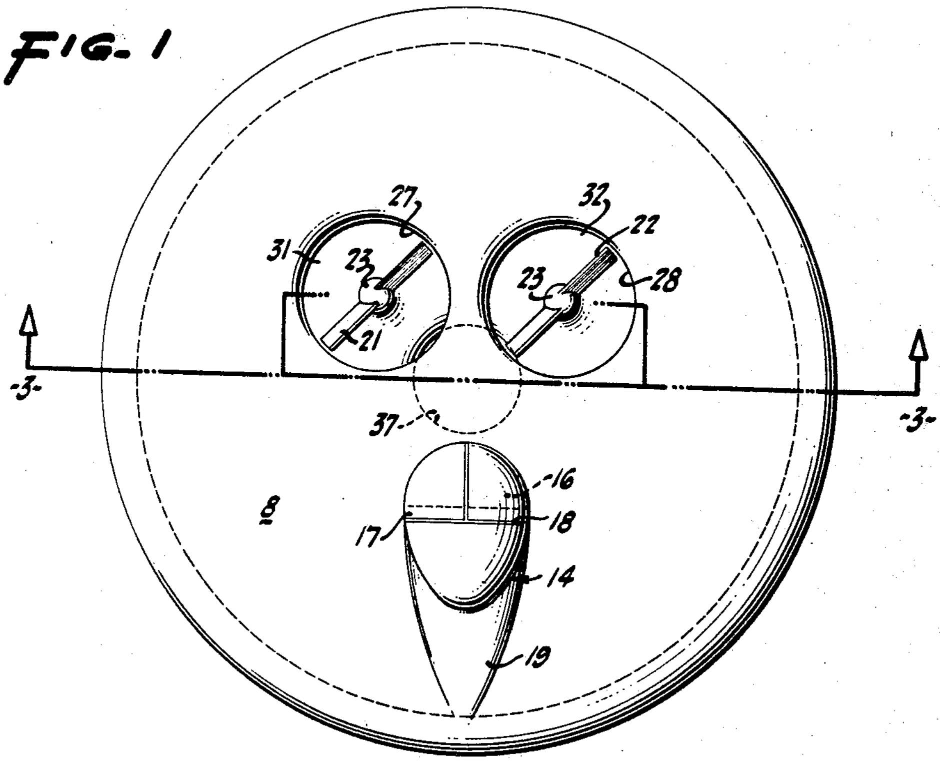
Nov. 12, 1968 P. S. MOLLER 3,410,507

AIRCRAFT

Filed May 6, 1966 5 Sheets-Sheet 1

FIG-1



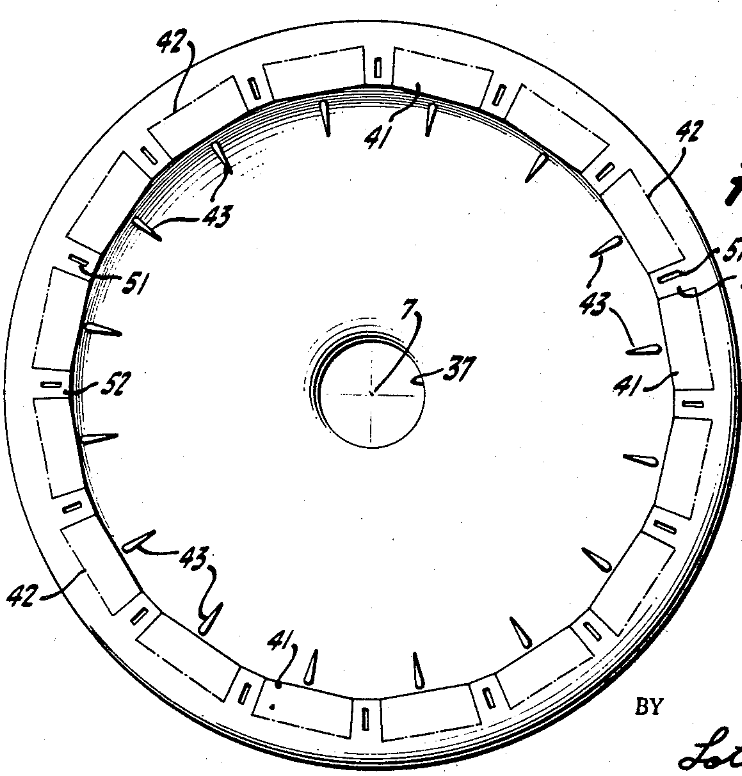


FIG-2

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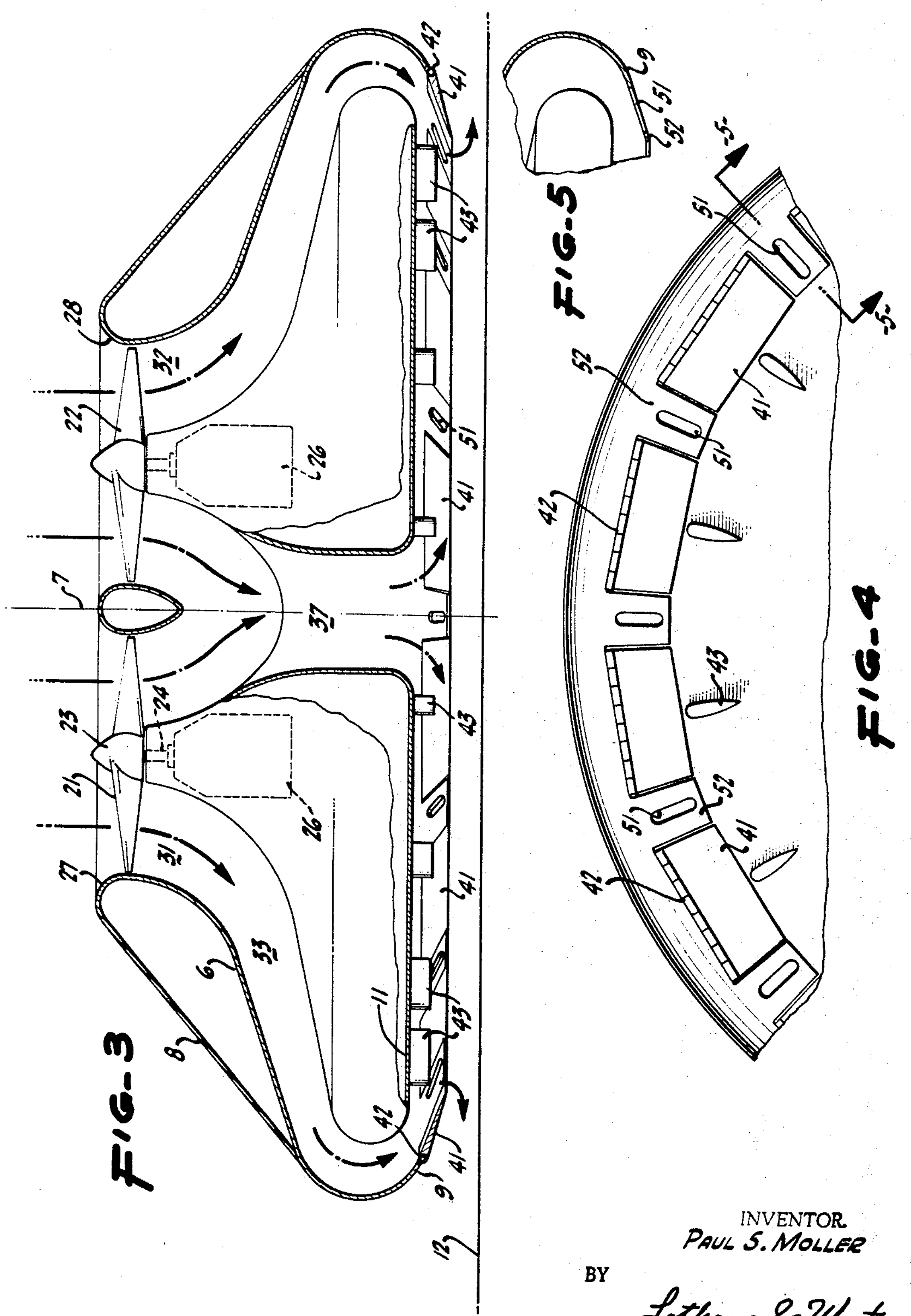
Nov. 12, 1968 P. S. MOLLER 3,410,507

AIRCRAFT

Filed May 6, 1966 5 Sheets-Sheet 2



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Nov. 12, 1968 P. S. MOLLER 3,410,507

AIRCRAFT

Filed May 6, 1966 5 Sheets-Sheet 3

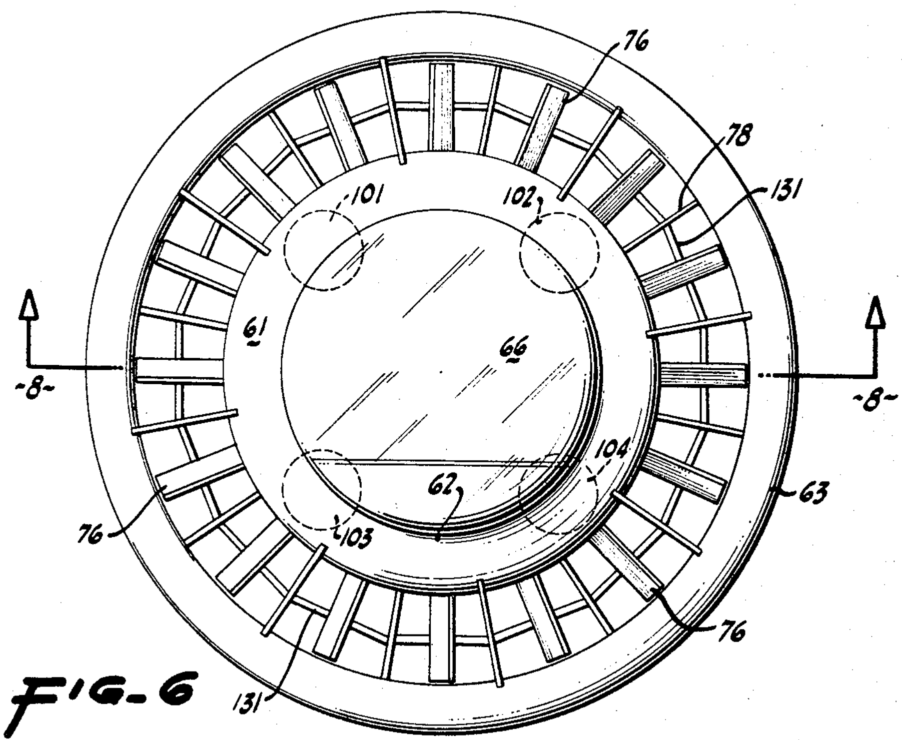

FIG-6

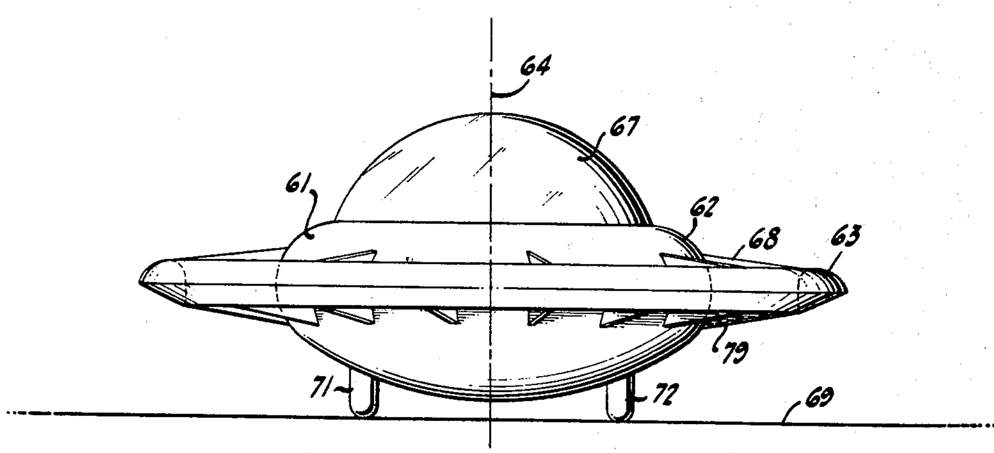

FIG-7

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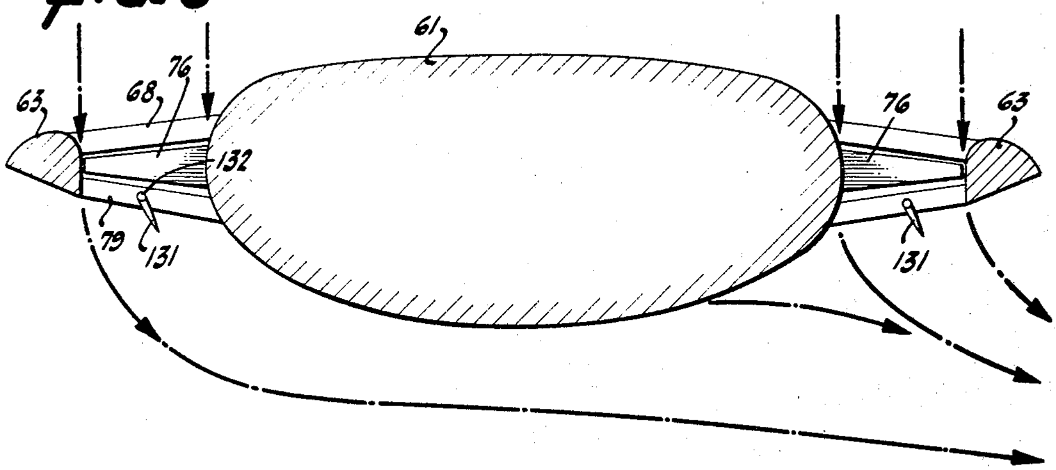
FIG-8



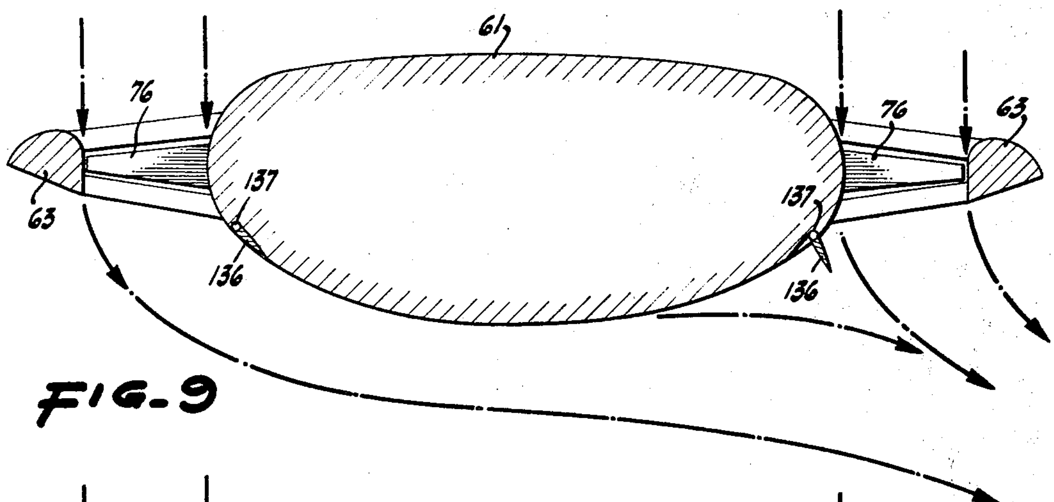


FIG-9

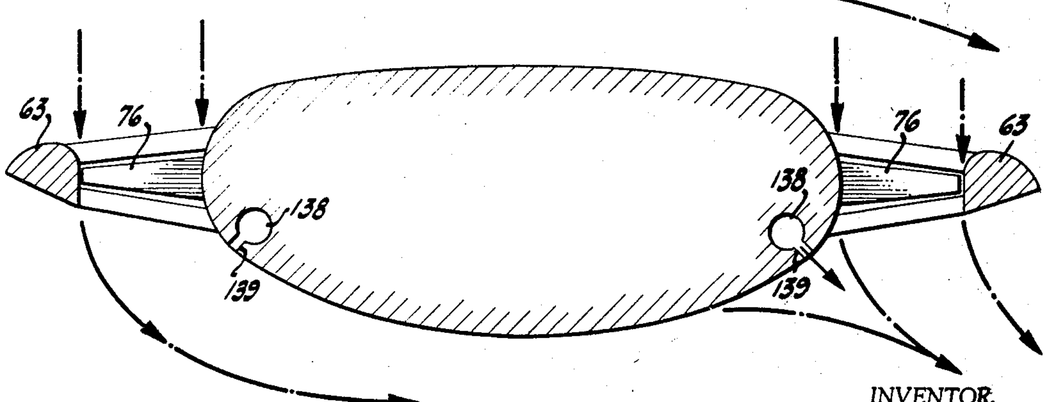


FIG-10

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AIRCRAFT

Filed May 6, 1966 5 Sheets-Sheet 5

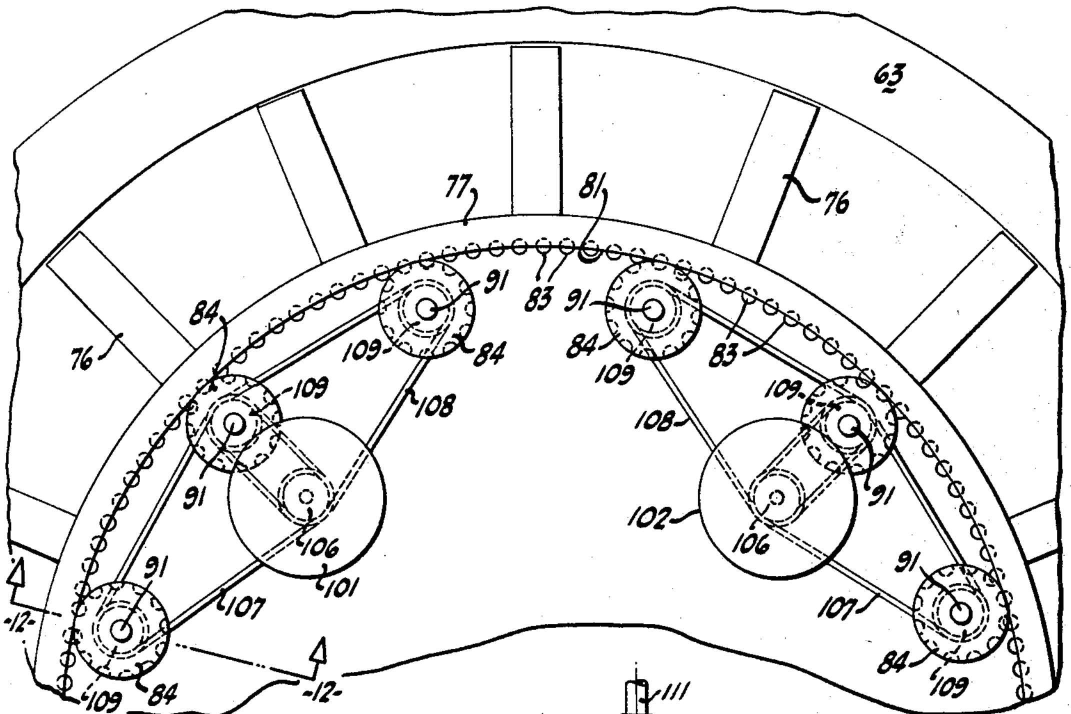

FIG-11

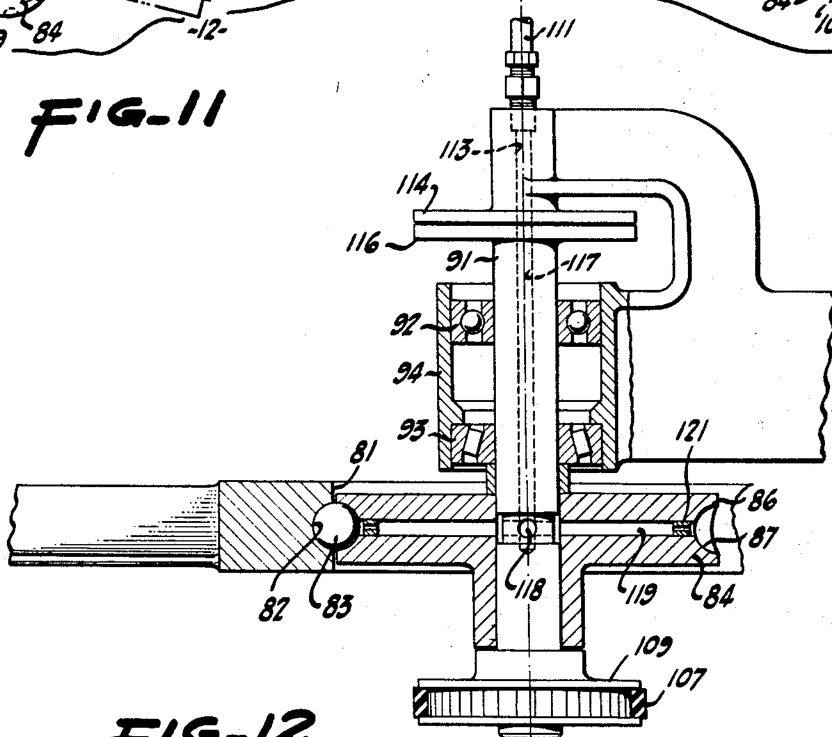

FIG-12

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United States Patent Office

3,410,507

Patented Nov. 12, 1968

3,410,507

AIRCRAFT

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Filed May 6, 1966, Ser. No. 548,256
7 Claims. (Cl. 244—23)

