GYROSCOPICALLY STABILISED AERIAL VEHICLES

TECHNICAL FIELD

[001] The present invention relates to an aerial vehicle. More particularly, in preferred forms, the invention relates to aerial vehicles having gyroscopic fans with pivoting fan blades.

BACKGROUND

[002] Any references to methods, apparatus or documents of the prior art are not to be taken as constituting any evidence or admission that they formed, or form part of the common general knowledge.

[003] Since the invention of flight, a variety of different forms of aircraft have been developed such as, for example, helicopters and aeroplanes. There are many factors and forces involved in achieving stable and controllable flight, with different types of aircraft have different flying characteristics with various advantages and disadvantages.

[004] For example, fixed wing aeroplanes can be configured to fly relatively fast over long distances but cannot fly too slow or hover and require long runways for horizontal take-off and landing. Helicopters, on the other hand, are able to take off and land vertically and can hover, but are more limited in their size, as well as the speed and distance they can travel. These characteristics make fixed wing aeroplanes well suited to long distance point to point travel of relatively large loads and helicopters well suited to shorter travel of a relatively small load and/or to emergency and rescue operations

where the ability to fly slowly and hover is particularly advantageous. It is desirable to provide an aerial vehicle that combines the advantages and/or minimises the disadvantages to at least provide an aerial vehicle with different, preferably more versatile, characteristics.

[005] One application for aerial vehicles is in the fighting of fires. Uncontrolled fires pose a serious problem today and large fires can rage out of control sweeping through woods/forests, communities, industrial areas and businesses resulting in loss of forests/woods, homes, other property, animals and even human life. Efforts employed to contain fires are not always successful. Controlling and preventing the spread of fires is often difficult.

[006] There are many known methods and techniques for controlling and preventing the spread of fires. These methods include traditional uses of firefighters and equipment, including such techniques as the dumping of large amounts of water or fire suppressing chemicals from aircrafts onto the fire, creating fire lines across the direction of travel of the fire, spraying water or fire suppressing chemicals onto the fire by firefighters on the ground, and back burning an area towards the fire in a controlled manner so as to effectively remove wood or other sources of fuel from an approaching fire.

[007] It has been found that the use of water and chemicals alone can be ineffective against larger fires. It has been hypothesised when a fire's intensity is greater than a certain threshold, the use of water and other fire suppressant material becomes largely ineffective because the water or fire suppressant evaporates or gets dissociated

before reaching the core of the fire. In view of these issues, it is also desirable to provide an alternative method of suppressing fires, particularly larger fires.

SUMMARY OF INVENTION

[008] According to an aspect of the invention, there is provided an aerial vehicle comprising:

an aerodynamic body;

a jet turbine or an electric motor coupled to the aerodynamic body by an aerial vehicle frame to provide thrust to the aerial vehicle, the jet turbine having a source of fuel, an engine air intake to draw air, and an outlet through which a combusted air fuel mixture is exhausted;

a shaft assembly configured to be driven by the jet turbine; and

a gyroscopic stabilisation assembly comprising at least one gyroscopic member coupled to the jet turbine by the shaft assembly;

wherein the at least one gyroscopic member is configured to be rotationally driven by the jet turbine and gyroscopically stabilise the aerial vehicle during flight; and wherein the aerial vehicle has a plurality of control surfaces.

[009] In an embodiment, the gyroscopic member is a gyroscopic fan comprising a plurality of fan blades. The gyroscopic fan preferably comprises a plurality of pivoting fan blades. Preferably the gyroscopic fan comprises a plurality of alternating pivoting fan blades. Orientation of one or more of the fan blades for the fan is preferably variable to allow the pitch of said one or more blades to be varied. The one or more fan blades may be pivotally coupled to the shaft to allow the pitch of said one or more

blades to be varied. In an embodiment, the gyroscopic member may comprise a gyroscopic disc. In an embodiment, the gyroscopic member provides reversed thrust (pitch reversal) to the aerial vehicle as (down force) acting against the thrust of the jet turbine. This can happen more quicker than regulating the jet turbine thrust, due to time lag.

[010] In an embodiment, ~~The~~ the plurality of fan blades may be arranged around a centre hub. The centre hub is preferably coupled to the shaft. The shaft assembly is coupled to the vehicle frame. The shaft assembly may further comprise a controller for controlling the gyroscopic stabilisation assembly. The controller may control the gyroscopic stabilisation assembly via a gear box such that angular momentum from the gyroscopic stabilisation assembly is significantly larger than the moment of inertia of the aircraft such that the aerial vehicle is substantially gyroscopically stabilised during flight. The aerial vehicle is preferably configured to allow vertical take off and landing (VTOL). The fan blades may be curved. ~~The gyroscopic fan is preferably located within the aerodynamic body. The radially distal ends of the fan blades are preferably contained within an opening of the aerodynamic body. Preferably the opening is a circular opening in a fuselage of the aerodynamic body.~~

[011] In an embodiment, the radially distal ends of the fan blades allow the pitch of said one or more fan blades to be varied, the fan assembly may further comprise a controller for controlling the gyroscopic stabilisation assembly at the radial distal fan blade ends, and are preferably contained within an opening of the aerodynamic body. Preferably the opening is a circular opening in a fuselage of the aerodynamic body. ~~the~~ The ~~shaft~~ fan assembly ~~is~~ may be coupled to the vehicle frame. The ~~shaft~~ fan

assembly may further comprise a controller for controlling the gyroscopic stabilisation assembly. The controller may control the gyroscopic stabilisation assembly ~~via a gear box~~ such that angular momentum from the gyroscopic stabilisation assembly is significantly larger than the moment of inertia of the aircraft such that the aerial vehicle is substantially gyroscopically stabilised during flight. The aerial vehicle is preferably configured to allow vertical take off and landing (VTOL).

