'ensemble de protection de rotor (16) en dessous du rotor (52); 15
- caractérisé par le fait qu'**au moins un aileron formant grille (74) s'étendant radialement depuis le segment de fuselage inférieur (14) en dessous du volet de pale (28), l'aileron formant grille (74) permettant au véhicule aérien (10) de passer d'un mode vol vertical à un mode vol horizontal, et par la présence de six volets de pales (28) ou plus. 20
- 35 2. Véhicule aérien selon la revendication 1, comprenant en outre:
- un train d'atterrissage (18) s'étendant vers le bas depuis la périphérie extérieure de l'ensemble de protection de rotor (16). 40
- 45 3. Véhicule aérien selon la revendication 2, comprenant en outre:
- une installation motrice (48) installée dans le segment de fuselage inférieur (14) à proximité de l'ensemble de protection de rotor (16), l'installation motrice (48) comportant un arbre (50) s'étendant entre le segment de fuselage inférieur (14) et le segment de fuselage supérieur (12), le rotor (52) étant fixé à l'arbre (50) de façon rigide. 50
- 55 4. Véhicule aérien selon la revendication 3, comprenant en outre:
- un réservoir à carburant (64) installé dans le segment de fuselage supérieur (12) à proximité



- de l'ensemble de protection de rotor (16).
5. Véhicule aérien selon la revendication 4, dans lequel le réservoir à carburant (64) inclut une vessie qui y est installée, la vessie étant gonflable pour mettre sous pression le carburant dans le réservoir à carburant.
6. Véhicule aérien selon la revendication 5, comprenant en outre:
- une conduite de carburant (56) menant du réservoir à carburant (64) à l'installation motrice, la conduite de carburant étant acheminée au moins partiellement à l'extérieur de l'ensemble de protection de rotor (16).
7. Véhicule aérien selon la revendication 6, comprenant en outre:
- une conduite haute pression (60) menant de l'installation motrice (48) à la vessie à l'intérieur du réservoir à carburant (64), la conduite haute pression étant acheminée au moins partiellement à l'extérieur de l'ensemble de protection de rotor (16).
8. Véhicule aérien selon la revendication 7, comprenant en outre:
- une chape supérieure (22) installée sur le segment de fuselage supérieur (12).
9. Véhicule aérien selon la revendication 8, comprenant en outre:
- au moins un capteur (68) disposé à l'intérieur de la chape supérieure (22).
10. Véhicule aérien selon la revendication 9, dans lequel le capteur (68) est au moins l'un des suivants:
- un capteur optique, un capteur infrarouge (IR), un capteur de fréquence radio (FR), un capteur de champ magnétique, un capteur chimique, un capteur acoustique, et un capteur de mouvement.
11. Véhicule aérien selon la revendication 10, comprenant en outre:
- au moins un appareil de prise de vues disposé à l'intérieur de la chape supérieure (22).
12. Véhicule aérien selon la revendication 11, dans lequel l'appareil de prise de vues est au moins l'un des suivants: une caméra vidéo, un appareil photo, une caméra vidéo numérique, un appareil photo numérique, une caméra vidéo couleur, une caméra vidéo noir et blanc, une caméra thermique, une caméra vidéo infrarouge, et une caméra nyctalope.
13. Véhicule aérien selon la revendication 12, comprenant en outre:
- au moins un microprocesseur (66) à l'intérieur du segment de fuselage supérieur (12).
14. Véhicule aérien selon la revendication 13, comprenant en outre:
- au moins un émetteur-récepteur (72) relié au microprocesseur (66) et traversant la chape supérieure (22).
15. Véhicule aérien selon la revendication 14, comprenant en outre:
- au moins un système mondial de positionnement par satellite à l'intérieur du segment de fuselage supérieur (12) et relié au microprocesseur (66).
16. Véhicule aérien selon une quelconque des revendications précédentes, dans lequel le segment de fuselage supérieur (12) et le segment de fuselage inférieur (14) définissent ensemble un fuselage définissant un axe longitudinal, l'ensemble de protection de rotor (16) entourant au moins une partie du fuselage dans un plan perpendiculaire à l'axe longitudinal; le rotor (52) tournant à l'intérieur de l'ensemble de protection de rotor (16) dans un plan perpendiculaire à l'axe longitudinal; le volet de pale (28) ayant une extrémité fixée de façon articulée à la protection de rotor (16), le volet de pale (28) tournant autour d'un axe radial s'étendant radialement depuis l'axe longitudinal; et l'aileron formant grille tournant autour d'un axe central s'étendant radialement depuis l'axe longitudinal.