ABSTRACT OF THE DISCLOSURE

An aircraft has a central, passenger carrying nacelle with an outer surface defining a figure of revolution about a central vertical axis. A shell surrounding and spaced from the nacelle defines a passageway open at the top and bottom. An engine in the nacelle drives a fan in the passageway forcing air downwardly in the passageway to support the aircraft.

My invention relates to aircraft particularly of the type in which a load carrying body is sustained by a downwardly directed column or jet or cushion of air and in which directional control is achieved by varying the direction of the air flow in some fashion. Some vehicles of this nature are designed primarily for use quite close to the ground, so that the effect of air flow between the vehicle and the ground must be taken into account, whereas other vehicles of this general nature may or may not be designed to operate as ground effect machines close to the ground, but are designed to rise to considerably greater heights and far enough from the ground so that there is no or no substantial ground effect.

Aircraft of this general nature are known, but there has been considerable difficulty in providing effective and sufficient controls for such aircraft to maintain them in the desired attitude, to make them control well and to make sure that they are adequately stable.

It is therefore an object of my invention to provide an aircraft of this sort in which stability is satisfactory and sufficient.

Another object of the invention is to provide an aircraft of this character which is readily controlled.

A further object of the invention is to provide an aircraft of this nature in which the air flow is effective and efficient.

A still further object of the invention is to provide an improved arrangement of the various mechanical parts of the aircraft for appropriate performance.

A still further object of the invention is to provide an aircraft which is satisfactorily immune to danger due to malfunction of some of the parts.

A still further object of the invention is to provide an aircraft of this character which can operate well close to the ground and also at a great distance above the ground.

A further object of the invention is in general to provide an improved aircraft of the mentioned type.

Other objects together with the foregoing are attained in the embodiments of the invention described in the accompanying description and illustrated in the accompanying drawings, in which:

FIGURE 1 is a top plan of an aircraft in accordance with one form of the invention;

FIGURE 2 is a bottom plan of the aircraft of FIGURE 1;

FIGURE 3 is a cross section, to an enlarged scale, of the aircraft of FIGURE 1, the plane of section being indicated by the line 3—3 of FIGURE 1;

FIGURE 4 is a partial bottom plan of the structure of FIGURE 3 to the same enlarged scale;

FIGURE 5 is a cross section, the plane of which is indicated by the line 5—5 of FIGURE 4;

FIGURE 6 is a top plan of an aircraft pursuant to another form of the invention;

FIGURE 7 is a front elevation of the aircraft illustrated in FIGURE 6;

FIGURE 8 is a cross section, the plane of which is indicated by the line 8—8 of FIGURE 6, showing one form of control mechanism to an enlarged scale;

FIGURE 9 is a view similar to FIGURE 8 but showing a different form of control mechanism;

FIGURE 10 is a view similar to FIGURES 8 and 9 showing a further modified form of control mechanism;

FIGURE 11 is an enlarged view of a part of the structure in plan with portions removed to illustrate a drive arrangement; and

FIGURE 12 is a cross section, the plane of which is indicated by the line 12—12 of FIGURE 11.

In the first of the preferred forms of the invention, which has been satisfactorily flown at Davis, Calif., there is provided an aircraft particularly designed to carry one passenger and for use close to the ground. This aircraft includes a main frame **6** comprised of various structural members, sheets and covers arranged generally to provide a rigid figure of revolution about a vertical axis **7**. The external, upper configuration is generally defined by a conical surface **8** and by an inturned partially toroidal peripheral surface **9** leading to the vicinity of a substantially planar and usually horizontal lower or bottom surface **11** designed to rest near or to operate a short distance above the indicated planar surface **12** of the ground. The construction described in the main affords continuous enclosing surfaces.

There are some interruptions in the central or nacelle portion of the upper cone **8**. One interruption provides an operator's cockpit **14** affording a seat or station **16** for the operator. This station is enclosed in part by a transparent hood **17** having appropriate braces **18** and faired by an appendage **19** into the surface of revolution of the craft. The hood **17** is movable so that the operator can enter and leave without difficulty by moving over the surface of the cone **8**.

Supported on the frame **6** in the central nacelle and in symmetrical relationship with the axis **7** and preferably just behind the operator's station are a pair of suspension fans or propellers **21** and **22**. Each of these is provided with a driven hub **23** connected by appropriate shafting **24** to an individual propelling engine **26** likewise mounted on the frame **6**. Preferably the propellers or fans are disposed in substantially the same horizontal plane and are substantial duplicates in all aspects. Each of the fans is provided with one of a pair of individually contoured entrance ducts **27** and **28** merging with the outer surface of the aircraft so that the air flow to the fans is over smoothly configured surfaces and from the upper portion of the cone **8**.

The fans **21** and **22** both discharge generally downwardly parallel to the axis **7** into initially individual ducts **31** and **32**. These promptly merge into a single air passage **33** which for the most part extends circumferentially around the interior of the cone. The duct walls defining the passage **33** are carefully configured for efficient air flow toward the outer periphery of the enclosure. From the rim the duct walls are inflected inwardly all around the lower periphery of the structure so that the passage **33** discharges the guided air generally in a radially inward and slightly downward direction beneath the lower surface **11** of the frame **6**.

Although it is not always utilized, it is in many instances advantageous, particularly if central turbulence beneath the surface **11** is excessive, to provide in addition to the passage **33** a central, downwardly directed conduit **37** symmetrical with the axis **7**. The walls of the conduit **37** merge smoothly with the bottom surface **11**. Air discharged by the conduit **37** acts as a stabilizer. It blocks or diverts inward air flow, precludes cross flow and alleviates central turbulence. In general, the air flow from the fans **21** and **22** is as shown by the various arrows in FIGURE 3 when the craft is on or near the ground.

In order to control the efflux of the air from the passage **33** at various circumferential points around the lower, annular discharge openings, the inwardly directed portion **9** of the body, which also is a duct wall of the passage **33**, is provided with a number of substantially identical, inwardly directed flaps **41**. These are arranged in a circle and each is provided with a hinge connection **42** to the frame **6** of the machine. The flaps are individually pivoted about their individual hinges **42** to approach and receded from the bottom wall **11**. They thus govern the amount of air discharging from the passage **33** at the individual flap stations around the periphery of the machine. The flaps **41** are connected to a control instrumentality (not shown) at the operator's station so that the operator can regulate the amount of opening of each of the flaps **41** individually or in groups as desired and can thus discharge more or less air from any selected portion of the device and can vary the air direction to a limited extent.

The discharged air flows between the ground surface **12** and the bottom **11** and over a number of yaw controllers **43** projecting downwardly from the bottom **11** of the framework. With a structure of this sort and as so far described, the operator can control the efflux of the pumped air around the lower periphery of the frame so that he has little difficulty in controlling the attitude of the vehicle when the vehicle is at a short distance above the ground. Since the inwardly directed air flow or streams passing over the flaps **41** may cause considerable turbulence, particularly under the central portion of the vehicle, it is in many instances desirable to permit air to flow also through the vertically downwardly directed jet **37** so that some of the turbulence is obviated and a more stable air column, cushion or platform is provided for the vehicle.

Despite the foregoing, there may still be control difficulty. Particularly when the vehicle is very close to the ground, if its horizontal attitude is altered by tipping so that the periphery is closer to the ground at one point than at another, the discharging air which reverses and escapes outwardly under the flaps **41** between the lower surface of the flaps and the ground generates a locally pronounced Bernoulli effect. The low portion of the vehicle rim, or the flaps **41** that are closer to the ground than the others, tends to have the air flowing thereunder at a somewhat higher velocity and lower pressure. This lessens the vertical support under the already lower portion of the vehicle rim and aggravates the tilt or improper attitude of the craft. This effect becomes increasingly pronounced as the vehicle approaches the ground surface **12** and may cause serious difficulties. Some of this effect can be obviated by extremely precise control of the flaps **41**, but it is usually not practical to provide a sufficiently accurate control, particularly in a relatively small, inexpensive machine.

I have found in actual operation that the Bernoulli effect of importance close to the ground can be largely and practically obviated by the provision of permanently open slots **51** cut through the inturned lip **52** beneath the main body of the machine and extending between the spaced flaps **41**. It is also possible, if the edges of the flaps **41** are sufficiently accurately and closely spaced, simply to omit the inturned lip **52** therebetween and thus to leave narrow open spaces equivalent in area to that of the slots **51**. When I refer to slots herein, I intend to refer to either construction or to any construction which allows a continuous or permanent generally vertically downward escape or discharge of air beneath the lower peripheral surface of the aircraft.

With this arrangement I have found that a small fraction of the total air in the passage **33** discharges through the slots **51** or their equivalents in an approximately vertical direction. This discharge is adequate to prevent any deleterious Bernoulli effect beneath the vehicle. Even though one portion of the lower periphery of the vehicle should be too close to the ground and would normally tend to aggravate the Bernoulli effect, the downwardly flowing peripherally arranged air jets alleviate the Bernoulli effect and obviate the instability of the craft under those circumstances. While the slots **51** are all shown of substantially the same size herein, they can vary in effective area or in number in different parts of the lower periphery of the body.

The loads on the craft are generally arranged for good balance. For example, the engines **26** and fans **21** and **22** are displaced rearwardly to offset the eccentric loading at the forward operator's station **16**. The forward lip of each duct **27** and **28** in forward flight is thus on or near a diameter of the craft. This rearward location of the air intake structure thus eliminates or reduces nose-up moments. Yet, variations in live load, particularly their effect when the craft is near the ground, may cause some tipping and accentuation of the Bernoulli effect. The slots **51** can be particularly designed and arranged to compensate for any net eccentric load.

In order to make the vehicle safer, the area of efflux for air both from the central conduit **37** and from the peripherally discharging passageway **33**, particularly when the open slots **51** are taken into account, is always made greater than the area for influx of the air to either one of the propellers **21** and **22**. Each of the engines **26** has its own complete system, so that the failure of one of the engines in flight does not affect the operation of the other. Since the area for outflow of air from one propeller beneath the machine is considerably greater than the area for flow past the other, dead propeller, there is no reversal of air flow or back flow through an inlet. Even though but one propeller is operating, its entire output travels downwardly and discharges beneath the craft as designed. Thus, while there is some loss of support when one engine fails, there is no tendency for an upwardly directed air jet to interfere with the vehicle operation.

The form of the invention just described is particularly used in close proximity to the ground and while it can rise to some height thereabove, it is not efficiently designed for that use. The form of the invention shown in FIGURES 6–12 inclusive is designed to make but small use of ground effect and to make much larger use of momentum thrust effect and to rise to substantial heights above the ground.

In this latter instance, the aircraft includes a body and framework **61** constructed similarly to the preceding arrangement. There is provided generally a nacelle **62** and a spaced rim **63** which are both figures of revolution about a central, vertical axis **64**. The load carrying portion or nacelle of the vehicle is centrally disposed and is symmetrically located about the axis **64**. It takes the form of a passenger and load station **66** closed by a transparent dome **67**. The rim **63** is connected to the central body by a plurality of radial struts **68** and the entire vehicle when on the ground **69** is supported on wheels **71** and **72**.

The air flow and the resulting air cushion are provided by a plurality of fan blades **76** arranged in radial fashion about a circular fan rim **77** (FIGURE 11) having the axis **64** as a center. The outer ends of the fan blades **76** terminate just short of the approximately vertical inner surface of the rim **63**, which, with the body **62**, is configured to afford a smooth entrance for air to the upper side of the fan blades. A number of anti-swirl vanes **78** are extended between the rim **63** and the nacelle **62** to serve as guides for the entering air. The vanes are disposed to cancel the torque or rotational effect of the air passing through the device.

Supplementing the upper, anti-swirl vanes **78** there may be a plurality of lower, anti-swirl vanes **79** deflecting the fan-discharged air for the same purpose. Either the upper vanes **78** or the lower vanes **79** may be omitted, provided that the design of the remaining set is suitably adjusted. The net result is to provide an appropriate air flow into, through and from the craft so that in normal operation the nacelle **66** remains stationary and does not rotate about the vertical axis **64**.

In order to afford an appropriate mounting and driving means for the fan blades **76**, the inner fan rim **77** is both supported and propelled by the arrangements shown in FIGURES 11 and 12. The inner rim **77** is formed on its interior cylindrical surface **81** with a number of approximately hemispherical depressions **82** into each of which a sphere or ball **83** is permanently fastened, leaving about half of the ball to project. At appropriate points (in this case, twelve) on the framework of the body **61** there are mounted driving pinions **84** having a circular cylindrical outer surface **86**. At intervals the pinions have hemispherical depressions **87** designed to interfit with the balls **83** as the pinions rotate. Because of the interengagement of the balls **83** and of the hemispherically depressed pinion, load is transmitted between the rim **77** and the pinion **84** not only in a rotary sense but also in radial and vertical directions. That is, the pinion is not only a driving member for the rim **77**, but is also a radial and axial supporting member therefor.

As particularly indicated in FIGURE 11, a number of pinions **84** are evenly spaced about the interior periphery of the rim. Each of the pinions **84** is carried on a vertical shaft **91** at least partially confined and supported by bearings **92** and **93** in a bearing cage **94** connected to part of the framework **6**. Each group of the pinions **84** is appropriately driven from an adjacent one of a plurality of engines **101**, **102**, **103** and **104**. Each of these engines is entirely independent of the others. Any one can be operated even though all of the others fail. Each of the engines carries a drive pulley **106** around which belts **107** and **108** are trained. These belts are also trained in generally triangular drives around belt pulleys **109** at the bottom of the shafts **91**, each of the engines driving its group of three of the twelve pinions. By this means, the fan is not only located and supported, but is engine rotated.

Because lubrication and the bearing loads in this environment present some problems, I prefer to utilize some air bearings. From an appropriate air compressor on the vehicle (not shown) air under pressure is led through a number of tubes such as the tube **111** in FIGURE 12 to a central bore **113** in part of the framework **6**. Some of the air escapes between a stationary disk **114** forming part of the framework and a subposed rotary disk **116** at the upper end of the shaft **91**, thus providing an air thrust bearing. A remaining portion of the air from the duct **113** continues through a bore **117** in the shaft **91** and then travels through a central manifold **118**. From there the air flows radially through channels **119** to the hemispherical recesses **87** and thus escapes around the individual balls **83**. Preferably the channels **119** are provided with exit restrictions **121**. Despite the fact that some of the channels are open for much of their cycle of rotation, there is still pressure in the system of sufficient magnitude to ensure an air bearing between each hemispherical surface **87** and the adjacent ball **83** as the positioning, support and drive loads are imposed.

With this arrangement, when one or more of the engines is in operation, the fan is rotated about the axis **64** and drives a current of air of annular envelope configuration in a generally downward direction. This air is variously deflected in order to maneuver and control or stabilize the vehicle. For that reason, there may be situated in the outflow of the fan **76** a ring or plurality of deflectors **131** (FIGURE 8) symmetrical about the axis **64** and designed to be rocked about horizontal axes **132** and to swing through a vertical position and to both sides thereof under the control of an instrumentality (not shown) in the operator's station. As illustrated in FIGURE 8, the vanes **131** are tilted so as to deflect the air flow laterally to the right. The configuration of the underbody of the vehicle is such that a deflector inclination, as shown, tends to discharge the outgoing air in a direction having a downward component and also having a substantial lateral component. While some turbulence exists particularly near the confluence of the air flowing beneath the body and that flowing more nearly downwardly, there is a sufficient net, lateral reaction to produce side maneuverability of the body. By tilting one or various groups of the several vanes **131**, the operator may deflect the downflowing stream in any desired direction in order to give him directional control of his vehicle and also to assist him in preventing any instability, such Bernoulli effect instability, upon close approach to the ground.

As an alternative to the vanes **131**, there may be provided, as shown in FIGURE 9, a number of spoilers **136** symmetrically disposed in a ring about the axis **64** and also arranged to swing on horizontal axes **137** beneath the body of the vehicle. The spoilers **136** are so mounted as to be nested within the configuration of the body and in effect to continue its streamlined configuration in one extreme position. When one or more of the spoilers is moved about its axis **137**, it projects into the downflowing air stream. Normally, the interior portion of the annular stream tends to follow the configuration of the vehicle body and to emerge symmetrically along the axis **64** extended downwardly. However, as shown in FIGURE 9, one or more of the spoilers to the right-hand side of the figure have been projected from their recessed position and hence deflect the adjacent air flow toward the right. This flow reduces the pressure beneath the body of the vehicle and tends to cause an accompanying transverse flow beneath the vehicle body. The function of the spoiler installation is virtually the same as that of the deflecting vanes shown in FIGURE 8.