[012] In an embodiment, the aerial vehicle further comprises a cockpit module. The cockpit module may comprise a cabin. The cockpit module is preferably coupled with the vehicle frame. The cockpit module is preferably movably coupled to the vehicle frame. A cabin of the cockpit module is preferably coupled to the vehicle frame by a gimbal. The cockpit module may comprise a counterbalance arrangement to stabilise the cockpit by countering the movement of the aerial vehicle frame and/or exhaust of the jet turbine.

[013] In an embodiment, the cockpit module is pivotally attached to the aerial vehicle frame. A cabin of the cockpit module may be pivotally mounted to a gimbal ring for rotation about at least a first axis. The gimbal ring may be pivotally mounted to the aerial vehicle frame for rotation about a second axis.

[014] In an embodiment, the cockpit module is releasably coupled to the vehicle frame such that the cockpit module is detachable. The releasably coupling may allow the aerial vehicle to optionally have the cockpit module attached for crew assisted flying and/or autonomous flying or optionally have the cockpit module detached for remote

and/or autonomous flying. The releasable coupling may comprise an ejector assembly. The cockpit module may be in the form of a self-contained pod.

[015] In an embodiment, the body of the aerial vehicle comprises a fuselage. The fuselage may comprise a plurality of control surfaces. The control surfaces are preferably movably attached to the fuselage for controlling flight of the aerial vehicle. The plurality of control surfaces may be manipulated to control the flight of the aircraft about a pitch axis perpendicular to the longitudinal axis of the aircraft and a yaw axis that is perpendicular to both the longitudinal axis of the aircraft and the pitch axis.

[016] In an embodiment, the jet turbine, shaft, and gyroscopic stabilisation assembly are arranged longitudinally. The jet turbine, shaft, and gyroscopic stabilisation assembly may be arranged to rotate about a longitudinal axis of the aerial vehicle.

[017] In an embodiment, the jet turbine and gyroscopic stabilisation assembly are arranged transverse to each other. The jet turbine and gyroscopic stabilisation assembly may be arranged such that their respective axes of rotation are perpendicular (or at least substantially perpendicular). One or more gyroscopic fans may be arranged in a plane that is perpendicular to the longitudinal axis of the jet turbine.

[018] In an embodiment, parallel gyroscopic fans may be provided. A first fan may be located in an upper side of the fuselage and a second fan may be located in a lower side of the fuselage. The axial axis of the first fan and the axial axis of the second fan are preferably aligned. The shaft assembly may comprise a longitudinal shaft,

preferably coupled to the jet turbine, and a transverse shaft, preferably coupled to the one or more gyroscopic fans. The upper fan may provide down thrust in the direction to the centre of the aerial vehicle. The lower fan may provide upward thrust in a direction to the centre of the aerial vehicle and provide additional air pressure at the turbine intake.

[019] In an embodiment, the air flow directing assembly comprises an exhaust nozzle adapted to be directed towards specific directions. In such embodiments, the exhaust nozzle may be directed for suppressing fires.

[020] In an embodiment, the aerial vehicle further comprises a supporting structure positioned below the fuselage for supporting the jet turbine and allowing directional movement of the jet turbine. In such embodiments, the directional movement may allow the air flow directing assembly to direct some of the drawn air in a desirable direction, such as for suppressing fires.

[021] In an embodiment, the body may be annular. In such an embodiment, the fuselage may be in the form of a torus or ‘doughnut’ shape. A plurality of jet turbines may be mounted to the sides of the fuselage, preferably for propulsion and/or lift. The plurality of jet turbines mounted to the sides of the fuselage may be rotatable, preferably to enable VTOL capability. One or more gyroscopic stabilisation jets may be mounted to an inner side of the fuselage. At least one gyroscopic fan is preferably located in the centre of the body. A cockpit module may be located inside the body.

[022] In another aspect, the invention provides a method of suppressing a fire, the method comprising the steps of:

moving an aerial vehicle with a jet turbine coupled to an aerial vehicle frame of the aerial vehicle to a location in the vicinity of the fire wherein the jet turbine provides thrust to the aerial vehicle, the jet turbine having a source of fuel, an engine air intake to draw surrounding air, an outlet through which a combusted air fuel mixture is exhausted at a high speed and a shaft assembly adapted to be driven by the jet turbine,

operating a gyroscopic stabilisation arrangement coupled to the jet turbine by the shaft assembly and gyroscopically stabilising the aerial vehicle during flight; and

operating the jet turbine to draw air and controlling an air flow directing assembly an air flow directing assembly for directing combusted air fuel mixture from the outlet in a desirable direction for suppressing fires.

BRIEF DESCRIPTION OF THE DRAWINGS

[023] Preferred features, embodiments and variations of the invention may be discerned from the following Detailed Description which provides sufficient information for those skilled in the art to perform the invention. The Detailed Description is not to be regarded as limiting the scope of the preceding Summary of the Invention in any way. The Detailed Description will make reference to a number of drawings as follows:

Figure 1 is a side view of a gimbaled cockpit module for an aerial vehicle showing the gimble rings on the outside of the gimble pivots in accordance with an embodiment of the present invention;

Figure 2 is a side view of the gimbaled cockpit module illustrated in Figure 1 showing the gimbal ring on the inside of the gimbal pivots;

Figure 3 is a top view of an aerial vehicle 100 in accordance with an embodiment of the present invention;

Figure 4A is a top view of the aerial vehicle 200 with a cockpit module ~~105~~ 210 mounted thereto in accordance with another embodiment of the present invention;

Figure 4B is a top view of an alternative configuration of the aerial vehicle 200 illustrated in Figure 4A wherein the cockpit module 210 is located external to the aerial vehicle 200;

Figure 4C is a top view of an alternative configuration of the aerial vehicle 200 illustrated in Figure 4A wherein the cockpit module 210 are external pods;