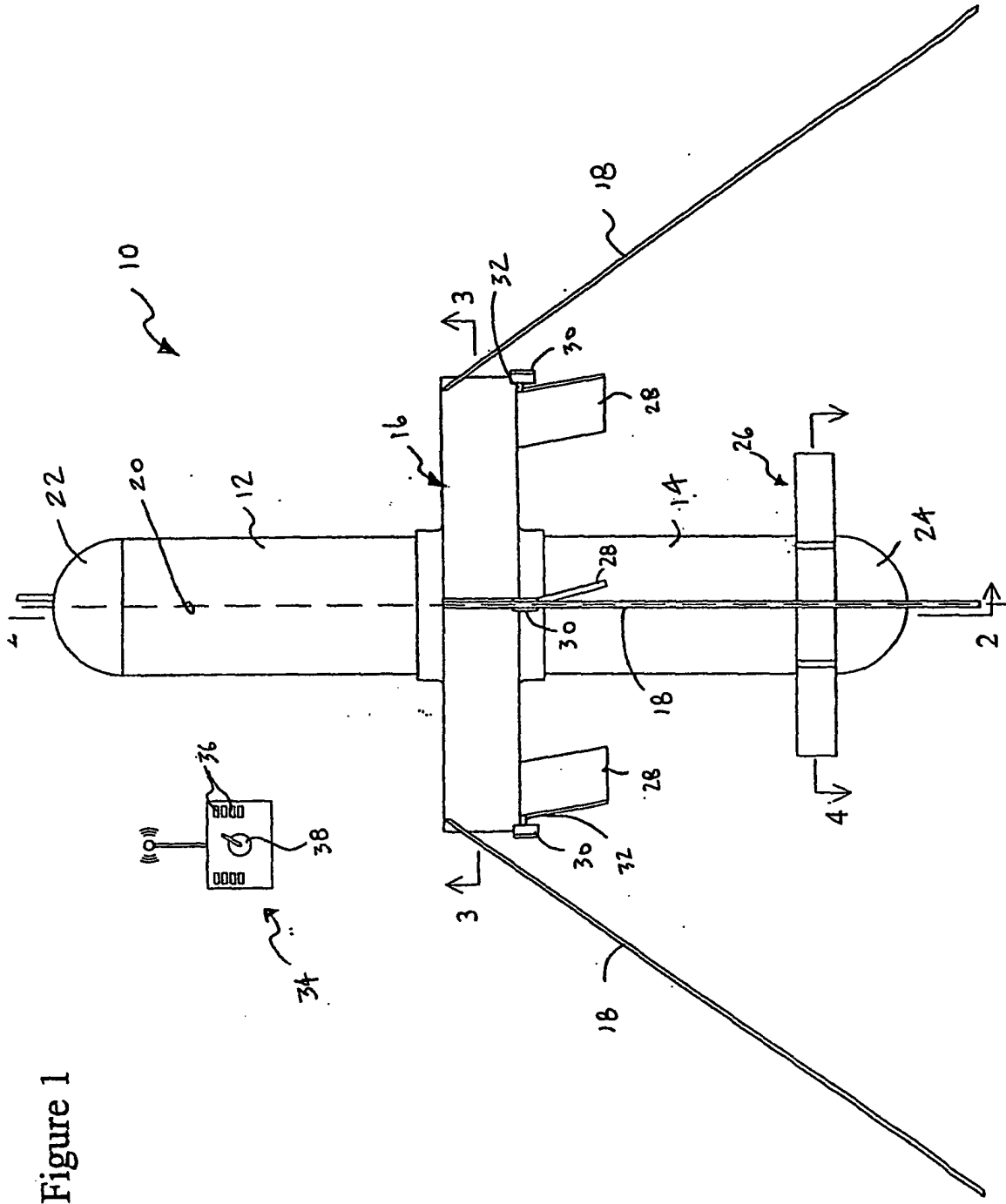


Figure 1

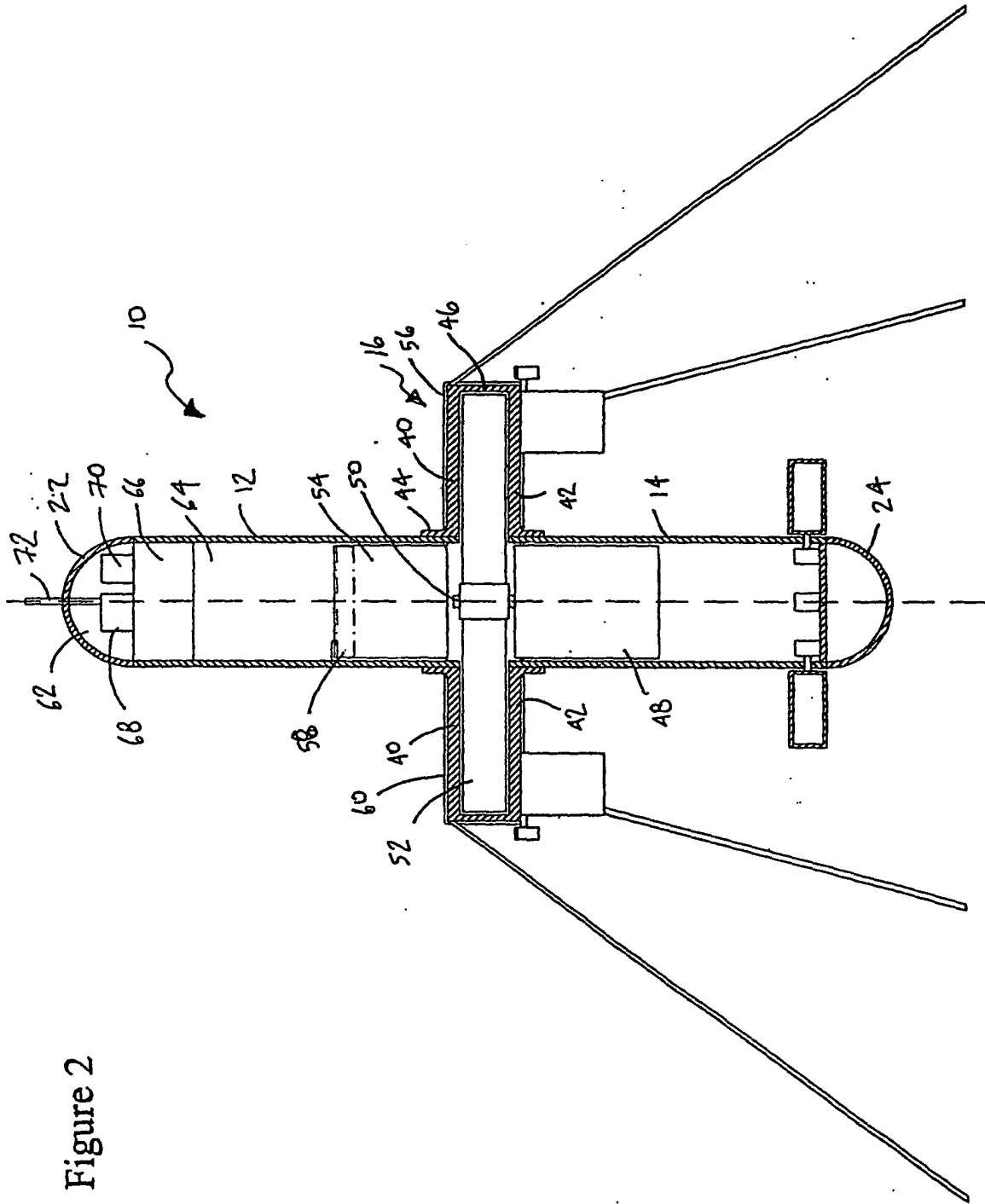


Figure 2