As another control alternative, in place of the vanes **131** or of the spoilers **136**, I may provide auxiliary power jets of air. As particularly illustrated in FIGURE 10, the body contains a manifold **138** from which individually controlled ducts **139** extend to the surface of the body. The individual ducts can be controlled from the operator's station. When the ducts toward the right, as shown in FIGURE 10, are opened and the remaining ducts toward the left as shown in that figure are closed, air issuing from the open ducts tends to deflect the main stream of air to the right as before, inducing flow from the left-hand side of the machine beneath the body to join the right-hand flow. The result of this structure is about the same as with the structures of FIGURES 8 and 9. In all of these instances, the operator is accorded means for controlling the direction of discharge or efflux of the normally downwardly flowing air cushion or stream so that the vehicle is readily maneuverable in the selected directions and so that compensation can be made for any local or temporary instability.

With the central nacelle, the operator and the removable load are generally symmetrically and centrally located so that variation in their weight does not disrupt the stability or attitude of the machine. It has been found that with this arrangement there is sufficient lift, stability and maneuverability to permit the machine to rise from the ground without disturbing ground effect and to maneuver at substantial altitudes far enough away from the ground so that ground effect is immaterial.

The large rotor, of which the fan blades **76** are a part, is rotated rapidly enough to provide a pronounced gyro-stabilizing effect. This is augmented by the similar effect of the drive pinions and their coupled engines. While the diameter of these latter rotating parts is not great, they turn at relatively high speed so that all of their gyro-stabilizing effects occur in effective amounts and about appropriate axes.

What is claimed is:

1. An aircraft comprising a central nacelle having an outer surface that substantially defines a figure of revolution about a central vertical axis, an outer shell surrounding said nacelle and spaced therefrom to leave an intervening passageway open at the top and at the bottom and that is substantially annular in any plane normal to said axis, means for connecting said outer shell to said nacelle, a ring surrounding said nacelle, fan blades on said ring extending outwardly therefrom substantially across said passageway, means in said nacelle for accommodating a passenger and at least one engine, an engine driven shaft in said nacelle rotatable about a vertical shaft axis fixed in said nacelle, and interfitting drive members connecting said engine driven shaft and said ring to rotate said ring and said fan blades about said central vertical axis in a direction to force air downwardly in said passageway from the top to the bottom thereof.

2. An aircraft as in claim 1 in which said interfitting drive members also hold said ring and said nacelle against relative displacement along said vertical axis.

3. An aircraft as in claim 1 in which said interfitting drive members include balls on one of the members and hemispherical sockets of a similar size on the other of the members.

4. An aircraft as in claim 3 in which said interfitting drive members are sized to allow an air film between them.

5. An aircraft as in claim 1 in which a plurality of anti-swirl vanes fixed to said nacelle extend substantially across said passageway.

6. An aircraft as in claim 1 in which said outer surface of said nacelle extends downwardly and inwardly toward said central axis, and means are provided for deflecting the air flow thereover.

7. An aircraft as in claim 6 in which said deflecting means is an outlet for an air stream.

References Cited

UNITED STATES PATENTS

3,124,323	3/1964	Frost	244—12
2,718,364	9/1955	Crabtree	244—12
3,170,529	2/1965	Kelley et al.	244—23
3,276,723	10/1966	Miller et al.	244—12
3,291,236	12/1966	Foshag	114—671

FOREIGN PATENTS

678,700	1/1964	Canada.

MILTON BUCHLER, *Primary Examiner.*

T. W. BUCKMAN, *Assistant Examiner.*

March 11, 1969 E. GUERRERO 3,432,120

AIRCRAFT

Filed May 20, 1966 Sheet 1 of 3

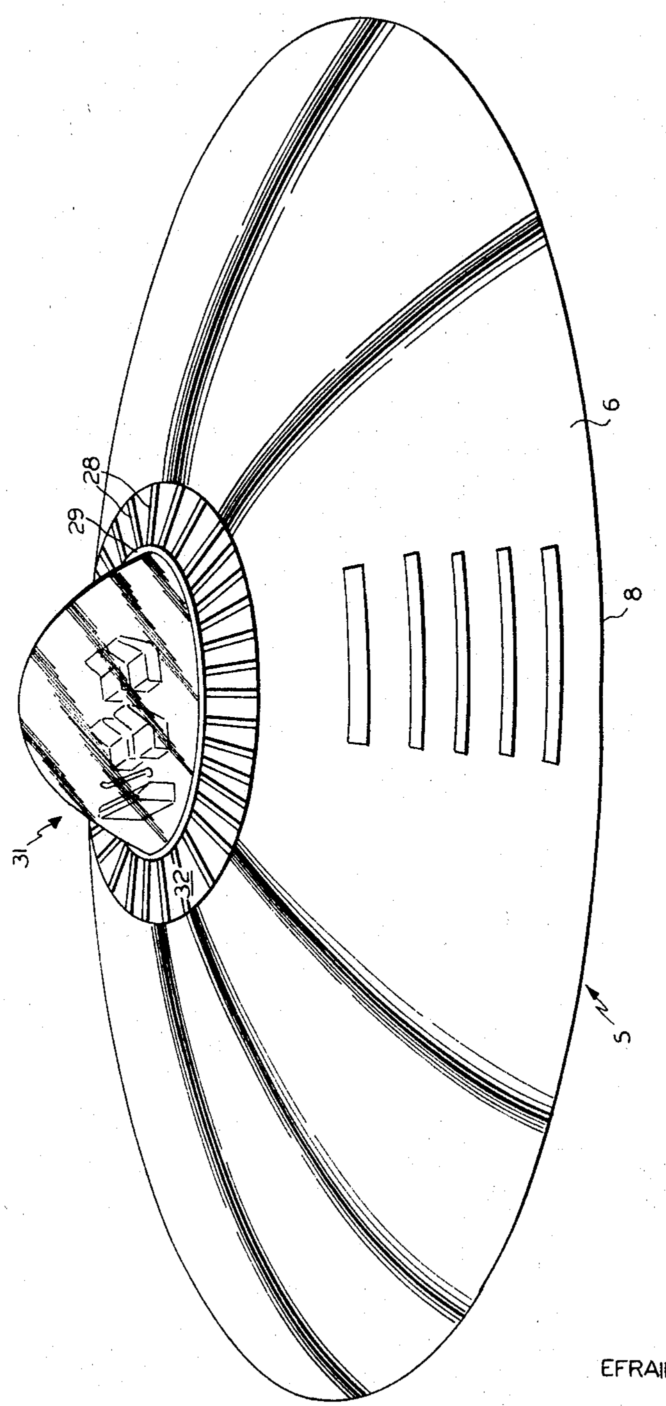

FIG. 1

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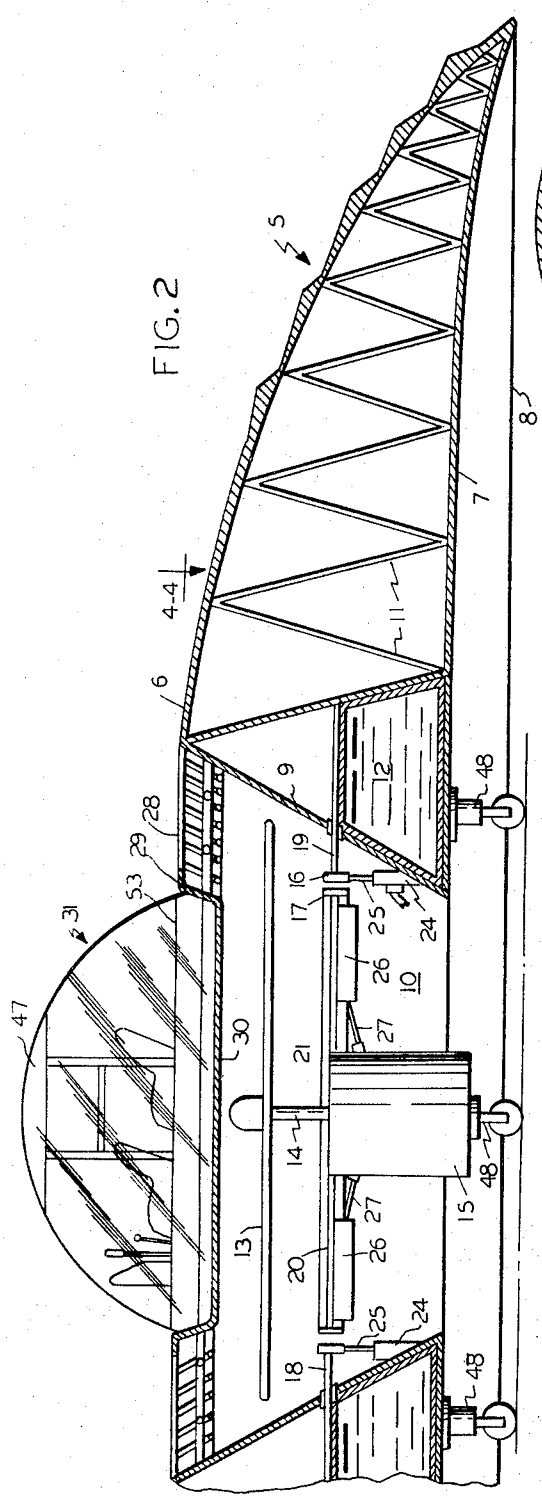

FIG. 2

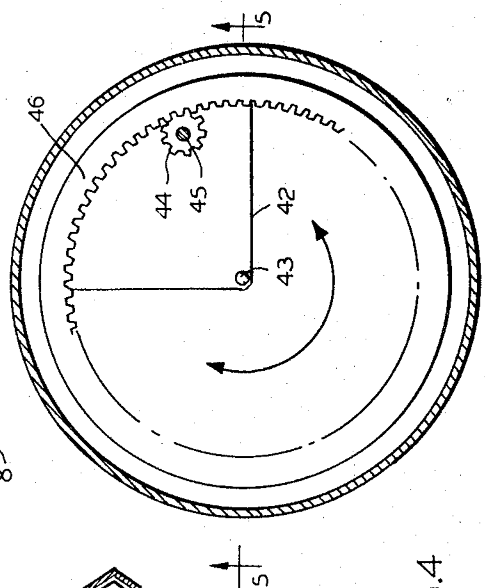

FIG. 4

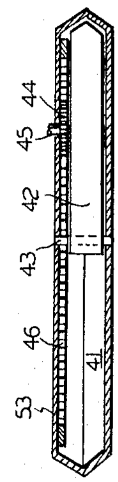

FIG. 5

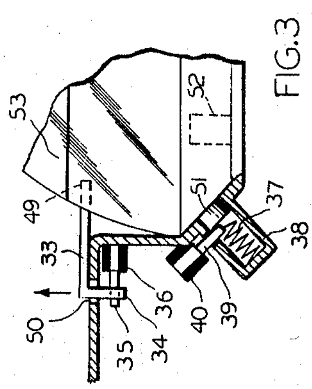

FIG. 3

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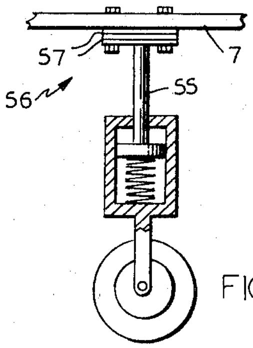

FIG. 6

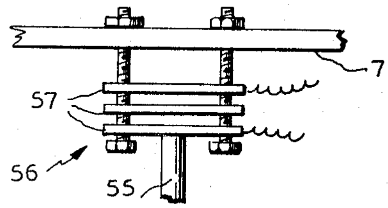

FIG. 7

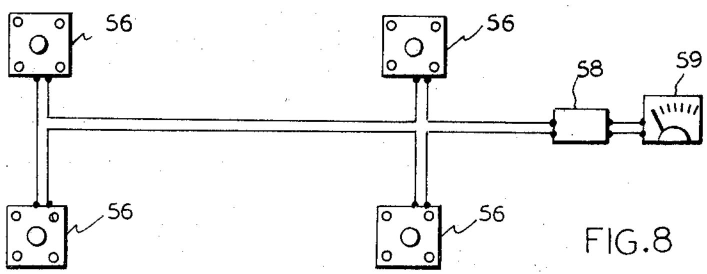

FIG. 8

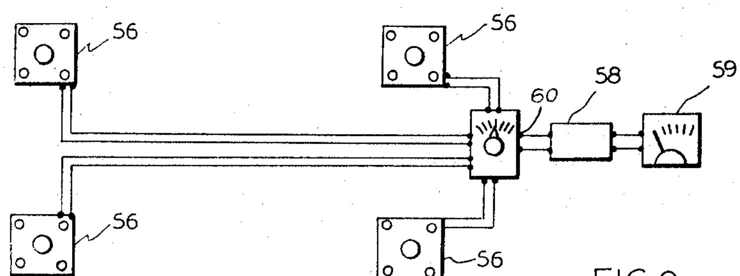

FIG. 9

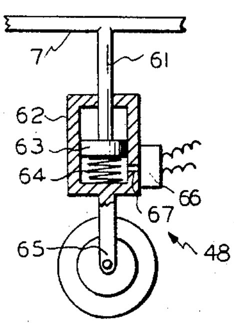

FIG. 10

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ABSTRACT OF THE DISCLOSURE

The specification discloses floatable aircraft with an annular wing and an air duct mounted within the wing. The impeller, control surfaces, and motor are gimbal mounted in the air duct to provide directional movement for the aircraft. Weight sensing means are mounted on the ground engaging members to sense the load on each ground engaging member and the total weight of the aircraft. The weight distribution may then be calculated and a shiftable ballasting member is rotated to dynamically balance the aircraft.

This invention relates to aircraft. More particularly, it pertains to aircraft safety systems and an improved aircraft embodying such systems.

This invention relates to an aircraft suitable for use as an all-around personnel transportation vehicle by a large proportion of the population and therefore it must satisfy a wide variety of critical requirements. Such aircraft must be as simple as possible from the standpoint of construction and maintenance, since complexity leads to expense, and expense has been an important deterrent to the development of general aviation. Such aircraft must have VTOL capability for practical utility. The aircraft should be able to operate from land, and, at least land and float upon the water, in order to permit an emergency landing virtually anywhere. It should be able to bring its occupants from cruising altitude to a safe landing in the event of a full or partial power failure. It should not have exposed moving parts such as propellers or rotors which would be hazardous to personnel who are near the vehicle when it is landing, taking off or operating on or near the ground.

It will be appreciated that certain of the above requirements are met by helicopters, which have VTOL capabilities and are able to descend from cruising altitude in the event of a power failure, provided the structural integrity of the main rotor and its ability to rotate freely are not impaired. Nevertheless, the helicopter has not yet demonstrated its feasibility as a practical all-around means of transportation for large proportions of the population. Cost is perhaps the principal deterrent factor at present, since the acquisition and operating costs of helicopters are at present substantially greater than those of fixed-wing aircraft of equivalent weight-carrying capacity. Even if acquisition costs could be reduced by increases in volume of production, the helicopter still suffers from the disadvantages of having high maintenance costs, exposed rotors, and inability to make a safe descent upon impairment of the rotor or its ability to turn (e.g. through gear box failure).

Recently, new types of circular wing aircraft have been proposed. According to one suggestion found in the art, a circular wing aircraft is provided with a vertically oriented central opening or duct through the wing. A power plant with a downwardly thrusting impeller, e.g. contra-rotating props, is gimballed in the duct to provide lift and at least a measure of lateral control. Such aircraft can be made with VTOL capability and the capability of producing at least some lift by autorotation of the props in case of power failure. They have

the further inherent virtue of having semi-enclosed props as opposed to the completely exposed rotors of helicopters. The present invention pertains to improvements in aircraft generally, and to improvements in circular wing aircraft of the general type just described.

The invention may be better understood by referring to the accompanying drawings in which like reference numerals refer to like parts throughout the several views, and in which:

FIGURE 1 is a perspective view of an aircraft constructured in accordance with the invention.

FIGURE 2 is a partial, vertical sectional view of the aircraft of FIGURE 1.

FIGURE 3 is an enlarged portion of FIGURE 2.

FIGURE 4 is a sectional vew of the lower portion of the passenger compartment taken along section line 4—4 in FIGURE 2.

FIGURE 4 is a sectional view taken along section line 5—5 in FIGURE 4.

FIGURE 6 is an enlarged detail view of a weight-determining landing gear assembly for an aircraft.

FIGURE 7 is a partial, exploded view of the landing gear assembly of FIGURE 6.

FIGURES 8 and 9 are schematic diagrams of weight-distribution sensing systems adapted for connection with the landing gear assembly of FIGURES 6 and 7.

FIGURE 10 is a schematic diagram of an alternate form of weight-determining landing gear assembly.

In a preferred embodiment of the invention, the aircraft includes, as disclosed in FIGURES 1 and 2, an annular wing **5** having upper and lower walls **6** and **7**, both of which are transversely curved downwardly and joined together, as at **8**, at the outer periphery of the wing. The inner ends of the upper and lower walls are joined together by a circular downwardly, inwardly inclined wall **9** forming an air duct **10** in the center of the wing. The skin of the wing may be any suitable synthetic resinous or elastomeric material supported by a series of struts **11** formed of fiber-glass reinforced resin or light metal and extending in a zig-zag course between the upper and lower walls of the wing. Disposed within the wing around the duct **10** is an annular tank **12** for storage of the fuel supply. An impeller **13** is disposed in the upper end of the duct **10** for creating a downward flow of air through the duct, the impeller being mounted on the upper end of the shaft **14** of a motor **15**. The motor is supported by a pair of gimbal rings **16** and **17** disposed in concentric relation, the outer ring **16** being pivotally mounted on shafts **18** and **19** projecting from opposite sides of the wall of the duct while the inner ring **17** is pivotaly mounted on shafts (not shown) connected to the outer ring and with their axis disposed at right angles to the axis shafts **18** and **19**. Hydraulic cylinders **24** are mounted on the wall **9** beneath the ring **16** adjacent the pivotal mountings of the rings having rods **25** in contact with the lower edges of the ring adjacent their pivotal mountings. The hydraulic cylinders are used to adjust the degree of tilt between the outer ring and the aircraft, thus serving to control aircraft roll. A second set of hydraulic cylinders (not shown) are mounted on the outer gimbal ring near the shafts which attach it to the inner ring, for tilting the one ring with respect to the other and therefore controlling aircraft pitch. Yaw control is provided by a plurality of generally upright control surfaces **26**, pivotally supported on generally radial shafts **20** and **21** extending from the motor to the inner gimbal ring **17**. By means of suitable operating linkage **27**, the control surfaces are caused to pivot to any desired position about shafts **20** and **21**, thus controlling (e.g., preventing and/or imparting any desired degree of) rotational movement on the part of the aircraft. In the preferred embodiment of the aircraft wherein a single rotating impeller is used, these control surfaces also counteract the torque generated by a single propeller, thus making it unnecessary to provide two propellers rotating at different speeds.