Figure 5A is a side view of the aerial vehicle 200, with the cockpit module, in a first position (take-off or landing);

Figure 5B is a side view of an alternative configuration of the aerial vehicle 200, with a plurality of jet turbines 250;

-Figure 6 is a side view of the aerial vehicle 200, with the cockpit module in a second position (in-flight);

-Figure 7 is a top view of an aerial vehicle 300 in accordance with a further embodiment;

-Figure 8 is a side view of the aerial vehicle 300 with the cockpit module being shown in a non-pivoted position;

-Figure 9 is a side view of the aerial vehicle 300 with the cockpit module being shown in an upwardly pivoted position;

-Figure 10 is a side view of the aerial vehicle 300 showing cross-sectional planes X-Z;

-Figure 11 is a sectional view of the aerial vehicle 300 along plane X (shown in Figure 10);

-Figure 12 is a sectional view of the aerial vehicle 300 along plane Y (shown in Figure 10);

-Figure 13 is a sectional view of the aerial vehicle 300 along plane Z (shown in Figure 10);

-Figure 14 is a frontal view of the aerial vehicle 300;

Figure 15 is a top view of the aerial vehicle 300;

Figure 16 is a rear view of the aerial vehicle 300;

Figure 17A is a frontal view of the aerial vehicle 300 with wing flaps in a different position to that illustrated in Figure 14;

Figure 17B is a frontal view of the aerial vehicle 300 with wing flaps in a different position to that illustrated in Figure 17A;

Figure 18 is a perspective view of a plurality of aerial vehicles 100, without cockpit module, fighting a fire; and

Figure 19 is a perspective view of two linked aerial vehicles 100, without cockpit module, fighting a fire;

Figure 20 is a perspective view of an aerial vehicle 400 in accordance with a further embodiment; and

Figure 21 is a top view of the aerial vehicle 400 illustrated in figure 20.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[024] Figures 3,18 and 19 illustrate a first embodiment of an aerial vehicle 100 configured to be gyroscopically stabilised in a manner that will be described in greater detail below. Figures 1 and 2 illustrate a releasably attachable cockpit module 105, shown attached to an aerial vehicle like aerial vehicle 100 to form aerial vehicle 200 as shown in figures 4A to 6. As seen best in figures 5A, 5B and 6, the aerial vehicle

200 comprises a ducted fuselage ~~210~~ 245 that includes an opening in which a jet turbine 250 is positioned to provide a propulsion mechanism. Suitable engines that can be employed to generate an exhaust include pulsejet engines, turbojet engines, turbojet engines with afterburner, axial-flow turbojets, gas turbine propulsion engines, rocket engines, turbofan aircraft engines, low-bypass turbofans, high-bypass turbofans, turboprops, ramjets, turboshaft engines, underwater jet engines, shockwave triple engine jet trucks, electric ducted fans and others. Combinations of different types of engines also can be used.

[025] The jet turbine 250 positioned in the opening of the fuselage ~~210~~ 245 preferably works like any other jet turbine whereby air is drawn in by the turbine and a compressor raises the pressure of the air. The compressor is made with many blades attached to a shaft assembly 260. The blades spin at high speed and compress or squeeze the air. The compressed air is then sprayed with fuel and an electric spark lights the mixture. The burning gases expand and blast out through ~~exhaust nozzle~~air flow directing assembly 255 at the back of the engine. As the jets of gas shoot backward, the engine and the aerial vehicle 200 is thrust in an opposite direction (which is an upward direction with respect to figures ~~5~~5A and 5B). As the hot air is going to the air flow directing assembly~~nozzle~~ 255, it passes through another group of blades called the turbine. The turbine may be attached to the same shaft assembly 260 as the compressor and spinning the turbine may cause the compressor to spin.

[026] In this embodiment, the fuselage ~~210~~ 245 ~~of the aerial vehicle 200 is mounted on an aerial vehicle frame 245 and~~ is shown to be of a specific shape that is generally symmetrical about an axis. However, the shape of the fuselage ~~210~~ 245 is not to be

regarded as limiting and the shape of the fuselage ~~210~~ 245 may be varied in other embodiments. The jet turbine 250 drives the shaft assembly 260 which is also coupled to a gyroscopic stabilisation assembly comprising a gyroscopic stabilisation fan assembly 240. The gyroscopic stabilisation fan assembly 240 assists with stabilisation of the aerial vehicle 200 during flight.

[027] The blades of the gyroscopic stabilisation fan assembly 240 are arranged around a central hub that is coupled with the shaft assembly 260. The blades of the gyroscopic stabilisation fan assembly 240 are alternating pivoting fan blades that vary the angle of the fan blades as needed to provide the necessary stabilisation to the aerial vehicle 200. In the preferred embodiment, the longitudinal axis of the fuselage ~~210~~ 245 extends longitudinally through the ducted opening along the shaft assembly 260 that also drives the blades of the gyroscopic stabilisation fan assembly 240. The gyroscopic stabilisation fan assembly 240 includes a plurality of blade members that are preferably variable pitch blades such that the pitch of the blades can be changed by pivoting the blade members. Since the blade members are of variable pitch, i.e. each blade member can pivot about its longitudinal axis (its pitch axis) in order to adapt the orientation of its leading edge to engine speed. The orientation of the blade members (also referred to as the pitch setting) thus constitutes one of the parameters that enable the thrust of the jet turbine 250 to be managed easily. The fan blades provide pitch reversal, acting against the thrust of the jet turbines, stabilising the altitude of the aerial vehicle rapidly.