Figure 3

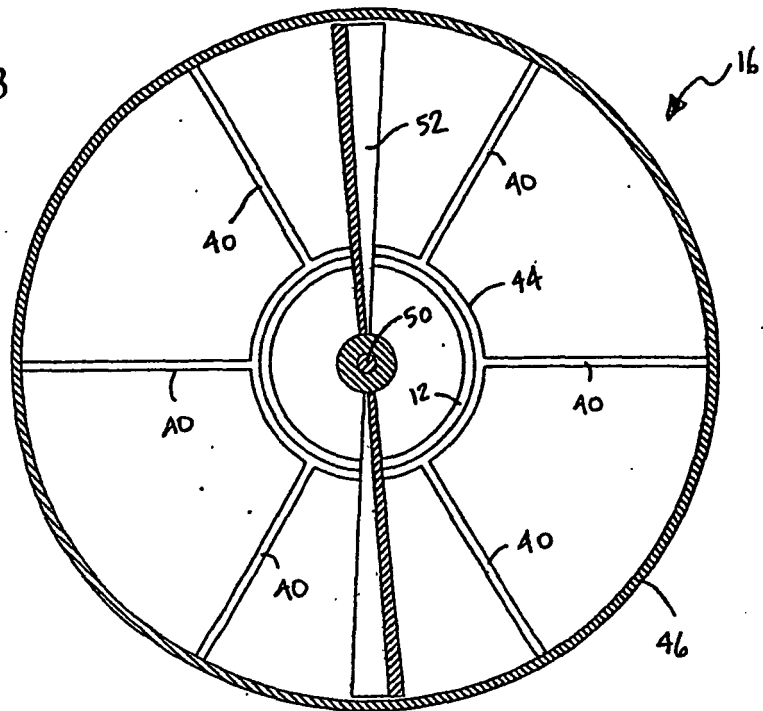


Figure 4

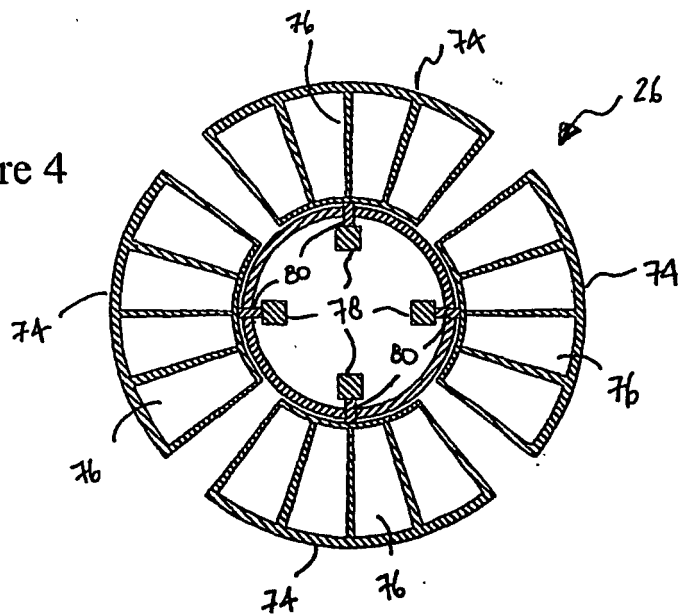