A plate **29**, supported by radial bars **28** extending outwardly to the wing at the top edge of duct **10**, partially covers the upper end of the duct **10** and has a depressed central recess **30** which serves as a receptacle for a detachable dome-shaped cabin **31** of air-tight construction. The bars form a grill **32** to allow air to enter the duct. As shown in FIGURE 3, the cabin is detachably held in the recess by arms **33** anchored to the cabin **31** at their inner ends **49** and extending over the rim of the recess **30** and having depending apertured ends **34** extending through openings **50** in the plate **29**, beneath which they engage a latch bolt **35** adapted to be withdrawn from engagement by a solenoid **36**. Around the bottom of the recess **30** are a series of ejector springs **37** mounted in cylinders **38**. The springs are normally held compressed by plungers **39**, which extend through the walls of the cylinders and are adapted to be retracted from such engagement by solenoids **40**. Upon retraction of the plungers **39**, the springs **37** expand and press outwardly against followers **51** to eject the cabin from the recess. A plurality of electrically-fired, solid fuel thrusters **52** may be provided to assist in cabin ejection. A parachute is mounted in a compartment **47** in the top of the cabin **31** and means may be provided for opening the parachute when the cabin is detached for an emergency landing. The aforementioned solenoids, thrusters and parachute opening means may all be controlled by a single "eject" button on the pilot's instrument panel **54**.

A compartment **41** is disposed in the bottom of the cabin **31**, beneath the floor **53**, as shown in FIGURES 2–5. It contains a ballasting member **42** pivotally mounted to swing around a vertical shaft or axis **43** disposed centrally in the compartment. The rotation of the ballasting member may be accomplished and controlled by gear wheel **44** which may be rotated in a fixed position by a shaft **45** controlled from the passenger compartment. Gear wheel **44** meshes with a ring gear **46** fixedly attached to ballasting member **42** and adapted to rotate therewith about shaft or axis **43**. Thus, by rotating shaft **45**, the pilot may rotate the ballasting member **42** to any desired position to compensate for imbalance in the weight distribution of the aircraft or its load. The ballasting member may be a dead weight, or more desirably, a compartment or a carrier means for luggage, fuel or other objects having appreciable weight. An access hatch may be provided through floor **53** if needed.

The aircraft is supported on the ground by four ground-engaging members provided with weight-sensing means and thereby constituting a weight-measuring landing gear assembly which may, if desired be adapted to measure total weight of the aircraft or weight distribution, or both, preferably the latter. Over-loading of an aircraft can result in dangerous effects on controllability. Also, controllability may be seriously affected by improper weight distribution. At present, proper loading is determined by determining the weight of each object which has been loaded in the aircraft and its position in respect to a specified datum position. These quantities are then employed in calculations which yield the moment arm of each of the objects in the aircraft, and the total obtained by summing the resultant moment arms is compared with a graph which shows the acceptable center of gravity envelope for the aircraft. The repetitious performance of such calculations on the loading of an aircraft that is being used for frequent, miscellaneous short-haul trips at different loadings is a burdensome process, thus tempting the pilot to rely on estimates or to neglect the calculations altogether. The weight measuring landing gear of the present invention which is useful not only with the aircraft disclosed herein, but also with other types of aircraft, e.g. fixed and rotary wing types and other circular wing aircraft, solves the foregoing problem by providing a rapid, accurate means of determining loading and weight distribution without calculations.

In accordance with one embodiment shown in FIGURES 6–8; a plurality of ground engaging members **48**, including wheel and shock absorber-mounting struts **55**, are connected to the lower surface **7** of the aircraft through transducers **56** having pressure and contact plates **57**. Each transducer measures a portion of the total weight of the aircraft. The transducers are connected in series to an amplifier **58** for totalizing the weight units measured by the individual transducers and for showing the total weight thus measured on an indicating means, such as a meter **59**, digital reader, or "go-no-go" lights on the pilot's instrument panel.

In accordance with a more preferred embodiment illustrated in FIGURE 9, the transducers are not connected in series with one another, but rather are individually connected to switching means **60**. The switching means is connected to the amplifier **58**. In all other respects, the system is like the one just described. The switching means is provided with a plurality of positions, which may, for convenience, be referred to as positions (*a*), (*b*), (*c*), (*d*), (*e*) and (*f*). In position (*a*), all transducers are connected in series with one another and with the amplifier input, so that the indicating means, which may in this case be a digital reader or meter-type indicator **59** "reads" the total weight of the aircraft. When the switching means is in position (*b*), all of the transducers are connected in parallel with the amplifier input, so that the indicating means **59** registers the average load on the ground engaging members **48**. In positions (*c*), (*d*), (*e*) and (*f*), the first, second, third and fourth transducer **56**, respectively, are individually connected with the amplifier input, and the indicating means **59** will, in each position, indicate the actual load on each ground engaging member **48**. If the indicating means is of the meter type, it may be provided with a manually resettable set-pointer (like the manually resettable hand on a common household barometer). The set-pointer is positioned over the indicating needle of the meter with the switch in position (*b*). Then, as the switching means is moved through positions (*c*), (*d*), (*e*) and (*f*), the deflection of the needle from its original position may, in each case, be noted. The deflection or deviation furnishes an indication of the imbalance, if any, in the loading of the aircraft. The amount of deviation noted as the switching means is adjusted may be compared with predetermined values shown on the dial face or elsewhere, which represent the maximum deviation which may be tolerated without producing unstable flight characteristics. If the deviation is found excessive in any of the positions (*c*), (*d*), (*e*) and (*f*), the position of the ballasting member is shifted as necessary to reduce the aforesaid deviations as much as possible. If the shifting of the balancing member is not effective to reduce all deviations, both positive and negative, to acceptably low values, the pilot knows that he may not take off without altering the loading of the aircraft.

The foregoing embodiment of a weight-measuring and distribution-checking system is only illustrative of a wide variety of laternative embodiments that fall within the spirit of the invention. For instance, in a more sophisticated system, the entire switching and deviation-checking function could be performed automatically by a rudimentary computer with an interconnection to the power plant to prevent application of take-off power in the case of an over-load or dangerously imbalanced load. Also, the ground engaging members need not necessarily be wheeled.

The pressure and contact plate transducers **56** of FIGURES 6–9 are only exemplary of a wide variety of transducers that could be employed. For instance, where the aircraft has ground engaging members which include hydraulic shock absorbers or oleo struts through which the weight on each ground engaging member is transmitted to the ground, an electrical hydraulic pressure sensing device may be mounted on the shock absorber in communication with the reservoir of fluid within. For instance, the aircraft may be supported on the ground by four ground-engaging members **48**, each of which (FIGURE 10) includes a leg **61** depending from the lower surface **7** of the wing adjacent its inner periphery in spaced relation with one another. The legs are slidably mounted in hydraulic cylinders **62** and have pistons **63** at their upper end in engagement with shock absorbing springs **64** disposed in the cylinders **62**. Attached to the lower ends of the cylinders are casters **65**. The weight on each leg will create a hydraulic pressure in a hydraulic fluid maintained in the cylinders **62** and transmitted to pressure sensor **66** via an aperture in the cylinder wall. An electrical signal from pressure sensor **66** may be transmitted to weight and balance indicator instrument **59** in the cabin in the same manner as from transducers **56** of FIGURE 9, so the pilot can easily determine if there is a dangerously unequal distribution of the weight on the casters.

While systems involving electrical transmission of data to the pilot's instrument panel are highly convenient, electrical means are not essential. For instance, a pressure line from each shock-absorber can be run to the pilot's control panel and connected to its own individual gauge, so that the pilot can visually note the differences in the readings among the gauges. The gauges may, if desired, have their dials marked with red and green sectors to indicate safe and unsafe conditions of loading and balance.

From the foregoing description, it is apparent that the present invention provides improvements in aircraft which render same safer and more convenient to use. The invention provides a circular wing aircraft which is symmetrically designed, has a simplified control system, is capable of vertical take off and landing, is relatively inexpensive to construct because of the very high degree of standardization of structural components which may be attained in the circular wing, and is capable of riding on a cushion of air close to the ground, thus capitalizing on the "ground effect" as a result of the dependent peripheral portions of the wing. When the wing is of waterproof construction, which is preferred, the aircraft may be operated to and from the water's surface, since a substantial portion of the volume of the wing is below the top of the engine housing, thus insuring that the engine will not be completely submerged when the aircraft is afloat. This facilitates the supplying of combustion air to the engine with reduced danger of water ingestion. Moreover, the present invention provides an aircraft weight and balance measuring system useful in circular wing and many diverse types of aircraft, which system makes it possible for a pilot to determine the loading and balance of his aircraft by means of instruments. When such a weight and balancing system is provided in an aircraft in conjunction with a shiftable ballasting member, it is possible for the pilot to manipulate the ballasting member and, possibly, to alleviate improper balancing of the aricraft without handling objects or reloading the aircraft. While it could be possible to provide an aircraft of any description with either a shiftable ballasting member, or a weight and balance determining system alone, it is apparent that special advantages flow from providing both, and the provision of both is therefore, a definitely superior arrangement.

What is claimed is:

1. An aircraft, comprising; a floatable, watertight annular wing having upper and lower walls traversely curved downwardly and joined with one another at their downwardly projecting peripheries; a vertically disposed duct disposed in the center of the annular wing; motor means, impeller means, and control surface means mounted on gimbals within said duct, said control means mounted adjacent said impeller means to control the rotation of air in said duct about the generally vertical axis thereof; and a cabin mounted atop said wing over said duct and surrounded by passages for the entry of air into said duct.

2. An aircraft in accordance with claim **1** wherein said cabin is ejectable and is provided with self-contained parachute operable upon ejection of said cabin from said aircraft.

3. An aircraft in accordance with claim **1** wherein said wing walls have a skin of synthetic resinous or elastomeric material supported from within said wing by a skeletal framework of structural members.

4. An aircraft in accordance with claim **3** wherein said structural members are of fiber-glass reinforced plastic.

5. An aircraft in accordance with claim **1** wherein said aircraft comprises a shiftable ballasting member.

6. An aircraft in accordance with claim **1** wherein said aircraft is provided with a plurality of ground engaging members and sensing means for sensing the weight exerted on said ground engaging members by said aircraft.

7. An aircraft in accordance with claim **6** wherein said aircraft comprises a shiftable ballasting member.

8. An aircraft in accordance with claim **7**, wherein said sensing means are connected with weight indicating means in the cabin and control means for controlling the shifting of said ballasting member are also provided in said cabin and connected with said ballasting member.

9. An aircraft in accordance with claim **6** wherein said sensing means are connected with means for detecting the total weight of the aircraft and for determining whether said load is in balance.

10. An aircraft in accordance with claim **1** wherein said impeller means further comprise a single propeller and means for counteracting the torque of said propeller.

11. An aircraft having a ballasting apparatus comprising: an airframe; a baggage compartment mounted within said airframe to rotate in an arcuate path about an axis, said axis being disposed at the center of gravity for said aircraft, said compartment being adapted to receive baggage and other freight carried by the aircraft; transmission means mounted within said airframe to rotate said baggage compartment about its axis, whereby the roation of said ballasting means about its axis changes the effective center of gravity for the aircraft.

References Cited

UNITED STATES PATENTS

1,730,941	10/1929	Myers	114—124
2,585,480	2/1952	Makhonine	244—93
2,615,330	10/1952	Blackmon et al.	177—136 X
2,807,428	9/1957	Wibault	244—23
2,935,275	5/1960	Grayson	244—23
2,953,320	9/1960	Parry	244—12
2,969,032	1/1961	Pinnes	244—23 X
2,963,245	12/1960	Bolton	244—93
3,193,214	7/1965	Hollingsworth	244—12
3,321,035	5/1967	Tarpley	177—136

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U.S. Cl. X.R.

244—93; 114—124; 177—136

VERTICAL LIFT AIRCRAFT

Filed April 24, 1967

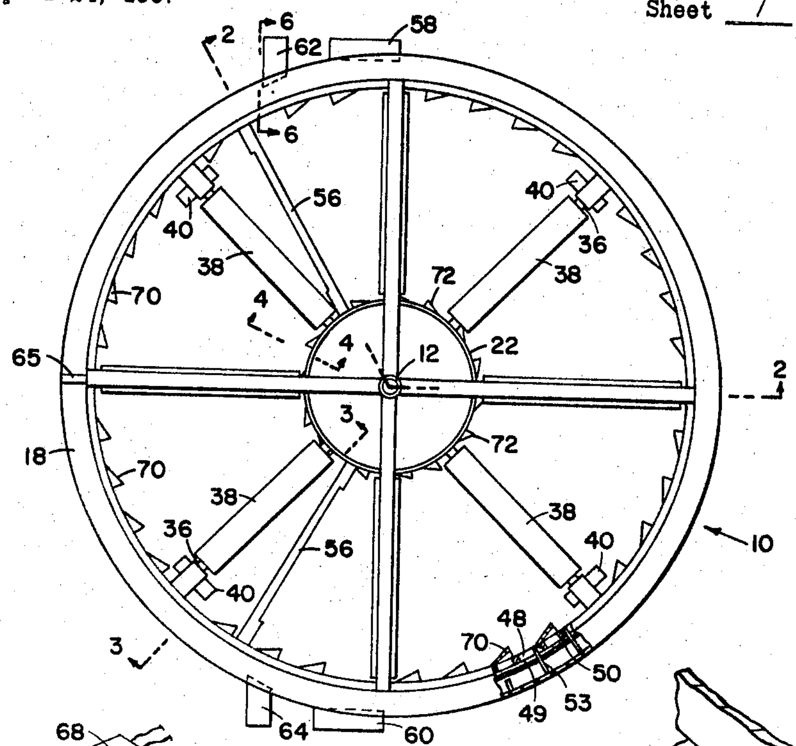

FIG. 1

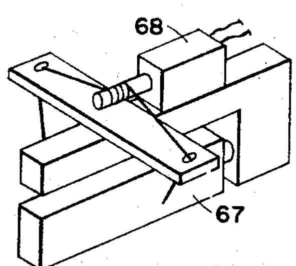

FIG. 8

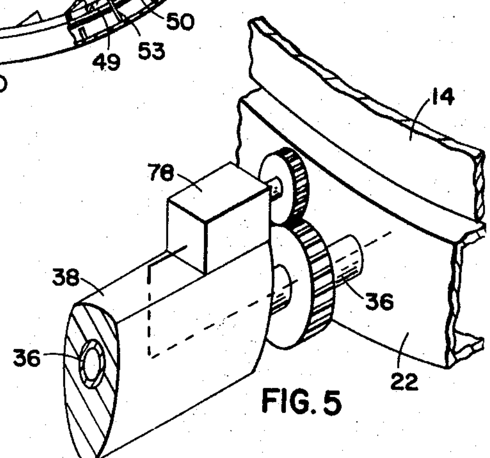

FIG. 5

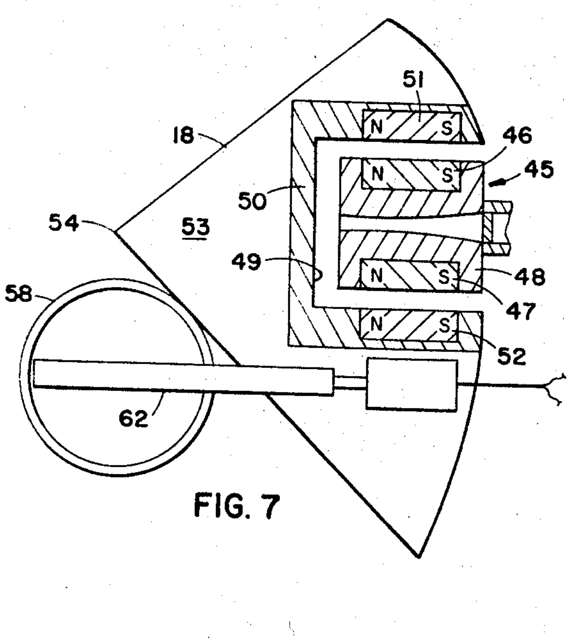

FIG. 7

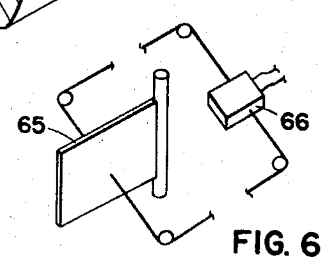

FIG. 6

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VERTICAL LIFT AIRCRAFT

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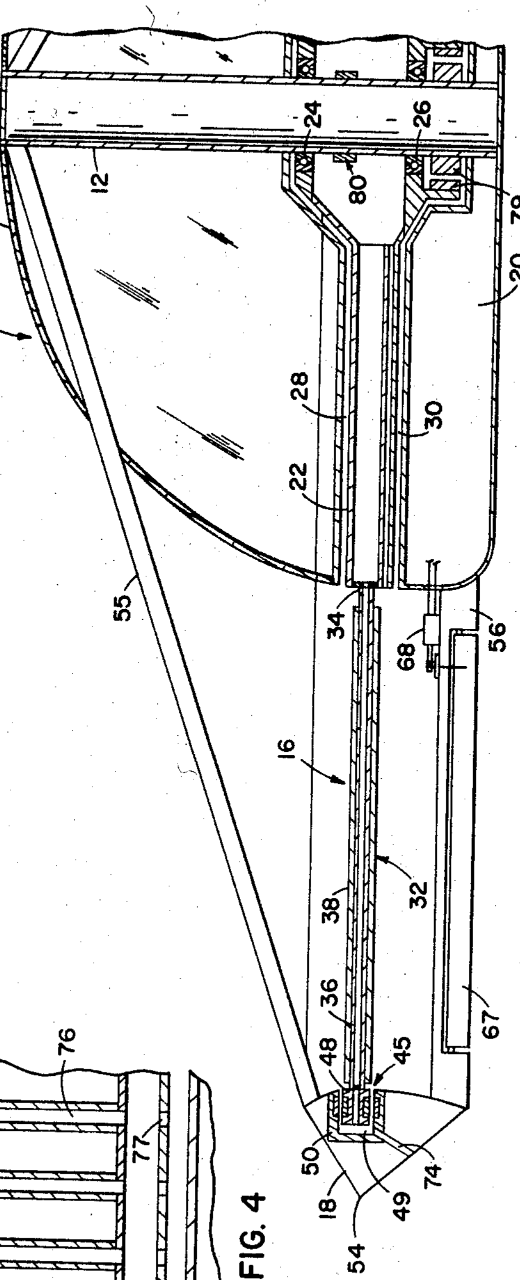

FIG. 2

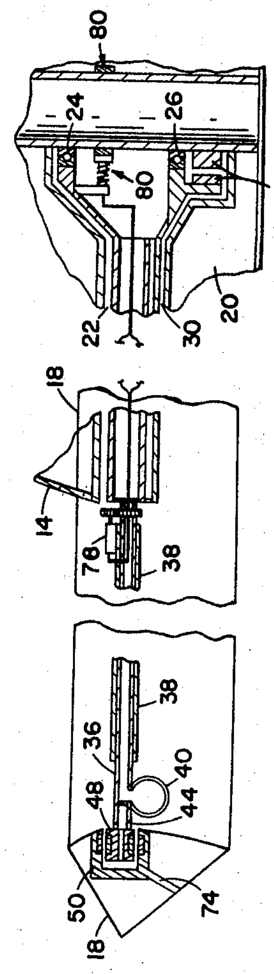

FIG. 3

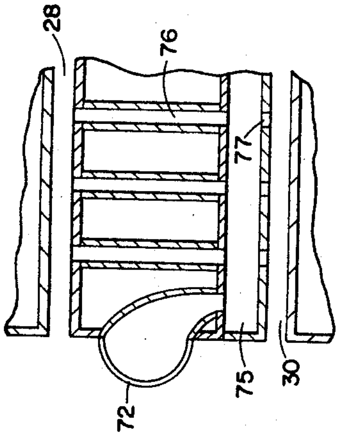

FIG. 4

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VERTICAL LIFT AIRCRAFT

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ABSTRACT OF THE DISCLOSURE

A vertical lift aircraft employing a ducted fan powered by reaction motors, the motors being located near the periphery of the fan blades and the periphery of the fan blades being supported by a supporting and stabilization ring which is supported by an air and magnetic bearings, in turn supported by an outer fuselage, and which is in turn supported by a central support about which there is loacted a passenger cabin fuselage, the fan blades thus being positioned to rotate about the cabin fuselage in a duct between it and the outer fuselage.