~~**[028]** A controller is also provided for controlling the gyroscopic stabilisation arrangement via a gear box such that angular momentum provided by the gyroscopic stabilisation arrangement (particularly the fan blades of the gyroscopic fan 240) is~~

~~significantly larger than the moment of inertia of the aerial vehicle 200 so that the aerial vehicle 200 is substantially gyroscopically stabilised during flight.~~

~~[029]~~ **[028]** It is important to appreciate that the provision of the gyroscopic stabilisation arrangement in combination with the jet turbine 250 provides a vertical take-off and landing (VTOL) aerial vehicle 100 and 200 (and also aerial vehicles 300 and 400 described hereinafter). Providing an aerial vehicle with VTOL capability allows the aerial vehicle 100, 200, 300, and 400 to be used in a large variety of situations including, for example, firefighting efforts, especially where access to, or conveyance of fire suppressing media to, the area concerned is proves otherwise difficult, impossible or dangerous.

[029] The aerial vehicle 100 has a cockpit module 105. The cockpit module 105 has a cabin 110. The aerial vehicle 100 has an ejector assembly 120 adapted to eject the cockpit module 105 from the rest of the aerial vehicle 100. The aerial vehicle 100 can be attached to a gyroscopic stabilisation fan assembly 140.

[030] The gyroscopic stabilisation arrangement is preferably configured to provide sufficient angular momentum, by sufficient mass angular velocity, such that the aerial vehicle 100, 200, 300, and 400 is gyroscopically stabilised during various phases of flight. In one embodiment the fuselage may be fixedly attached to the jet turbine. In another embodiment, the jet turbine may be pivotably mounted to the fuselage especially when the air flow directing assembly~~exhaust nozzle~~ of the jet turbine needs to be directed towards a fire front, or the like.

[031] In a preferred embodiment, the airframe~~fuselage 110~~ 145 is adapted to allow the aerial vehicle 100, 200, 300, and 400 to land and take-off in a vertical take-off or landing (VTOL) profile. In particular, an undercarriage assembly comprising landing gear in the form of landing struts may allow the aerial vehicle to take-off from a land based surface or a water based surface, with the plane of the fan blades of the gyroscopic fan being substantially parallel to the plane of the ground to allow the aerial vehicle to land in a similar manner. In the preferred embodiment, the fuselage may be pivotally or movably fastened to the aerial vehicle's frame which may allow relative movement between the fuselage and the aerial vehicle frame.

[032] The aerial vehicle 100 and 200 can also be equipped with annular wing flaps ~~115, 215~~ that may be mounted to the outer lateral surfaces of the fuselage. The annular wing flaps ~~115, 215~~ may also provide additional flight surfaces to facilitate horizontal flight of the vehicle 100 and 200 (such as illustrated in FIGS. 3 to 6). It should also be appreciated that in a horizontal flying configuration, the plane of the gyroscopic stabilisation arrangement would be substantially perpendicular to the plane of the ground as shown in Figure 6. It will, however, be appreciated by persons of ordinary skill in the art, by the following description that the provision of the flight surfaces and annular wing flaps ~~115, 215~~ may be optional.

[033] As has been described in the earlier sections, the aerial vehicle 100 and 200 includes a gyroscopic stabilization arrangement which gyroscopically stabilises the aerial vehicle 100 and 200 during its entire flight envelope. It is important to appreciate that the use of gyroscopic stabilisation results in a more stable aerial vehicle thereby providing stable flight characteristics which is very important for achieving the flexible

and versatile flight characteristics for a variety of applications including, for example, in suppressing fires. Each of the blade members of the gyroscopic stabilisation fan assembly 240 are attached to a rotating propeller shaft, which is in turn coupled to the shaft assembly 260, so as to generate sufficient angular momentum such that the aircraft is gyroscopically stabilised so that when external or internal moments are applied to the aircraft, the resulting force of the moments is translated into gyroscopic precession. It should be appreciated that a larger aerial vehicle with increased motor size and increased performance will require larger gyroscopic stabilisation members or gyroscopic stabilisation members that are rotated at higher angular velocities in order to gyroscopically stabilise the vehicle. Similarly, smaller and more lightweight aircraft require smaller and more lightweight gyroscopic stabilisation members.

[034] The aerial vehicle 200 may also include a cockpit module ~~105~~ 210 which is coupled, preferably via an ejector assembly ~~releasably coupling~~ 220, with the frame of the aerial vehicle 200. The cockpit module ~~105~~ 210 includes a counterbalancing arrangement 230 to counterbalance the cockpit module ~~105~~ 210 by countering the movement of the fuselage ~~210~~ 245 and/or exhaust of the jet turbine 250. In the presently described embodiment, the cockpit module ~~105~~ 210 may comprise a gimbal like mechanism to allow a cabin ~~106~~ 210 of the cockpit module ~~105~~210, and its occupants, to be positioned in a substantially upright position during all periods of flight, including both during vertical take offs and landing of the aerial vehicle 200 (as illustrated in figures 5A and 5B) and during horizontal flight (as illustrated in figure 6). The cockpit module ~~105~~ 210 may include navigation and flight control equipment for controlling the aerial vehicle 200 and also address some of the safety requirements. The aerial vehicle 200 has at least one reusable fuel pod 280.

[035] In the preferred embodiment, the cabin ~~106~~ 210 of the cockpit module ~~105~~ 210 is pivotally mounted to a gimbal ring ~~125~~ 225 at attachment points ~~135~~ 235 for rotation about a first axis. As seen most clearly in figure 2, a counterbalance arrangement 135 with ~~the~~ a gimbal ring 125 is attached to aerial vehicle frame 145 at attachment points 130 to allow rotation about a second axis thereby allowing the cabin ~~106~~ 110 of the cockpit module 105 to roll or pitch which allows a counterbalancing force to be applied to the cockpit module 105. In figures 5A and 5B, the cockpit module ~~105~~ 210 is shown in a first upright position when the aerial vehicle 200 is in a take-off or landing position. In Figure 6, the cockpit module ~~105~~ 210 is shown in a horizontal flying position whereby the cabin ~~106~~ 110 of the cockpit module ~~105~~ 210 can also be seen in an upright position even though the cockpit module ~~105~~ 210 itself has rotated.