Figure 5

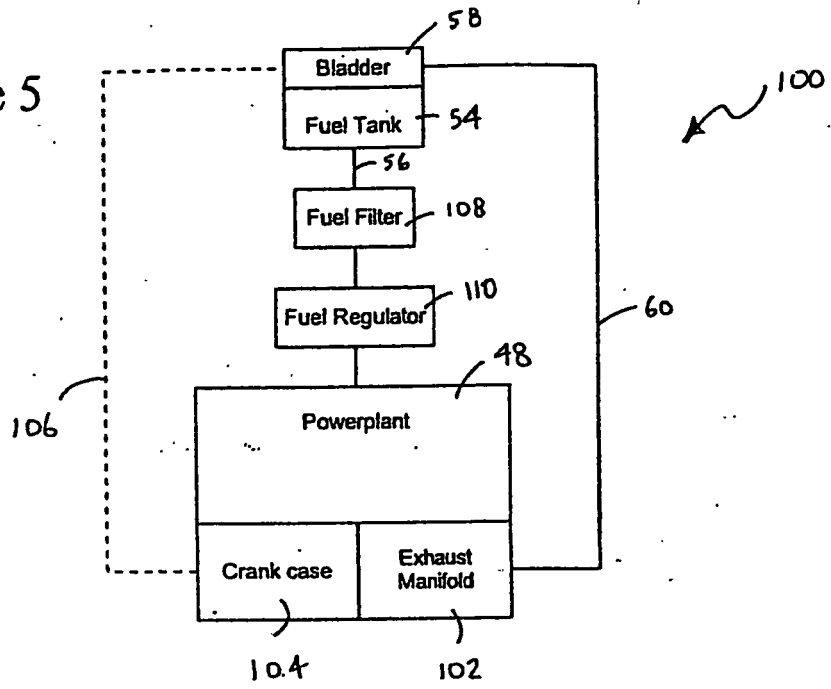
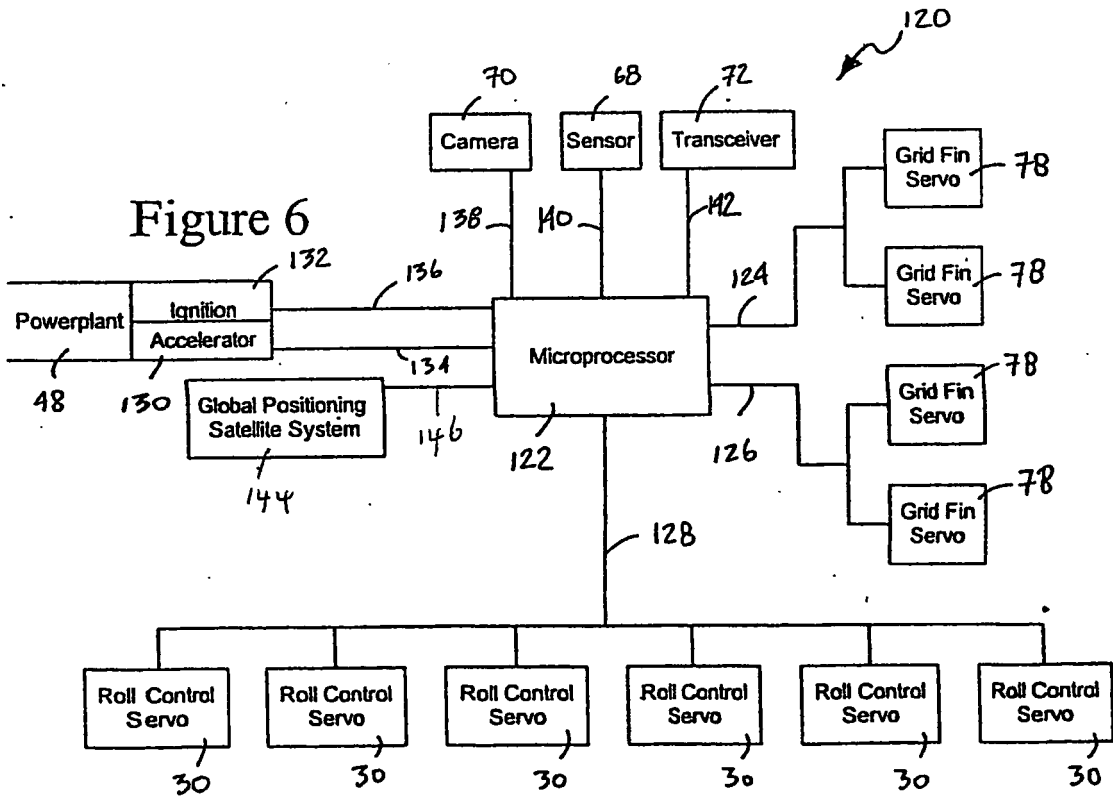


Figure 6



**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

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