This invention relates to a vertical lift aircraft and particularly to such aircraft employing a new and improved ducted fan lift system.

An object of this invention is to provide a novel and highly efficient lift system in an aircraft embodying the known advantages of the ducted fan concept and wherein the system is essentially free of friction and yet the aircraft is simple and uncomplex both as to manufacture and operation.

A further object is to utilize the high speed efficiency characteristics of reaction type engines, such as the Athoyd or ram-jet, or turbo-jet, in a novel manner to translate their known high efficiencies at high air speeds in general to a high efficiency lifting force for use in an aircraft capable of both hovering and high forward speeds.

A further object is to provide an aircraft of great maneuverability and stability.

A further object is to provide annular central and circumferential bearings of great capacity and minimum friction to guide and confine a highly loaded lift fan rotor in a fixed plane relative to said aircraft.

A further object is to provide power or energy for vertical lift additional to that available at any given moment from the basic lift producing propulsion units alone.

A further object is to permit precise maneuvers in any horizontal and/or vertical direction when hovering, so as to permit safe operation at minimum altitude in confined areas.

A still further object is to provide a simplified lifting system embodying the above characteristics which is readily adaptable to aircraft of various sizes and configurations.

In accordance with the invention a ducted fan type vertical lift aircraft is constructed with a central fuselage and an outer ring-shaped fuselage between which would be an annular duct in which a fan assembly would rotate. The central fuselage houses a passenger and control cabin and the outer fuselage is supported by struts from the central fuselage. The outer fuselage provides a substantial bearing support for a ring or wheel which surrounds and provides end support for the fan blades of the fan assembly. With this support, which is in addition to support for the fan assembly from its central point of rotation about a vertical shaft extending vertically at the center of the passenger and control cabin, means are provided to permit the blades to be rotated at very high speeds without danger of their being thrown outward by the high centrifugal forces developed at high speeds. This in turn permits the efficient usage of reaction motors, including

ram-jets, which is one feature of the invention are positioned near the periphery of the blade assembly.

As a further feature and advantage of the ring support for the blades, this ring support, by virtue of its rotation, provides gyroscopic stabilization and kinetic energy which can be called on to augment the power otherwise available for lift and this is particularly of value in instances of brief requirements for additional power as for example where there is a temporary loss or reduction of power from the prime power source.

As still an additional feature of the invention a fuel or fuel tanks are included in the rotating blade assembly and fuel is fed directly from the tank or tanks, which are positioned near the axis of the vertical shaft support, out through hollow tubular members which mount individual fans, to the reaction motors. The reaction motors are thus supplied through conventional pressure regulating means by virtue of the centrifugal force created by the rotation of the fan blade assembly.

As still another feature of the invention essentially frictionless support is provided for the support between the periphery of the ring confining the fan and the outer fuselage by providing a self-pumping air bearing system, a magnetic bearing or a combination of both. Similarly, support for the fan assembly with respect to the central cabin is provided or assisted by a second self-pumping or self-generating air bearing system.

These and other objects, features and advantages of the invention will become more apparent from the following description when considered together with the drawings in which:

FIG. 1 is a plan view of an embodiment of the invention less control systems;

FIG. 2 is a partial section view along the lines **2—2** of FIG. 1 drawn to different proportions for purposes of illustration;

FIG. 3 is a partial section view along the lines **3—3** of FIG. 1;

FIG. 4 is a partial section view along the lines **4—4** of FIG. 1;

FIG. 5 is a perspective view diagrammatically shown of a portion of the blade control means for controlling the pitch or attitude of blade **38**;

FIG. 6 is a partial section view along the lines **6—6** of FIG. 1;

FIG. 7 is a diagrammatic view of the rudder control means for rudder **65**; and

FIG. 8 is a perspective view diagrammatically shown of a portion of the vertical deflector control system shown in FIG. 2.

Referring now to the drawings, aircraft **10**, which is of circular configuration has its major elements concentrically disposed about its central vertical structural support or shaft **12**. These elements are: a central passenger cabin, cockpit or fuselage **14**, fan assembly **16** and annular fuselage **18**. An auxiliary compartment **20** is also provided and it and passenger cabin **14** are rigidly attached to support **12**.

Fuel tank **22** is annular in shape and is radially and vertically supported by a support shaft **12** through bearing assemblies **24** and **26**. Vertical forces arising from tank **22** are additionally supported by an air layer of compressed air in an upper air bearing chamber **28** between top bearing surface of tank **22** and bottom bearing surface of cabin **14**, and by a lower air bearing chamber **30** between a bottom bearing surface of tank **22** and top bearing surface of compartment **20**. Tank **22**, in addition to serving to hold fuel and to provide vertical support, also provides an inner mounting and radial support for each blade assembly **32** of fan assembly **16**. This is accomplished by connecting an inner end **34** of tubular member

36 to the periphery of tank 22. Each tubular member 36 rotatably supports a fan or lift blade 38, which according to its rotary position about tubular member 36, provides a varying degree of lift with a given speed of rotation of fan assembly 16. A reaction motor 40, a ram-jet, is mounted near the outer end of each of four of tubular members 36, near the outer end of a tubular member. If only one motor is used or an otherwise unbalanced arrangement of motors is used, appropriate auxiliary weight balancing means for fan assembly 16 would be provided. The tubular members which support motor 40 also provide means for fuel flow to each motor and provide a passageway through which control communications means connect motors 40 and the cockpit.

The outer tips 44 of tubular members 36 are rigidly secured to ring 45. Ring or ring member 45 consists of an upper ring-shaped permanent magnet 46 and lower ring-shaped permanent magnet 47, of, for example a thin sheet of magnetizable metal or ceramic. The magnets are inset in non-conductive support member 48 which attaches ring 45 to tubular members 36. The outer region of each magnet, for example, would be of North polarity and the inner region of each magnet would be of South polarity. Outer fuselage 18 houses a coordinate magnetic assembly which is of a U-shaped configuration or channel and serves as a wheel or ring guide 49 within which ring 45 rotates. Ring guide or channel 49 of outer fuselage 18 has inset in a non-conductive support portion 50 permanent magnets 51 and 52, respectively, wherein these magnets form a portion of the legs of the channel and the magnets are magnetized in like polarity to those of the adjacent magnets of ring member 45. Thus there is repulsion between adjacent surfaces which tends to stabilize and hold ring member 45 centered in channel 49 of fuselage 18. Channel 49 is supported by bulk heads 53 spaced about the circumference of outer fuselage 18 suitably interconnected by annular structural members and covered in accordance with well known air frame construction practices to produce a generally light weight rigid air frame. The exterior of outer fuselage 18 is streamlined as by bringing the circumference to a thin edge at edge 54. Outer fuselage 18 is supported by means of upper struts 55 and lower struts 56 to shaft member 12 (by means not shown).

Forward propulsion of the craft is provided by turbo jets 58 and 60, mounted on each side of the craft on outer fuselage member 18. Ailerons 62 and 64, of suitable heat resistant material, are mounted on fuselage 18 within the thrust cone of turbo jets 58 and 60 to provide auxiliary vertical control in forward flight. Fuel for turbo jets 58 and 60 is supplied from fuel tanks (not shown) mounted in fuselage 18. Conventional rudder 65, shown schematically, through servo control 66 provides auxiliary directional control at high speeds and is mounted at the rear of fuselage 18. It, together with turbo jets 58 and 60 and ailerons 62 and 64, are controlled through control communications connecting these units with appropriate hand and foot controls (not shown) in cockpit 14 through upper struts 55 or lower struts 56.

Extending downward from and hinged to lower struts 56 are vertical air deflectors 67 adjustable to provide a desired anti-torque moment in the craft. Vertical air deflectors 67, of which there are three, are disposed with one being radially in line with the normal heading of the aircraft and the others disposed radially and 120 degrees apart. Deflectors 67, which are pivoted on struts 56, are controllable through control means 68, diagrammatically illustrated, from cockpit 14 to rotate the craft to achieve any desired heading.

Compressed air for the air bearing systems of the craft is provided by air scoops 70 and 72 located on moving surfaces of ring member 45 and fuel tank 22, with air scoops 70 supplying air to ring guide 49 where it effects a radial thrust air bearing between ring 45 and ring guide 49, with a portion of the compressed air being conducted through a plurality of ducts 74 to the outside of fuselage 18 and discharged in a direction counter to rotation of ring 45 to provide additional anti-torque moment to the non-rotating portions of the craft. Air scoops 72 compress air in plenum 75 and ducts 76 and 77 and discharge air into chambers 28 and 30 to serve as a continuously replenishing vertical thrust air bearings of great size and capacity between fuel tank 22 and cabin 14 and compartment 20. Landing gears are of the conventional triangular type and are not shown.

As stated above one purpose of wheel or ring 45, when rotating, is to impart stability to aircraft 10 by its gyroscopic action. Further it affords temporary power augmentation, and thus lift augmentation, derivative from its stored kinetic energy, thus making it possible to achieve a temporary vertical lifting force greatly in excess of that capable of being produced at a given moment by the total thrust of the lift fan motors 40 alone.

This power-lift augmentation is very desirable, as it permits lift fan propulsion units of minimal thrust to maintain an in-flight state while at the same time providing vertical lifting forces temporarily required for take-off and for safe operation, and maneuver at minimum altitudes.

Power for vertical lift is provided by the high rotationally constrained thrust of reaction engines 40, with lift produced by adjustable airfoil rotor blades 38, configured in accordance with known aerodynamic principles, and jointly or progressively adjustable as to angle of attack through servo control 78 from cockpit 14. It is understood that airfoil rotor blades 38 could incorporate various well known devices or system, among them flaps, interiorily pressurized air discharged outwardly over the airfoils and the like, for producing various desired lift characteristics.

Vertical maneuver would normally be with aircraft 10 maintaining a horizontal attitude, with change in altitude effected by varying the lift produced by the lift fan assembly, with ailerons 62 and 64 and rudder 65 providing auxiliary vertical and lateral control at high forward speeds.

When lift fan rotor is in rotative movement, electric current for operation of various control systems, and for magnetizing magnets 46, 47, 51 and 52 should they be of the electromagnetic type, would be produced by centrally located generator 79, with current distribution between fixed and rotating elements both for power and control purposes being through conventional means such as slip ring assembly 80 (diagrammatically shown) or distribution may be through commutators, brushes or the like. Electric current for initial start up is provided by batteries (not shown) in lower compartment which are maintained charged by generator 79. In starting ram jet engines 40, generator 79 is changed to an electric motor mode of operation and fan assembly and engines 40 are rotated by it up to an operating speed electrically.

With fuel fed through tubular members 36 to ram jets 40 the engines are started. Fan blades 38 are adjusted by control 78 to force air downward past deflectors 67 which are initially positioned to counter any tendency for rotation of the aircraft as a whole. As the craft rises vertically the horizontal attitude of the craft is set at a desired heading by adjusting the position of the deflectors 67 to cause rotation of the craft until the desired heading of the craft is achieved. Next, jet engines 58 and 60 are started and the craft is accelerated to a desired operating speed as determined by the power setting of jet engines 58 and 60. As speed is increased, rudder 65 has an increasing effect in directional control and may be generally employed for steering. Ailerons 62 and 64 also become operative at normal operating speeds and may be employed to effect vertical control of the aircraft by deflecting the exhaust gases either up or down.

The above description of the invention is intended to be illustrative only. Various changes or modifications of the embodiment of the invention shown may be made by those skilled in the art without departing from the true spirit and scope of the invention.

I claim:

1. A vertical lift aircraft of generally circular configuration and comprising:

(A) a centrally positioned upper fuselage having a bearing surface on a bottom side;

(B) a centrally positioned lower fuselage having a bearing surface on a top side;

(C) an annular outer fuselage disposed generally in a horizontal plane and spaced from said centrally positioned upper and lower fuselage and including bearing means for supporting on its inner side the outer, upward and downward forces from a rotating ring;

(D) fuselage supporting means comprising a centrally positioned vertical supporting member directly supporting said upper and lower fuselage and including a plurality of struts interconnecting said support means and said outer fuselage and providing support for said outer fuselage;

(E) a lift fan assembly disposed to rotate in a given direction about said vertical support member and being rotatably mounted to said vertical support member in the region between said upper and lower fuselage and comprising:

(1) a generally annular fuel tank and having inner bearing means for rotatably attaching to said vertical supporting member and upper and lower bearing means for rotation with respect to said bearing surfaces of said upper and lower fuselage and a plurality of spaced outer mounting means for supporting a plurality of lift blade assemblies on the periphery of said tank,

(2) a plurality of lift blade assemblies, each lift blade assembly comprising a blade and a supporting tubular member, a said blade being rotatably mounted on a said tubular member, and an inner end of each said tubular member being mounted to a said outer mounting means of said fuel tank assembly,

(3) control means coupled to each said blade for selectively orienting each said blade about a said tubular member,

(4) at least one reaction motor, a said reaction motor being attached near an outer end of and to a said tubular member and said reaction motor being positioned to provide a generally horizontal rotating force to said lift fan assembly, and

(5) a supporting and stabilizing ring assembly comprising said ring, an inner edge of which comprises means for supporting a said outer end of each tubular member and including upper, lower, and outer ring bearing means for supporting said ring bearing means on said bearing means of said outer fuselage;

(F) lateral propulsion means mounted on a said fuselage for providing propulsion of said air craft in a horizontal plane; and

(G) attitude control means including means attached to said vehicle for varying air flow with respect to said vehicle.

2. The aircraft set forth in claim 1 wherein said means for varying air flow of said attitude control means comprises airfoils rotatably mounted about each of a plurality of said struts.

3. The vertical lift aircraft set forth in claim 2 wherein said bearing means of said annular outer fuselage comprises first means for providing magnetic fields and said upper and lower bearing means of said ring assembly comprises second means for providing magnetic fields and said first and second last named means are relatively positioned and oriented to magnetically oppose a change in vertical positioning of said ring assembly with respect to said outer fuselage.

4. A vertical lift aircraft as set forth in claim 3 wherein said bearing means of said annular outer fuselage includes an air bearing surface and wherein said outer bearing means of said supporting and stabilizing ring assembly comprises means attached to the inside edge of said ring for entraining and compressing air and including means for directing compressed air between said ring and said bearing surface.

5. The vertical lift aircraft set forth in claim 4 wherein:

(A) said bearing means of said annular outer fuselage comprises a channel in which a portion of said supporting and stabilizing ring rotates and wherein:

(1) an upper portion of said channel comprises a magnetic member having an inner pole of a first polarity and an outer pole of a second and opposite polarity, and

(2) the lower portion of said channel comprises a magnetic member having an inner pole of a first polarity and an outer pole of an opposite and second polarity;

(B) said upper bearing means of said supporting and stabilizing ring assembly comprises a magnetic member positioned with like poles adjacent to like poles of said magnetic member of said upper portion of said channel; and

(C) said lower bearing means of said supporting and stabilizing ring comprising a magnetic member positioned with like poles of said poles adjacent to like poles of said magnetic member of said lower portion of said channel.

6. The vertical lift aircraft set forth in claim 5 wherein the bearing surfaces between said upper fuselage and said fuel tank and between said lower fuselage and said fuel tank are separated and supported apart by compressed air and said fuel tank includes means mounted on its periphery for entraining air under pressure between said surfaces to produce said compressed air.

7. A vertical lift aircraft as set forth in claim 6 further comprising a plurality of passageways interconnecting the region between said outer bearing means of said supporting and stabilizing ring assembly and said bearing surface of said outer fuselage through said outer fuselage to a point on the outer surface of said fuselage and wherein the orientation of the outlet is along a line of direction having a directional component opposite to said given direction of rotation of said lift fan assembly.

8. The vertical lift aircraft set forth in claim 2 wherein said reaction motor is a ram jet engine.

9. The vertical lift aircraft set forth in claim 2 wherein said reaction motor is a turbo jet engine.

References Cited

UNITED STATES PATENTS

2,807,428	9/1957	Wibault	244—23
2,980,365	4/1961	Yohe	244—23
3,123,320	3/1964	Slaughter	244—12
3,182,929	5/1965	Lemberger	244—12

FOREIGN PATENTS

230,204 11/1963 Austria.

MILTON BUCHLER, *Primary Examiner.*

JAMES E. PITTENGER, *Assistant Examiner.*

U.S. Cl. X.R.

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FIG. 1.