[036] In firefighting embodiments of the invention, which is a preferred but by no means essential application, the exhaust may be obtained from one or more jet turbines or jet engines. As used herein, the term “jet turbine” refers to a turbine that accelerates and discharges a fast moving jet of fluid, e.g., a gas such as exhaust gas, to generate propulsion or thrust for the aerial vehicle. In a typical jet engine air from an air intake is directed to a rotating compressor where its pressure and temperature are increased. Pressurized air is introduced to a combustion chamber where it is combined with fuel and the mixture is ignited. The combustion raises the temperature of the gases, which expand through the turbine. In the turbine some of the temperature rise is converted to rotational energy, which can be used to drive the compressor. A combusted gas mixture (which is generally devoid of oxygen) exits through an exhaust directing assembly which includes an air flow directing assembly~~exhaust nozzle~~ 255.

[037] Preferably the turbine is a gas turbine, which acts like a windmill, extracting energy from the hot gases leaving the combustor. Suitable types of turbines that can be utilized include transonic turbines, contra-rotating turbines, statorless turbines, ceramic turbines, shrouded as well as shroudless turbines, electric ducted fans and others known in the art. Micro turbines may also be used in at least some embodiments.

[038] The air flow directing assembly~~exhaust nozzle~~ 255 can be a convergent-divergent, divergent, fluidic, variable, e.g., ejector nozzles, iris nozzles, or can have another suitable design. Generally, a jet turbine exhaust and an exhaust nozzle such as air flow directing assembly~~nozzle~~ 255 is characterised by its temperature, chemical composition, velocity, delivery volume, rate of delivery, pressure and by other parameters, e.g., noise, air quality, and so forth. Exhaust from a jet engine can have a temperature of several hundreds degrees and piping and exhaust nozzles may need to be protected by air cooling.

[039] The exhaust from such a vehicle is considered to be particularly well suited for suppressing fires using the exhaust generated by one or more engines, preferably jet engines. More specifically, the invention relates to using the exhaust to supress a fire, e.g., an above-the-ground forest, dwelling, commercial or industrial fire. As with fires, explosions also can be suppressed or smothered.

[040] With respect to its chemical composition, the exhaust gas from a jet turbine generally includes products of combustion, e.g., carbon dioxide (CO2), carbon monoxide (CO), and water (H2 O), un-combusted gas, e.g., nitrogen gas (N2), oxygen

(O2), uncombusted hydrocarbons (UHC) and other components such as soot (C), oxides of nitrogen (NOx) and/or oxides of sulfur (SOX). Compared to atmospheric air, which at sea level contains close to 21% by volume O2 and about 0.03% by volume CO2, jet engine exhaust has lower O2 and higher CO2 levels. For instance, the pressurized emission products of the complete combustion of hydrocarbon fuels in an efficiently operated turbine engine are comprised of about 72% volume/volume CO2 gas and about 27.6% volume/volume of steam. As a result, the chemical composition of the exhaust gas plays an important role when the aerial vehicle 100, 200 is utilised for control or extinguish a fire by directing the air flow directing assembly~~exhaust nozzle~~ 255 towards the fire. The ratio of air to fuel may also be manipulated by using a throttle mechanism, diluting with inert gases or by other means which may further lower the oxygen concentration in the exhaust resulting in improving the fire-fighting capabilities of the aerial vehicle 100, 200.

[041] As explained in the previous sections, using a jet turbine results in jets of gases being directed away from the aerial vehicle 100, 200 at extremely high velocities. During a fire suppressing operation, it is likely that there may be a considerable distance between the aerial vehicle 100, 200~~jet turbine 150~~ and the fire front, or leading edge of a fire and the aerial vehicle 100, 200~~jet turbine 150~~ should be capable of generating sufficient high exhaust pressure to blow significant quantities of exhaust gas mixture into the fire from such a distance. By way of example, any Pratt & Whitney JT8 through JT30 Series Turbine or similar turbine such as the GE9X high bypass providing excellent thrust to weight characteristics, may be capable of providing sufficient propulsion to fly the aerial vehicle 100 and 200 whilst also provide sufficient velocity to exhaust gases that are capable of extinguishing a fire. It might be important

to take into account some practical considerations such as not operating the jet turbine at 100% capacity in order to control the temperature of the exhaust gases particularly during a fire suppression operation. It is also important to note that other turbines fully capable of use in the present circumstances for the present job may provide different effective ranges of exhaust pressures may be used for providing the desired fire suppression functionality.

[042] Advantageously, the turbine 250 may be mounted on a support that not only supports the turbine 250 but also allows the turbine 250 to be moved in a plurality of directions. In at least some embodiment, the support may allow the turbine to be rotated 360 degrees. A steering assembly may be coupled with the support and be controlled by an operator of the aerial vehicle to control the orientation of the jet turbine 250 in order to direct the exhaust gases in a desirable direction in order to supress a fire.

[043] As shown in figure 18, a plurality of such aerial vehicles 100 may be used to fight a fire. As shown in figure 19, two (or more) such aerial vehicles 100 may be coupled together in tandem by provision of attachment ports to allow such multiple aerial vehicles 100 to be coupled together

[044] Figures 7A to 17 illustrate another embodiment of an aerial vehicle 300. The aerial vehicle 300 is also adapted to be gyroscopically stabilised by a stabilising arrangement comprising gyroscopic fans ~~335~~ 340 with variable pitch blades. The gyroscopic fan 340~~335~~ is arranged in a plane that is perpendicular to the longitudinal axis of the jet turbine ~~340~~350. The gyroscopic fan 340~~335~~ is coupled to the jet turbine

~~340~~ 350 by a shaft assembly ~~350~~ 360 which transfers power from the jet turbine ~~340~~ 350 to the gyroscopic fan 340~~335~~. It should be understood that the gyroscopic fan 340~~335~~ may be linked to the jet turbine ~~340~~ 350 by one or more other ways and provision of a shaft as illustrated may not be necessary in some embodiments. In the preferred embodiment, the shaft assembly ~~350~~ 360 may comprises one or more gearing mechanisms to control the operation of the gyroscopic fan 340~~335~~. In other embodiments, the gyroscopic fan 340~~335~~ may be linked to the jet turbine ~~340~~ 350 by electronic or other mechanical arrangements. The aerial vehicle 300 has an upper fan which provides down thrust in the direction to the centre of the aerial vehicle and a lower fan which provides upward thrust in a direction to the centre of the aerial vehicle and provides additional air pressure at the turbine intake.