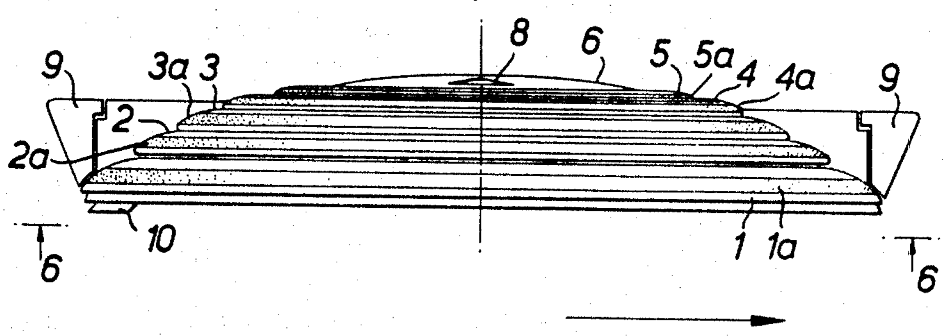
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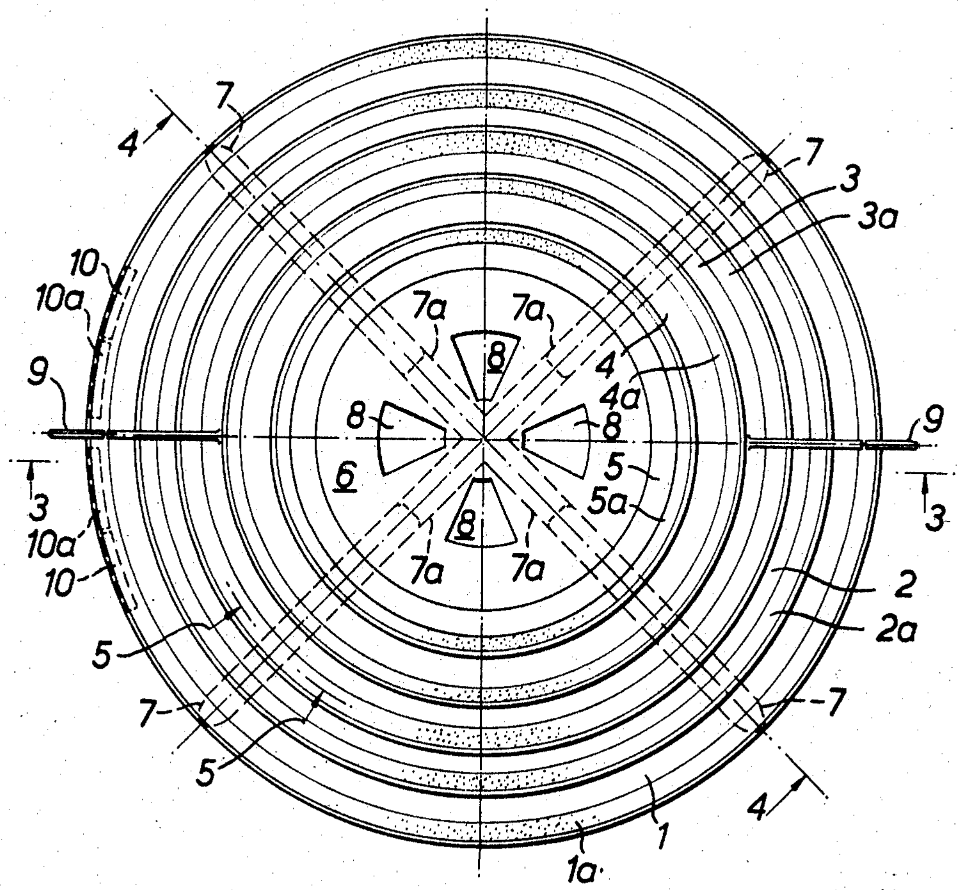
FIG. 2.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TRANSPORT

Filed March 7, 1966 9 Sheets-Sheet 2

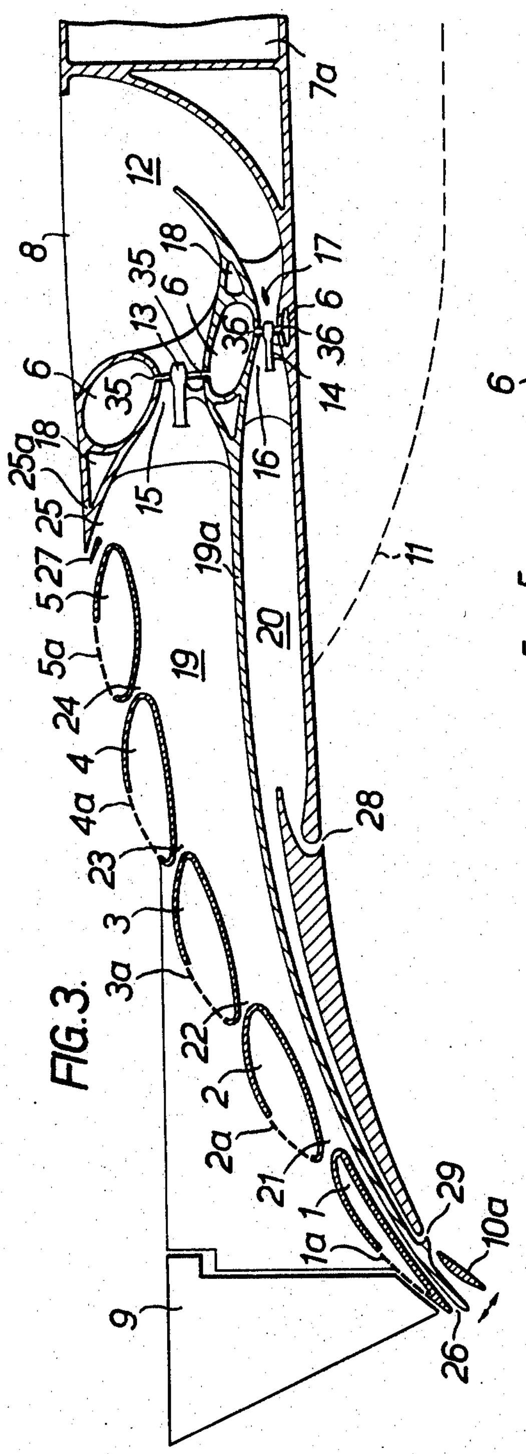

FIG. 3.

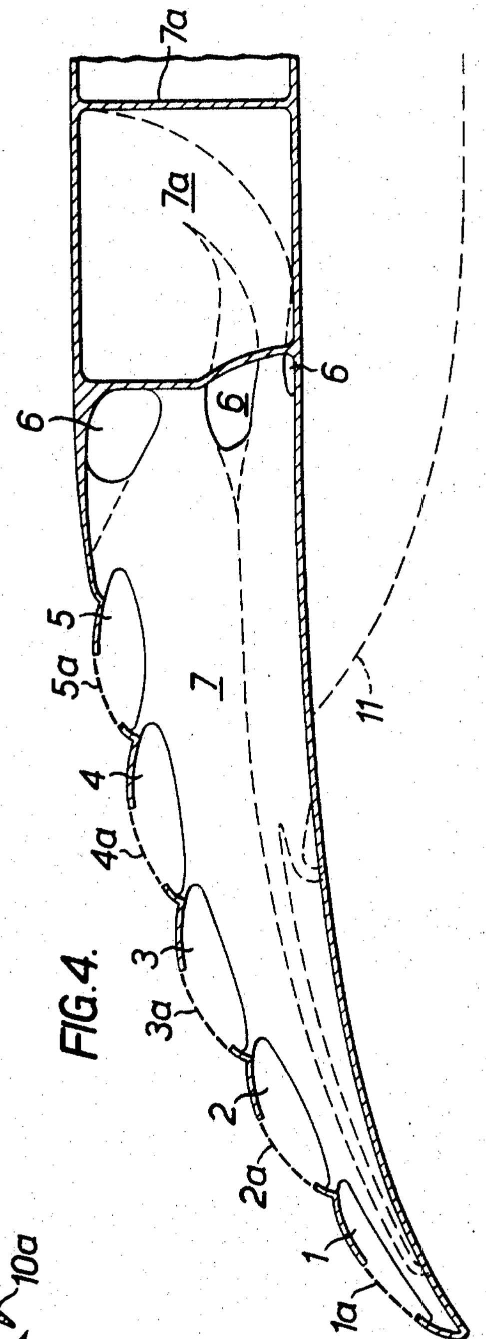

FIG. 4.

TRANSPORT

Filed March 7, 1966 9 Sheets-Sheet 3

FIG. 5.

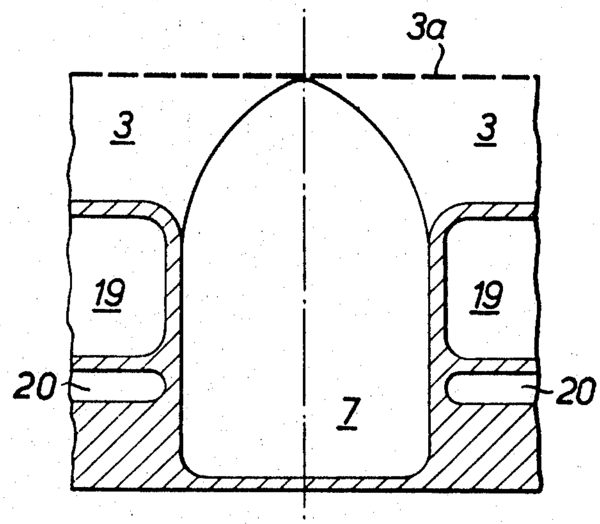

FIG. 6.

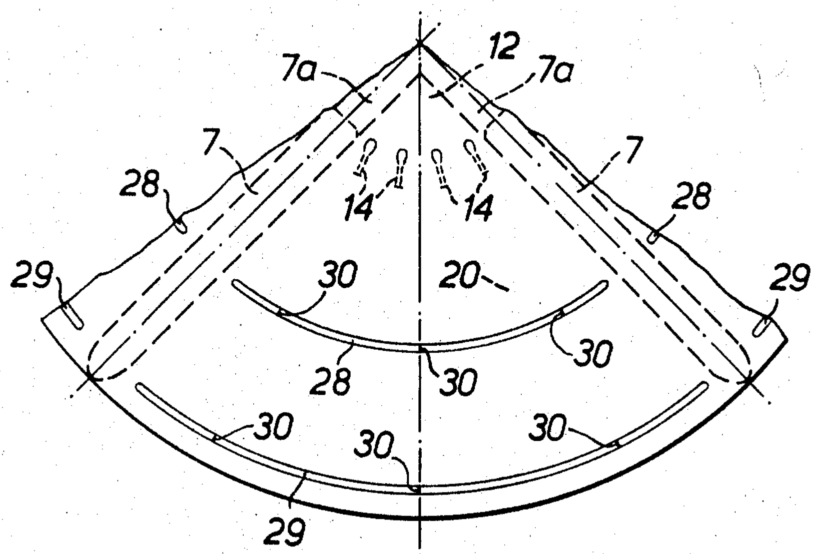

FIG.7.

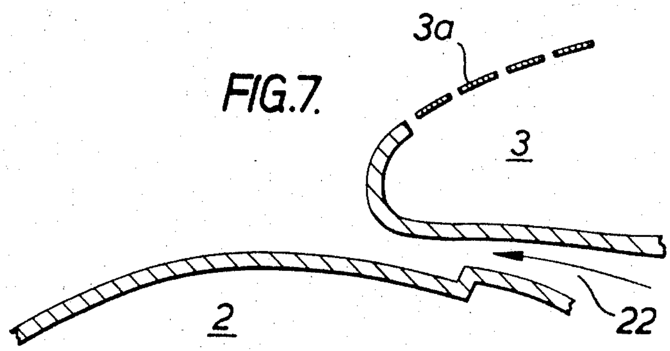
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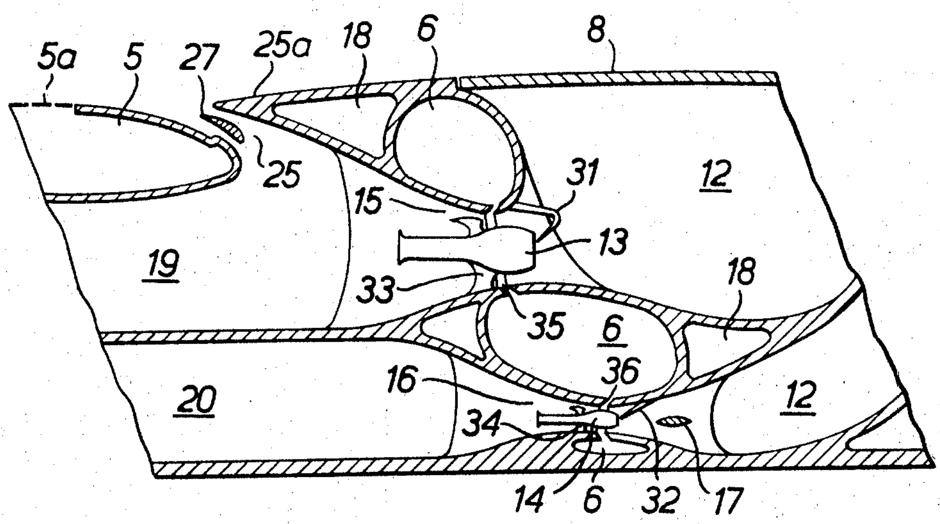
FIG.8.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Sept. 30, 1969 J. R. ROBERTS ET AL 3,469,802

TRANSPORT

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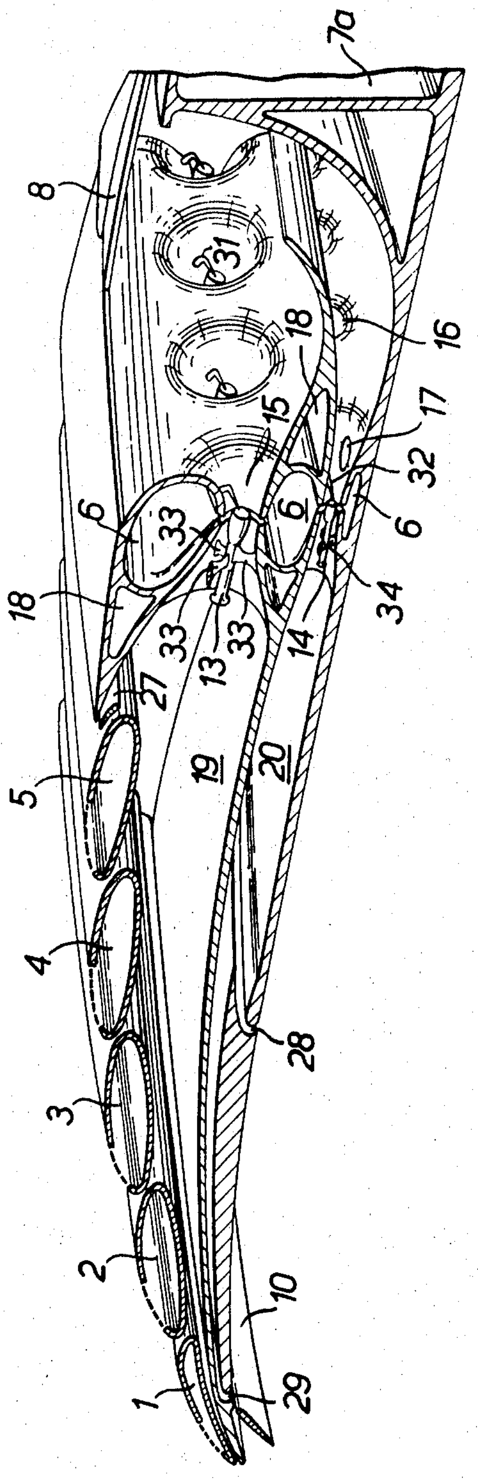


FIG. 9.

FIG.10.

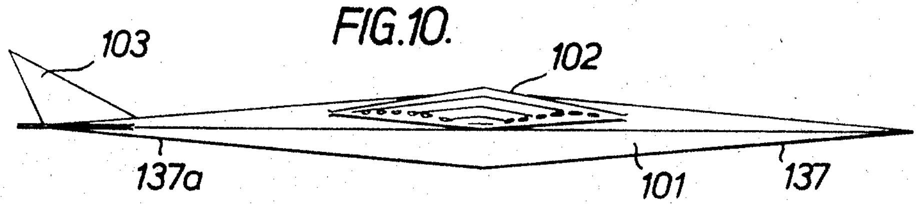


FIG.11.

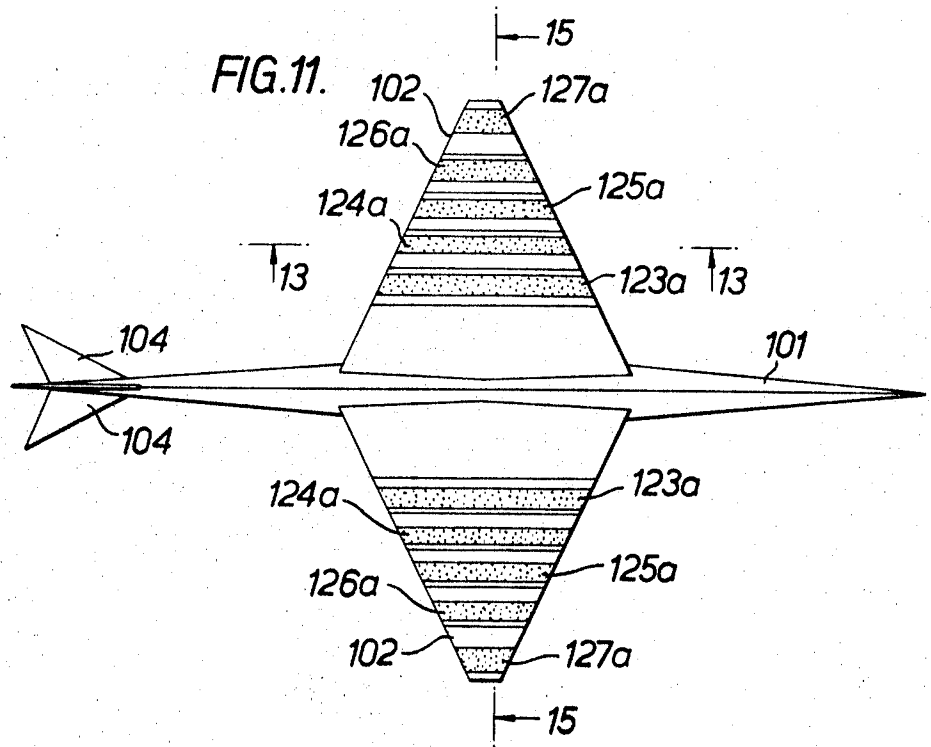
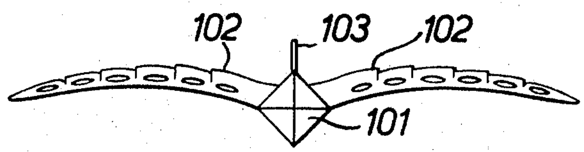


FIG.12.



TRANSPORT

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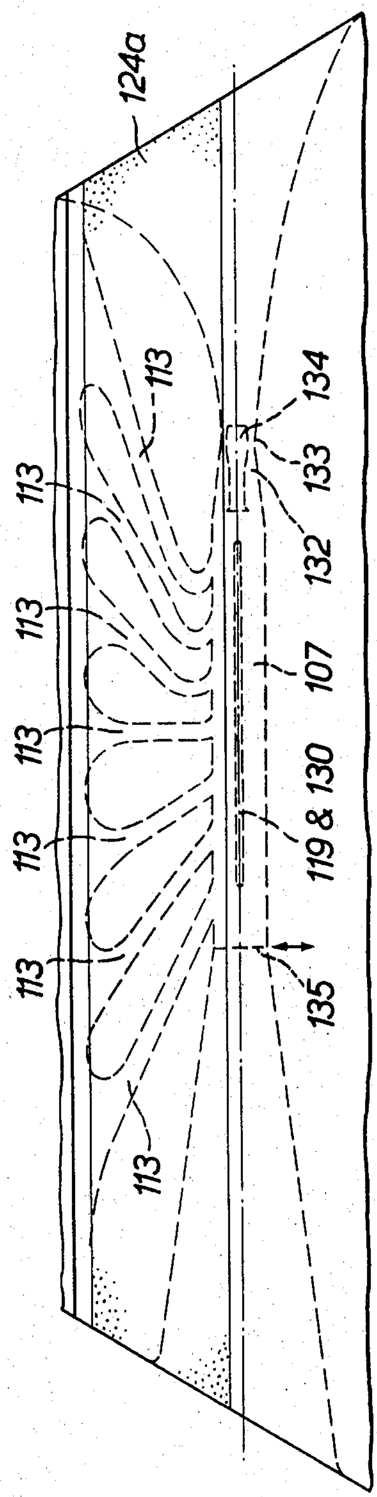

FIG.14.