[045] The aerial vehicle 300 is also adapted to be gyroscopically stabilised in a manner as has been previously described. The aerial vehicle 300 also comprises a ducted fuselage 345 that includes an opening in which the jet turbine 340 is positioned to provide a propulsion mechanism. The aerial vehicle 300 is provided with wing flaps ~~325~~ 315 on the sides of the aerial vehicle 300 that are adapted to pivot about pivot points ~~315~~. The aerial vehicle 300 also comprises an articulated front wing ~~320~~315 at the front of the aerial vehicle 300 that is adapted to pivot about pivot point 365.

[046] A controller 390 is also provided for controlling the gyroscopic stabilisation arrangement via a gear box 385 such that angular momentum provided by the gyroscopic stabilisation arrangement (particularly the fan blades of the gyroscopic stabilisation fan assembly 340) is significantly larger than the moment of inertia of the

aerial vehicle 300 so that the aerial vehicle 300 is substantially gyroscopically stabilised during flight.

~~[046]~~ [047] The aerial vehicle 300 also includes a pivoting cockpit module 310 (which provides an ovoid shaped 'pod' enclosure) that is adapted to be pivot along two different axes. Specifically, the cockpit module 310 is adapted to pivot about pivot point 330 A to allow the pivoting of the cockpit module 310 along a first axis (roll). The cockpit module 310 is also adapted to pivot about pivot point 330~~-~~B to allow the cockpit module 310 to pivot about a second axis (pitch). The provision of the cockpit module 310 allows the aerial vehicle 300 to be operated by a pilot, or the like, during flight. The cockpit module 310 is connected to the aerial vehicle 300 by an ejector assembly 320 which is adapted to eject the cockpit module 310 from the rest of the aerial vehicle 300.

~~[047]~~ [048] The aerial vehicle 300 may also relate to the use of exhaust generated from a jet turbine ~~340~~ 350 to suppress a fire. The jet turbine 350~~340~~ provides thrust to the aerial vehicle 300. During use, the engine air intake draws surrounding air and a combusted air fuel mixture is releases out of an outlet ~~360~~ 355 through which a combusted air fuel mixture is exhausted at a high speed. An air flow directing assembly comprising an exhaust nozzle may be used for directing the combusted air fuel mixture from the outlet 355~~360~~ in a desirable direction for suppressing fires.

~~[048]~~ [049] Figures 20 and 21 illustrate a further embodiment of an aerial vehicle 400 in which the body is annular with a torus (or 'doughnut') shaped fuselage 445. A plurality of jet turbines ~~440~~ 450 are mounted to the sides of the torus fuselage 445,

primarily for propulsion and/or lift purposes. The plurality of jet turbines 450~~440~~ mounted to the sides of the torus fuselage 445 may be rotatable, by at least 90 degrees, to enable VTOL capability. The jet turbines~~Gyroscopic stabilisation jets~~ 450 can be mounted to an inner side of the torus fuselage 445. A gyroscopic fan ~~435~~ 440 is located in the centre of the torus fuselage 445. A cockpit module ~~415~~ 410 can be located inside the torus fuselage 445 to allow provision of crew and/or passengers. Cargo can also be carried in the torus fuselage 445.

[050] The cockpit module 410 includes a counterbalancing arrangement 430 with a gimbal ring 425 at attachment points 435 to counterbalance the cockpit module 410 by countering the movement of the fuselage 445 and/or exhaust of the jet turbine 450.

~~**[049]**~~ **[051]** Advantageously, the present invention provides a versatile aerial vehicle (100, 200, 300, 400) that has many useful and versatile flight characteristics including, for example, aerial vehicles with VTOL capabilities and gyroscopically stabilised flight between take off and landing. As identified previously, one particular application of interest is in the fighting of fires. However, such vehicles could also be used for transportation or rescue operations. Still further, embodiments of the aerial vehicle could be used to land on other planets provided they have a suitable atmosphere. The gyroscopic fan could also be replaced with a gyroscopic disc to provide stabilisation in space, where there is no atmosphere, in space craft and/or satellites.

~~**[050]**~~ **[052]** In compliance with the statute, the invention has been described in language more or less specific to structural or methodical features. The term

“comprises” and its variations, such as “comprising” and “comprised of” is used throughout in an inclusive sense and not to the exclusion of any additional features.

~~**[051]**~~ **[053]** It is to be understood that the invention is not limited to specific features shown or described since the means herein described comprises preferred forms of putting the invention into effect.

~~**[052]**~~ **[054]** The invention is, therefore, claimed in any of its forms or modifications within the proper scope of the appended claims appropriately interpreted by those skilled in the art.