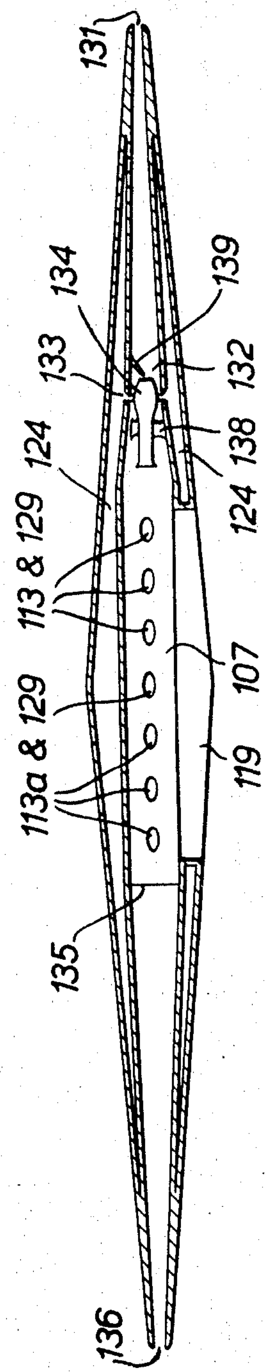

FIG.13.

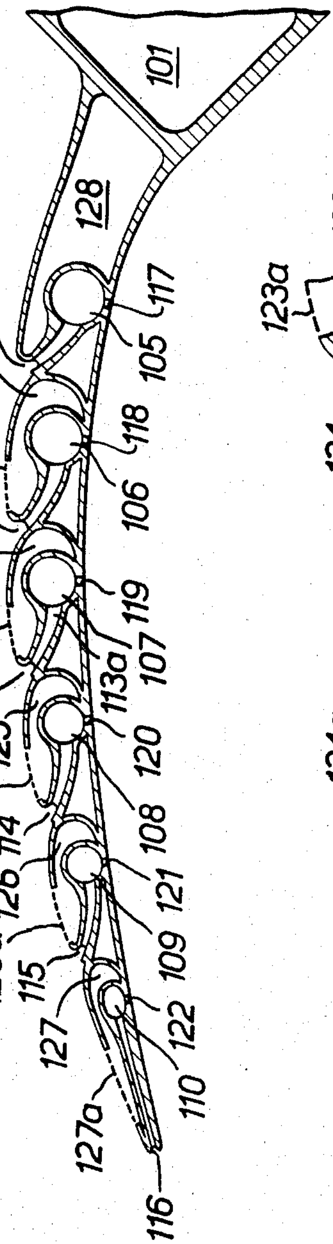
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FIG. 15.

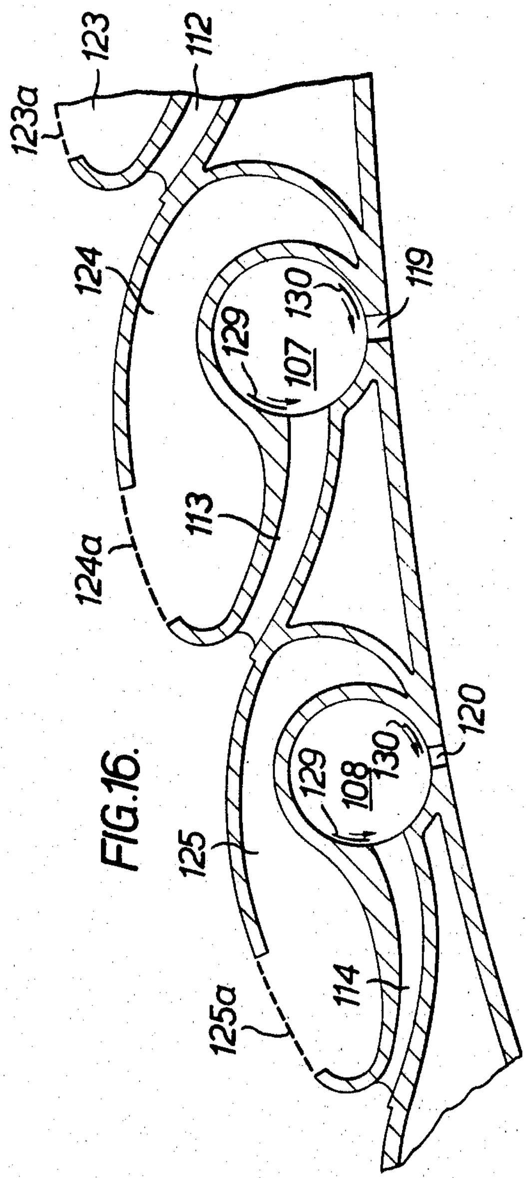
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FIG. 16.

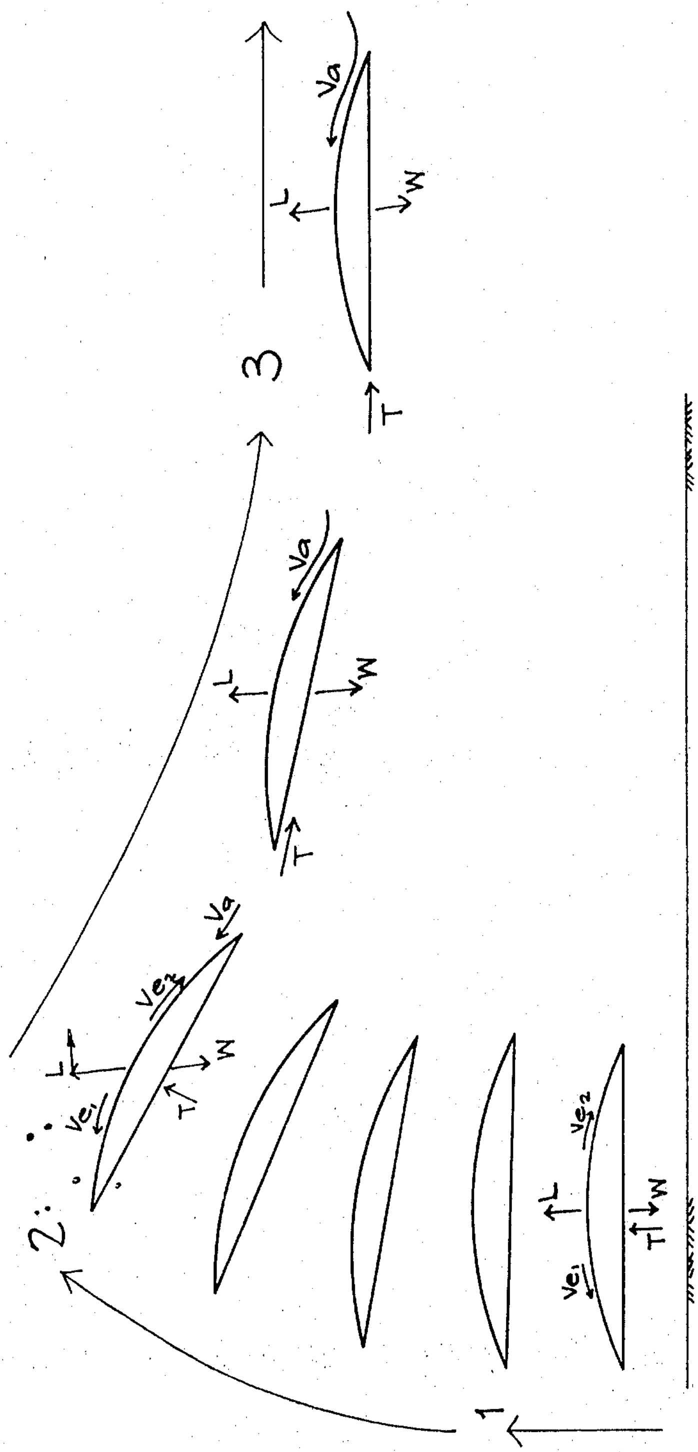

FIG. 17

United States Patent Office
3,469,802
Patented Sept. 30, 1969

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TRANSPORT

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Filed Mar. 7, 1966, Ser. No. 534,569
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Int. Cl. B64c *15/00, 29/04*
U.S. Cl. 244—12 10 Claims

ABSTRACT OF THE DISCLOSURE

An aircraft in which a body is provided with lifting surfaces and flow creating means within the body is adapted to produce a flow of air or gases relative to which lift of the body may be realized. Furthermore, means are provided for producing a reduced pressure between the flow of air or gases and the lifting surfaces so that vertical flight of the body results when such flow exists and the reduced pressure is operative between the flow and the lifting surface.

This invention relates to transport.

At present, a considerable amount of work is being devoted to V.T.O.L. and S.T.O.L. aircraft by the use of downwardly directed thrusts of air in which a sufficient volume of air is displaced downwardly to provide a direct lift for the aircraft even though there is no forward motion to cause lift on the wing surfaces. This technique has disadvantages in that tremendous amounts of power are required, with the thrusts of the jets necessarily exceeding the total weight of the aircraft giving excessive thrusts for sub-sonic horizontal flights.

It is therefore an object of the present invention to provide transport means and methods of operating the same which will obviate or minimize the foregoing disadvantages or which will at least provide the public with a useful choice.

Accordingly, in one aspect, the invention is directed to a method of transport which will impart vertical lift to an aircraft, comprising the steps of providing from within an aircraft having lift surfaces, a body of air of gases directed to move appropriately in relation to the lifting surfaces of the aircraft providing such a reduction in pressure between such body of air or gases and said lifting surfaces as to result in the aircraft being supported thereby.

In a further aspect, the invention is directed to a method of lifting a body having lifting surfaces, comprising the steps of causing a flow of air to pass from within the body relative to said lifting surfaces in a manner such that reduced pressures result between at least some parts of said flow of air and said lifting surfaces, so that the body is lifted relative to the flow of air, with such lifting causing the flow of air per se to be lifted relative to the earth's surface resulting in free flight in a vertical direction.

In a still further aspect, the invention is directed to an aircraft comprising a body adapted to carry personnel and/or materials, lifting surfaces associated with said body, flow creating means within said body adapted to produce a flow of a body of air or gases relative to which lift of the body may be effected and means to produce a reduced pressure as between said flow of air or gases and said lift surfaces in a such manner that vertical flight of said body takes place when said flow of air gases exists and said reduced pressure is operative between said flow of air or gases and said lifting surfaces.

In an alternative construction, the airfoils are arranged as approximately rectangular surfaces with the longitudinal axis thereof arranged parallel to a fuselage of the aircraft but provided with an airfoil section along the longitudinal axis thereof so that for vertical flight said body of air is caused to flow transversely of the fuselage and consequently transversely across said airfoil sections with forward motion being arranged by progressively diverting some air flow from the transeverse direction to the longitudinal direction and rearwardly so that an aircraft will rise vertically and then be translated to forward motion when a suitable height and attitude have been achieved.

2

In a still further aspect, the invention is related to an aircraft comprising a body having lifting surfaces and means within the aircraft to cause a flow of air to travel relative to said lifting surfaces in such a manner that a reduced pressure results between parts of said flow of air and said lifting surfaces whereby free flight of said body in a vertical direction results without the necessity for forward flight.

Further important objects and advantages of the invention will become more rtadily apparent to persons skilled in the art from the following detailed description and annexed drawings and in which drawings:

FIGURE 1 is a view in side elevation of one form of aircraft according to the present invention,

FIGURE 2 is a plan view of FIGURE 1,

FIGURE 3 is a view in half section taken along the line **3—3** of FIGURE 2, the view looking in the direction of the arrows,

FIGURE 4 is a view in half section taken along the line **4—4** of FIGURE 2,

FIGURE 5 is a view in part section taken along the line **5—5** of FIGURE 2, the view looking in the direction of the arrows,

FIGURE 6 is a quarter inverted plan view of the aircraft shown in FIGURE 2,

FIGURE 7 is an enlarged detailed view of a part of FIGURE 3 showing part of the annular airfoil sections and a primary plenum outlet slot therebetween,

FIGURE 8 is a further enlarged detailed view of part of FIGURE 3 showing an annular return duct, primary and secondary engines, and their respective venturis,

FIGURE 9 is a view in perspective have section of the aircraft shown in the preceding figures,

FIGURE 10 is a view in side elevation of a further alternative form of the invention,

FIGURE 11 is a plan view of the aircraft shown in FIGURE 10

FIGURE 12 is a view in front elevation of the aircraft shown in FIGURES 10 and 11,

FIGURE 13 is a view in cross section taken along the line **13—13** of FIGURE 11, the view looking in the direction of the arrows,

FIGURE 14 is a part plan view of the port wing of the aircraft shown in FIGURE 11,

FIGURE 15 is a view in section taken along the line **15—15** of FIGURE 11, the view looking in the direction of the arrows,

FIGURE 16 is an enlraged detailed view of part of FIGURE 15, and

FIGURE 17 is a diagrammatic view.

In the preferred form of the invention, an aircraft is provided with a body having lifting surfaces as will be seen from FIGURES 1–4. The aircraft in the preferred form is circular in outline and consequently surrounding the body or fuselage are a plurality of annular lifting surfaces **1–5** comprising a series of airfoil sections arranged with the leading edge of the second section adjacent to the trailing edge of the first, the leading edge of the third adjacent to the trailing edge of the second and so on. At least four to six such annuli are provided and for a larger aircraft more would be provided. The shape of the airfoil section will be referred to later. Small, i.e. narrow in width spaces channels **21–24** are provided between the trailing edge of one annulus and the leading edge of the next annulus. These may be continuous or discontinuous but preferably are as continuous as possible having regard to structural requirements.

Each airfoil section forward of the trailing edge thereof is perforated over part of the surface as indicated at **1***a*, **2***a*, **3***a*, **4***a* and **5***a* thereof for a short distance, preferably over a distance somewhat less than half of the exposed upper surface of the airfoil section. At least a part of the interior of each annular lifting surface is hollow as shown. The annuli are otherwise airtight except for the perforated portions on the upper surface thereof. The hollow interiors of the annuli are connected by radial ducts **7** as illustrated in FIGURES 2 and 5 where the annulus **3** is in communication with the duct **7**. The ducts **7** are provided as radial structural members **7***a* so that they serve the dual purpose of supporting the airfoil sections and forming the ducts communicating the interiors of the annuli with annular return ducts **6**. The hollow interiors of the airfoil sections are connected by ducts **7** to the three sets of return ducts **6** (FIGURES 3 and 4).

As shown particularly in FIGURES 3 and 4, the airfoil sections may overlap slightly with the undersurface of the trailing edge of, for example, the airfoil section as disclosed in the trailing annulus. The overlapping surfaces provide walls or orifices **21–24** which provide primary plenum outlet slots between adjacent airfoil sections and such orifices connect the exterior of the lifting surfaces with a chamber **19** defined by the undersurfaces of the annuli and a further membrane **19***a* which separates the two plenum chambers and a further plenum chamber **20** to be later described. The ducts **7** and structural members **7***a* divide the plenum chambers **19** and **20** into four parts. Referring to FIGURE 5, there is clearly shown the functions of the radial return duct **7** both in connecting the annular return duct **6** to the interior of the airfoil sections, such as the airfoil **3** (FIGURE 5), and also in separating the primary plenum chamber **19** into four individual plenum chambers **20** divided into four separate secondary plenum chambers. In addition, there is shown the perforated portion of the surface of the airfoil section **3**.

It can be seen in FIGURE 3 that each succeeding annulus is disposed slightly lower than the preceding annulus as shown in the drawings so that there is a drooping upper surface to the lifting surfaces which will be hereinafter discussed.

The chamber is supplied with means within the body for providing a source of a flow of air and/or gases, and this source preferably comprises a plurality of pulse jet engines **13**, with each engine being arranged in a primary venturi **15** (FIGURES 3 and 9). The precise number and power rating of such pulse engines **13** would of course depend on the size of the aircraft and the pulse jets may or may not be augmented, for example by the ram jet principle or otherwise.

However, other types of power sources will be useful, for example turbo-jet engines alone or turbo-jets driving turbo-fans, with such engines or fans discharging into the chamber **19**.

Since it is desired to pass a considerable volume of air over the lifting surfaces the flow from the sources of power, for example the pulse jet engines **13** within the venturi **15** in a manner such that the combustion gases induce a flow of air through the venturi (between the walls of the venturi **15** and the outer surface of the engine **13**) so that the combined flow of gases and air is considerably augmented compared with the flow of combustion gases of the pulse jet engine alone.

The flow of gases from the pulse jet engines and the flow of air induced to flow through the venturi by the action of the jet engines are led to the chamber **19**. Connection means comprising primary venturi apertures **35** are provided adjacent the throat of the venturi **15** and lead into the upper and center return ducts **6** to cause a reduction in pressure in the system to which such ducts **6** are connected (the radial ducts **7** and the hollow interiors of the airfoil sections **1–5**). This reduction in pressure causes air to be drawn from adjacent the upper surfaces of the outermost parts of the individual airfoil sections of the annuli through the perforated surfaces **1***a*, **2***a*, **3***a*, **4***a* and **5***a*, with this air being then discharged into the main flow of air caused by the venturi action.

The flow of gases from the engines **13** and the air passing through the venturis **15** cause a build-up pressure in the chamber **19**. This pressure causes an outflow of gases through the primary plenum outlet slots **21, 22, 23** and **24** and in addition, a further slot **25** is provided between the leading edge of airfoil section **5** and a shaped member **25***a* forming part of the fuselage adjacent a fuel tank **18** which conforms to the shape of the leading edge of the airfoil section **5** so as to provide this slot **25**. Furthermore, a Handley Page type of slot **27** is provided to assist in controlling the flow of air as is apparent from FIGURE 8. The flow of air passing through the slot **25** is the initial flow of air which passes outwardly and downwardly over the airfoil sections **5, 4, 3, 2** and **1** in that order, with the flow of air being supplemented by the additional flows through slots **24, 23, 22** and **21**. Adjacent the outer edge of the outer airfoil section **1**, there is a further slot **26** which serves to smooth the flow of air as it passes outwardly and downwardly over the trailing edge of the airfoil section **1**. It will be appreciated that the flow of air and gases over the airfoil sections is modified because of the inflow of air and gases through the openings **1***a* to **5***a* but this will be described hereinafter in more detail.