CLAIMS

1. An aerial vehicle comprising:

an aerodynamic body;

one or more~~a~~ jet turbine~~s~~ and/or ~~an~~ electric motor~~s~~ and/or engines coupled to ~~the aerodynamic body by~~ an aerial vehicle frame and/or fuselage of the aerodynamic body to provide thrust to the aerial vehicle, the jet turbine~~s~~ and/or electric motors and/or engines having ~~a source of fuel,~~ an ~~engine~~ air intake to draw air~~,~~ and an outlet through which ~~a combusted~~high speed air fuel ~~mixture~~ as thrust is ~~exhausted~~expelled;

a shaft assembly configured to be driven by the one or more jet turbine~~s~~ and/or electric motors and/or engines; and

one or more~~a~~ gyroscopic stabilisation assembly comprising at least one gyroscopic member powered by~~coupled to~~ the one or more jet turbine~~s~~ ~~by the shaft assembly;~~

and/or electric motors and/or engines to ~~wherein the at least one gyroscopic member is configured to be rotationally driven by the jet turbine and~~ gyroscopically stabilise the aerial vehicle during flight; and

one or more cabins and/or cockpit modules pivotally attached and movably coupled with the aerial vehicle frame and/or fuselage;

wherein the aerial vehicle has a plurality of control surfaces.

2. The aerial vehicle of claim 1, wherein the gyroscopic stabilisation assembly~~member~~ is a gyroscopic fan arrangement comprising a plurality of alternating pivoting fan blades.

~~3. The aerial vehicle of claim 2, wherein the gyroscopic fan comprises a plurality of pivoting fan blades.~~

~~4. The aerial vehicle of claim 3, wherein the gyroscopic fan comprises a plurality of alternating pivoting fan blades.~~

~~5~~3. The aerial vehicle of claim ~~3 or claim 4~~2, wherein the orientation of one or more of the ~~pivoting~~ fan blades is variable to allow the pitch of said one or more blades to be varied.

~~6~~4. The aerial vehicle of ~~any one of~~ claim~~s~~ 3 ~~to 5~~, wherein the one or more ~~pivoting~~ fan blades of the gyroscopic fan arrangement are pivotally coupled to the shaft around a centre hub to allow the pitch of said one or more fan blades to be varied providing pitch reversal, changing the thrust direction of the fan.

~~7. The aerial vehicle of any one of claims 2 to 6, wherein the plurality of fan blades are arranged around a centre hub coupled to the shaft.~~

~~8. The aerial vehicle of any one of claims 2 to 7, wherein the gyroscopic fan is preferably located within the aerodynamic body.~~

~~9~~5. The aerial vehicle of claim ~~8~~4, wherein radially distal ends of the fan blades are attached, supporting pitch reversal, changing the thrust direction of the fan, and contained within an opening of the aerodynamic body airframe and/or fuselage of the

aerial vehicles aerodynamic body and is configured to be driven by the one or more jet turbines and or electric motors and/or engines.

~~10. The aerial vehicle of claim 9, wherein the opening is a circular opening in a fuselage of the aerodynamic body.~~

~~11. The aerial vehicle of claim 1, wherein the gyroscopic member comprises a gyroscopic disc.~~

~~12. The aerial vehicle of any one of claims 1 to 11, wherein the shaft assembly is coupled to the vehicle frame.~~

~~13~~6. The aerial vehicle of ~~any one of~~ claim~~s 1 to 12~~4, wherein the shaft assembly further comprises a controller for controlling the gyroscopic stabilisation assembly and the jet turbines and/or electric motors and/or engines via a gear box such that angular momentum from the gyroscopic stabilisation assembly is significantly larger than the moment of inertia of the aircraft such that the aerial vehicle is substantially gyroscopically stabilised during flight.

~~14. The aerial vehicle of any one of claims 1 to 13, wherein the aerial vehicle is configured to allow vertical take off and landing (VTOL).~~

~~15. The aerial vehicle of any one of claims 1 to 14, further comprising a cockpit module coupled with the vehicle frame.~~

~~16. The aerial vehicle of claim 15, wherein the cockpit module is movably coupled to the vehicle frame.~~

~~17~~7. The aerial vehicle of claim ~~16~~1, wherein ~~a~~ the cabin and/or~~of~~ the cockpit module is pivotally coupled to the aerial vehicle frame and/or fuselage by a gimballed counterbalance arrangement.

~~18~~8. The aerial vehicle of claim ~~16 or 17~~7, wherein the one or more cabins and/or cockpit module~~s~~ ~~is~~ comprises a gimballed counterbalance arrangement to stabilise the one or more cabins and/or cockpit modules during flight by countering the movement of the aerial vehicle frame and/or high speed air as thrust and/or one or more jet turbines and/or electric motors and/or engines~~exhaust of the jet turbine~~.

~~19~~9. The aerial vehicle of ~~any one of~~ claim~~s~~ ~~16 to 18~~1, wherein the one or more cabins and/or cockpit module~~s~~ are ~~is~~ pivotally and movably attached to the aerial vehicle frame and/or fuselage, providing one or more cabins and/or cockpit modules that rotate about the aerial vehicle frame and/or fuselage.

~~20~~10. The aerial vehicle of ~~any one of~~ claim~~s~~ ~~15 to 19~~1, wherein the one or more cabins and/or cockpit module~~s~~ ~~is~~ are releasably coupled to the aerial vehicle frame and/or fuselage such that the one or more cabins and/or cockpit module~~s~~ ~~is~~ are detachable.

~~21~~11. The aerial vehicle of claim ~~20~~10, wherein the ~~releasably~~ releasable coupling allows the aerial vehicle to optionally have the one or more pivotally attached cabins and/or cockpit modules ~~cockpit module~~ attached for crew assisted flying or optionally

have the one or more pivotally attached cabins and/or cockpit modules ~~cockpit module~~ detached for remote and/or autonomous flying.

~~22~~12. The aerial vehicle of claim ~~20 or 21~~10, wherein the releasable coupling comprises an ejector assembly and the one or more cabins and/or cockpit module~~s~~ ~~is~~ are in the form of a self-contained pod.

~~23. The aerial vehicle of any one of claims 1 to 22, wherein the body of the aerial vehicle comprises a fuselage.~~

~~24~~13. The aerial vehicle of claim ~~23~~1, wherein the aerial vehicle frame and/or fuselage and/or cabins and/or cockpit modules comprise~~s~~ a plurality of control surfaces movably attached to the aerial vehicle frame and/or fuselage and/or cabins and/or cockpit modules for controlling flight of the aerial vehicle.

~~25. The aerial vehicle of any one of claims 1 to 24, wherein the jet turbine, shaft, and gyroscopic stabilisation assembly are arranged longitudinally.~~

~~26~~14. The aerial vehicle of claim ~~25~~10, wherein the jet turbine~~s~~ and/or electric motors and/or engines, shaft assembly, gimballed cabins and/or cockpit modules, and gyroscopic stabilisation assembly are arranged to rotate about a longitudinal axis of the aerial vehicle frame and/or fuselage.

~~27~~15. The aerial vehicle of ~~any one of~~ claim~~s~~ ~~1 to 24~~10, wherein the jet turbine s and/or electric motor and/or engines, and the gyroscopic stabilisation assembly are arranged transverse to the gimballed cabins and/or cockpit module~~seach other~~.

~~28~~16. The aerial vehicle of claim ~~27~~10, wherein the jet turbines and/or electric motor and/or engines, and gyroscopic stabilisation assembly are arranged such that their respective axes of rotation are substantially perpendicular to each other.

~~29~~17. The aerial vehicle of claim ~~27 or claim 28~~10, wherein one or more gyroscopic fans and are arranged in a plane that is perpendicular to the gimballed cabins and/or cockpit modules and/or jet turbines and/or electric motors and/or engines~~longitudinal axis of the jet turbine~~.

~~30. The aerial vehicle of any one of claims 27 to 29, wherein parallel gyroscopic fans are provided.~~

~~31. The aerial vehicle of claim 30, wherein a first fan is located in an upper side of the fuselage and a second fan is located in a lower side of the fuselage.~~

~~32~~18. The aerial vehicle of ~~any one of~~ claim~~s~~ 10~~1 to 31~~, wherein the aerial vehicle frame and/or fuselage and/or cabins and/or cockpit modules are ~~the body is~~ annular having an airframe and/or fuselage in the form of a torus with a plurality of jet turbines and/or electric motors and/or engines mounted to the sides of the aerial vehicle frame and/or fuselage to provide thrust to the aerial vehicle~~fuselage~~.

~~33~~19. A method of suppressing a fire, the method comprising the steps of:

moving an aerial vehicle with a jet turbines and/or electric motors and/or engines coupled to an aerial vehicle frame of the aerial vehicle to a location in the vicinity of the fire wherein the jet turbines and/or electric motors and/or engines

provide~~s~~ thrust to the aerial vehicle, and for suppressing fire, the jet turbines and/or electric motors and/or engines having a source of fuel, an ~~engine~~ air intake to draw surrounding air, an outlet through which ~~a combusted air fuel mixture is exhausted at a~~ high speed air as thrust is expelled for suppressing fire; and a shaft assembly adapted to be driven by the one or more of jet turbines and/or electric motors and/or engines,

operating a gyroscopic stabilisation arrangement coupled to one or more~~the~~ jet turbines and/or electric motors and/or engines by the shaft assembly and gyroscopically stabilising the aerial vehicle during flight; and

operating the jet turbines and/or electric motors and/or engines to draw surrounding air and controlling ~~an air flow directing assembly an air flow directing assembly~~ for directing the ~~combusted~~ high speed air ~~fuel mixture~~ from the outlet through an air flow directing assembly in a desirable direction for suppressing fires;

wherein the aerial vehicle has gimballed cabins and/or cockpit modules for crew assisted flight or movably coupled with an aerial vehicle frame and/or fuselage for autonomous flight.

20. An aerial vehicle comprising:

an annular aerodynamic body having a fuselage in the form of a torus;

one or more jet turbines and/or electric motors and/or engines mounted to the sides of the fuselage and/or an aerial vehicle frame to provide thrust to the aerial vehicle, the one or more jet turbines and/or electric motors and/or engines having a source of fuel, an air intake to draw air, and an outlet through which a high speed air as thrust is expelled; and

one or more gyroscopic stabilisation fan assembly comprising one or more gyroscopic members coupled to one or more jet turbines and/or electric motors and/ or engines;

wherein the at least one gyroscopic member is configured to be rotationally driven by the one or more jet turbines and/or electric motors and/or engines and gyroscopically stabilise the aerial vehicle during flight and provide high speed air as thrust for suppressing fire:

wherein the aerial vehicle has one or more cabins and/or cockpit modules movably coupled with the aerial vehicle frame by a pivotal and/or gimbal arrangement.

21. A method of suppressing a fire, the method comprising the steps of:

moving an aerial vehicle with an annular aerodynamic body having an airframe and/ or fuselage in the form of a torus, having gimballed cabins and/or cockpit modules for crew assisted flight or movably coupled with the vehicle frame and/or fuselage for autonomous flight and one or more jet turbines and/or electric motors and/or engines coupled to the sides of the fuselage, and control surfaces for controlling flight, and a gyroscopic stabilisation fan arrangement coupled to the one or more jet turbines and/ or electric motors and/or engines to provide high speed air as thrust to the aerial vehicle and for suppressing fire; and

moving the aerial vehicle to a location in the vicinity of the fire wherein the gyroscopic stabilisation fan arrangement and the one or more jet turbines and/or electric motors and/or engines provide high speed air as thrust for suppressing fire,

and operating the one or more jet turbines and/or electric motors and/or engines to draw surrounding air and controlling an air flow directing assembly or directing the high speed air as thrust from the outlet in a desirable direction for suppressing fires.

22. The aerial vehicle of claim 19, wherein the one or more cabins and/or cockpit modules are pivotally attached to the aerial vehicle frame providing 360 degrees rotation in relation to the aerial vehicle frame and/or fuselage.