It is to be noted that the primary venturi **15** and the pulse jet engines **13** are provided on the wall of an air intake chamber **12** (FIGURE 3), and the air intake chamber **12** is provided with air intakes **8** which each have controllable shutters.

As above mentioned, a secondary plenum chamber **20** is provided and this chamber is pressurized in substantially the same manner as that of the chamber **19**, namely, by the provision of pulse jet engines **14** mounted in venturis **16**, with the venturis having secondary venturi apertures **36** connecting the venturis to the annular return ducts **6** as shown. The air intake to the pulse jet engines and the venturis is from the air intake chamber **12** but in this case a pluraltiy of butterfly valves **17** control the supply of air to the pulse jet engines. The valves **17** are grouped in four groups, with each of the four groups operating over an arc of 90° so that by closing one of the four groups the part of the plenum chamber **20** associated with that group has its pressure reduced compared with that in the remaining three chambers **20**. The plenum chamber **20** is per se, divided into four compartments by the hollow ducts as mentioned above, and the structural members **7***a* intersecting the plenum chamber **20** to this end. Leading from each section of the plenum chamber **20** is a secondary plenum outlet slot **28** and further secondary plenum outlet slot **29**. These slots are substantially ring-shaped as shown in FIGURE 6. These slots are segments of rings and are formed in cross section as disclosed in FIGURE 3 to direct jets of air and gases downwardly and inwardly. The purpose of these jets is firstly to provide a certain amount of lift and secondly to permit their control for the purpose of controlling the attitude of the aircraft. It will be understood that if the butterfly valve leading to one quarter of the plenum chamber **20** is closed, then the jet issuing from the secondary plenum outlet slots **28** and **29** in the other three quarters will now exert an unbalanced force tending to drive the aircraft in a direction other than directly vertical. This will be referred to later in describing the flight pattern of the aircraft. It is to be understood that the lift of the aircraft results from the fact that there is normal atmospheric pressure below the aircraft augmented by a flow of air and gases through the slots **28** and **29**, and on the upper surface because there is reduced pressure, so that the pressure on the lower surface must produce an upward force. In addition, there is a kinetic reaction resulting from the downward flow of gases from the slots **28** and **29**. Manually controllable pivotable deflectors **30** are provided transverse to the length of the slots **28** and **29** to enable any tendency of the aircraft to spin on its vertical axis to be controlled. The flow of the air and gases from the slots may be controlled in other ways, such as for example, by varying the sizes of these orifices, by blocking the same, or varying the direction of flow of air and/or gases therefrom so that dimensional stability can be maintained.

In addition to the foregoing which are concerned with control of the aircraft during vertical flight conditions only, i.e. when there is little or no horizontal component of flight, control surfaces are provided to control the aircraft during forward flight. Such control surfaces may comprise rudders **9** for directional stability (FIGURES 2 and 3), elevators **10***a* (FIGURE 2) for pitch control and **10** for the normal control of roll or lateral stability. These controls will be manually controllable in a known manner as applied to conventional aircraft.

So that the aircraft can be self-sustaining in horizontal flight in the manner in which a conventional aircraft is self-sustaining, the airfoil sections **1** to **5** are formed so that they droop towards the outer edge and overall contour is arranged whereby upon looking at the aircraft as a whole, for example, the sections in FIGURE 3 or 4, and when the aircraft is moving in the direction of the arrow shown in FIGURE 1, the contours of the airfoil sections are combined so that an overall lifting surface results which will cause lift when the aircraft is moving through the air horizontally at a sufficient speed.

As mentioned earlier, the fuel tanks **18** are provided in the fuselage and there are connected by suitable connections, such as pipes **31** to supply fuel to the pulse jet engines **13** and by pipes **32** to the jet engines so that these latter will operate in the known way. Primary engine mountings **33** and secondary engine mountings **34** are provided as shown.

A load pack or seating compartment **11** is provided in a suitable disposition in relation to the aircraft, for example underneath the lower surface thereof, as shown in FIGURES 3 and 4. The load pack or seating compartment can be fixed or detachable as desired.

The flying of the above discussed aircraft is as follows:

The pulse jet engines **13** and **14** are activated and as a result a flow of gases draws air through the venturis **15** and **16** surrounding the engine and this mixture of air and gases enters the chambers **19** and **20**, respectively. In addition, the air passing through the venturis causes air to be drawn out via passageways **35** and **36** from the annular return ducts **6** and thus out of the radial ducts **7** and hence from the hollow interiors of the airfoil sections **1–5** and this of course, causes a reduction in pressure over the perforated portions **1***a*–**5***a* of the airfoil sections.

The air and gases passing into the chamber **19** cause a flow of air and gases through the slot **25** which is directed outwardly and to some extent downwardly by the shape of the surface of the airfoil section **5** and by the slat **27**. This air then passes over the airfoil section **5** with some of the air being withdrawn through the perforated section **5***a* and then the remaining air leaps up with a further supply of air and gases passing through slot **24**. The shape and the relative arrangement of the airfoil sections are such that the sections are at an angle of incidence to the airflow such that a lift is induced by reducing the pressure relative to the surface of the annuli. It is believed that this annular incidence between the air flow from the slots **21** to **24** and the general line of airflow over the surfaces of the airfoil sections is a much greater angle of incidence than is met with in normal practice and has the advantage that it allows a high lift to be obtained with a low velocity of air or gas.

The air flowing from each succeeding jet meets air flowing from an earlier jet, except, of course, the first jet coming from the slot **25**. Thus, there is a deflection of the the combined flow of air and gases which it is believed tends to follow the surfaces of the airfoil and this tendency is increased by the removal from the rear part of each airfoil section of air adjacent that portion of the surface through the perforated portions **1***a* to **5***a* which air flows into the hollow interiors of the airfoils through the radial duct **7** and the annular return duct **6**, the passageways **25** and **26** back into the air flow through the venturi **15**. Hence, a reduction of pressure may be obtained above the lifting surfaces partly due to the flow of air and gases moving outwardly over the lifting surfaces and partly due to the induction of air flow through the perforated portions **1***a* to **5***a* with the latter assisting laminar flow.

The flow of air in general follows the surface of the airfoil sections which in cross section is arranged to be undulating but drooping towards the outer edge as above referred to. A series of hills thus appears being the centers of the airfoil sections and a series of hollows appear at the junctions between adjacent airfoil sections, i.e. where the new flows or jets of air and gases are admitted. The air and gas flow, because of the secondarily directed air through succeeding slots and because of the reduced pressure at the rear of the airfoil sections tends to follow this undulating surface, but is separated therefrom by a short distance in which the reduced pressure operates.

It is to be noted that the secondarily directed air and gases do not result from forward motion of the airfoil sections through the air but from the pressure in the chamber **19** forcing this flow of air and gases outwardly through the slots **21** to **25**.

The secondary plenum chamber **20** is, of course, also pressurized by operation of the pulse jet engines **14** and by the flow of air through the venturi **16**. The pressurized air and gases are discharged through the orifices **28** and **29**. The flow from these orifices is directed downwardly but also inwardly as can be seen from the shape of the slots in FIGURE 3. The effect of the outflow of air and gases from these slots is three-fold. Firstly, there is a kinetic effect which gives some lift due to the reaction from the gas flow. Secondly, there is a build-up of pressure below the aircraft due to the downward and inward flow of the gas streams which augments the atmospheric pressure existing below the aircraft. Thirdly, the stability of the aircraft is controllable by the pilot operating either butterfly valves **17** for each of the four quarters into which the slots **28** and **29** are divided or alternatively or in addition the pilot may control the pivoted deflector **30** to control spinning of the aircraft. In controlling the aircraft, for example viewing FIGURE 2, should the aircraft drop on any "side" which has reference to any of the four quadrants separated by the radial ducts **7**, then the pilot will reduce the pressure to the chamber **20** on the high side of the aircraft. Since the pilot has control of four chambers he has control of the stability of the aircraft.

As a result of a reduction in pressure on the upper surfaces of the aircraft and of the increase of pressure on the lower surfaces due to the downwardly directing jets both by the kinetic and pressure effects, lift of the aircraft is obtained. As a particular result thereof, the body of the air flowing over the upper surfaces of the aircraft is in turn lifted because the slots **21** to **25** per se, are being lifted so that as the slot is being lifted, the jet of air emerging from the slots is lifted. Consequently, there is an upward movement of this body of air even though the flow of air from the jets is downward relative to the surfaces of the airfoil sections. However, the whole of the aircraft is being lifted as above stated. It is to be noted that during vertical lift, the conventional aircraft control surfaces **9**, **10** and **10***a* are not used. It is, however, now required that the aircraft start to move in a horizontal direction. To cause forward movement of the aircraft, the pilot controls the butterfly valve **17** leading to the forward quadrant of the chamber **20** to reduce the pressure in that chamber and as a result, the forward portion of the aircraft will drop. The slots **28** and **29** in the three remaining quadrants will, however, exert a thrust which will be substantially along the vertical axis of the aircraft as previously although the line of thrust may be somewhat forward of the vertical, but in any event, the net result is that the thrust has a horizontal component which is directed forwardly, thus tending to start to move the aircraft in a forward direction. Hence, the lift component moves to the rear while the weight component moves forward effecting a forward component of force tending to tilt the aircraft in a forward direction. In addition, because of the reduction of lift due to the reduction in pressure in the forward quadrant, the aircraft will tend to move downwardly as well as forwardly. This is controlled by the pilot to a stage where there is an increase in forward air speed. At an appropriate time, the pilot either operates shutters **8** on the air intake to the three forward quadrants of the chamber **19** and deactivates the engines of these quadrants thus stopping the flow of air over three forward quadrants, and leaving only the rearmost quadrant operating. The pilot simultaneously shuts off the lower jets **28** and **29** to all quadrants. The foregoing imparts thrust from the rear quadrant causing a rapid increase in horizontal velocity sufficient to sustain a forward flight by virtue of the movement of the air over the lifting surfaces operating as an airfoil as a whole. At this stage, the orthodox rudder, elevator and aileron control system is brought into operation and the aircraft is now flying in the same manner as an orthodox aircraft with the vertical flight system being inoperative, except that thrust is obtained from the rear quadrant by the discharge of gases over the airfoil surfaces of this quadrant.

To land, the following procedure is employed:

The machine enters a climb attitude and power is applied to all of the engines thus causing a loss of horizontal velocity and therefore a loss of normal airfoil lift. However, this is replaced by vertical lift due to the flow of air and gases over the airfoil surfaces, then the whole of the lift is provided by the engines causing air to flow from within the aircraft over the airfoil surfaces. The pilot now controls the attitude of the aircraft using the controls which operate the slots **28** and **29**, and when the aircraft is in its horizontal disposition, the pilot then reduces power supplying air and gases to the chambers **19** so that the aircraft starts to sink or descend. The pilot comes in contact with the ground when he can deactivate the engines. Of course, the rate of sink is controllable by increasing or decreasing the power to the engines supplying the chambers **19**. In the above horizontal flight, power is obtained by using the flow of air and gases over the rearward part of the rearward quadrant of the aircraft. Horizontal flight can also be achieved by separate thrust sources incorporated in the aircraft.

In relation to the construction, it should be stated that generally the gaps between the rings should increase towards the outer edge.

The above described construction is of particular value for subsonic travel. For supersonic travel or flight, certain variations would, of course, be necessary, not from the viewpoint of obtaining vertical lift but to permit the aircraft to also obtain supersonic speeds in forward flight. Thus, in FIGURES 10 to 16 there is illustrated diagrammatically an aircraft designed for accomplishing such end.

There is no difference in operating principle between the aircrafts of FIGURES 1 to 9 and FIGURES 10 to 14 in relation to the vertical lift aspect of both aircraft. In the aircraft of FIGURES 1 to 9, the airflow is from the center of the aircraft outwardly over annular rings. In the embodiment shown in FIGURES 10–14 in order to provide vertical lift, there is a flow over each wing from the fuselage outwardly towards the wing tips. Thus, referring to FIGURES 10 and 11, an aircraft of more orthodox appearance than the circular aircraft above described is illustrated and includes a fuselage **101**, a wing **102**, rudder **103**, and a tail plane **104**. As in the previously described aircraft, the lift surfaces are provided as airfoils over which air and gases may be directed from within the aircraft for vertical lift and this flow is along the length of the wings and over which air may pass when the aircraft is moving in a forward direction for normal horizontal flight and this flow is transverse to the length of the wings, i.e. in orthodox flow. On FIGURE 12 it will be seen that the wings **102** are curved or drooped to a similar configuration as the cross section of the circular aircraft lifting surfaces. With reference to FIGURE 15, there is illustrated a series of airfoil sections **123**, **124**, **125**, **126** and **127** arranged with the trailing edge of one adjacent the leading edge of the next with a slot **112**, **113**, **114** and **115** between adjacent leading and trailing edges. As was the case of slot **26**, a slot **116** is provided to pull air and gases off smoothly during vertical flight. Associated with each of the slots **112–115** is a plenum chamber **102**, **107**, **108**, **109** and **110**, and an additional plenum chamber **105** supplies air and gases to slot **111**. In FIGURES 13 and 14 it will be seen that the plenum chamber **107** is provided with a pulse jet engine **134** mounted on a mounting **38** and having a fuel pipe **139** located in a venturi **132**. The venturi is connected by a venturi aperture **133** with the hollow interior of an airfoil **123** leading to a perforated section (of which **123***a*, **125***a*, **126***a* and **127***a* are counterparts in the remaining airfoils) of the airfoil **124***a* in a similar manner to that in which the venturi **15** of the circular aircraft leads to the perforated sections, e.g., **4***a*, of the airfoils. The jet engines **134** and the venturi **132** discharge air and gases into the plenum chamber **107** where a primary lift plenum outlet valve **129** controls the flow of air and gases from the plenum chamber **107** to the slot **113** and thus the control of air and gases to slot **113**. Additionally, the plenum chamber **107** supplies air to a secondary lift plenum outlet **119** which is controlled by a valve **130** (FIGURES 15 and 16). The secondary lift plenum outlets **117**, **118**, **119**, **120**, **121** and **122** correspond to the previously described secondary lift outlets **28** and **29**. In FIGURE 14, a thrust control valve **135** is provided and beyond such thrust control valve there is an outlet **136** leading to the trailing edge of the wing. It is to be understood that the wing as shown in FIGURE 13, has an airfoil section and more particularly is a triangular shaped airfoil having an inlet **131** for admitting air to the pulse jet engine **134** which is especially suitable for supersonic flight.

To provide fore and aft trim, fore and aft twin jets **137** and **137***a* are shown in FIGURE 10, and ducts lead from a plenum chamber to the jets, for example the chamber **105** being in communication with jets **137** and **137***a*. These jets are controllable to provide longitudinal stability, and are provided on the undersurface of the fuselage. Fuel tanks are illustrated at **128**.

The operation of the supersonic aircraft is substantially similar to the operation of the circular aircraft. In beginning flight, the engines **134** are started but the controls are operated in the following manner:

The thrust control **135** is positioned to prevent the egress of air and gases rearwardly through the thrust outlet **136**, in other words, the valve is closed so that the chamber **107** and so on are under pressure. In addition, the plenum primary outlet valves **129** are opened as shown in FIGURE 16. As a result, air and gases under pressure from the chambers **107** and **110** may pass though the slots **111** to **115**. In addition, the plenum secondary outlet valve is also opened so that air and gases may pass through the secondary lift plenum outlets **119** and **112**. There are now flows of air and gases substantially similar to the flows of air and gases in the circular aircraft. Thus, there is a flow of air and gases from the slot **111** which passes outwardly along the line of the wings toward the wing tips thereof. This flow of air and gases passes firstly over the airfoil **123** is then augmented by a further flow of air and gases over the airfoil **124** and so on towards the wing tip. This corresponds to the flow of gases described in connection with the circular aircraft. Moreover, there is a downward flow from the secondary lift plenum outlets **117** and **112** which are controllable by the valves **130** to give control of stability of the aircraft in a lateral direction and of course, the pliot will also control the jets **137** and **137***a* for longitudinal stability of the aircraft. Due to the flow of air outwardly along the length of the wings towards the wing tips, there will be vertical lift as previously described in connection with the circular aircraft.

Again, when the aircraft reaches a suitable altitude, a transfer to horizontal flight will be necessary. In this connection, the aircraft is caused to assume a nose down attitude by control of the jets **137** and **137***a* and valves **135** are then partially opened to give some forward thrust which results from the egress of air and gases from plenum chambers **107** and so on rearwardly beyond the valves **135** through the thrust outlet **136**. Progressively, the valves **130** and **119** to **122** are closed while the valve is progressively opened. In this way, there is a build-up of horizontal speed and a lessening of the vertical lift effects due to the flow of air along the length of the wings with this flow of air being replaced by a flow of air over the upper surface of the wings in a direction transverse to the length of the wings, i.e. in normal air flow. Until there is forward motion, the ordinary conventional controls of the aircraft are not in use and conversely after horizontal flight has been achieved, the control of the jets **137** and **137***a* to give control of longitudinal stability are not used.

It will be apparent that there is a similar principle of operation between the circular and the supersonic aircraft, though in detail there is a variation in the application of power. During supersonic flight, it will be understood that air enters the continuous aperture **131** in the wings of the aircraft, flows through or around the jet engines **134** and passes rearwardly through the chambers **105** to **110** and out at the rear of the wing through the apertures **136** to give a constant forward thrust to the aircraft.

Referring to FIGURE 17 and more particularly to the question of take-offs, namely, the position from rest to the zone **1** which may be termed the vertical take-off phase, the primary and secondary engines are controlled to be on uniform power for providing engine rest and vertical velocity as hereinabove described. With respect to the zone between **1** and **2**, that is the tilt phase, differential power is applied to the front and rear quadrant secondary engines for causing the aircraft to tilt forwardly thereby imparting some horizontal velocity to the aircraft due to the thrust vector which now has a horizontal component associated therewith. The guard phase, that is to say, zones **2–3**, has the primary engine stopped from the front and both side quadrants thereby bringing about a loss of engine lift and consequently a loss of altitude. This results in increase in forward air speed by reason of the tilted attitude of the aircraft augmented by the thrust from the rear quadrant effecting a rapid increase in horizontal velocity until the position **3** is attained, when the air speed over the lifting surfaces as an entity is sufficiently high to reflect lift due to the normal airfoil action of the lifting surfaces as a whole.

From the position or zone **3** forward, the horizontal flight phase is illustrated and after the position **3** has been attained, forward thrust is effected on the primary engines in the rear quadrant to afford sufficient horizontal velocity to maintain such flight controlled by the orthodox or conventional elevator, aileron and rudder assemblages.

With respect to landing, the procedure is reversed so that in phases or zones **3–2** (the stall phase), the aircraft enters a climb position and power is applied to all of the engines thereby causing a loss of horizontal velocity and as a consequence, the loss of normal airfoil lift. Such airfoil lift is replaced by the lift as above described which effects vertical lift.

Turning now to phases or zones **3–1** (let-down phase), at position **2** the normal airfoil lift due to the forward velocity is zero and the whole of the lift is effected by the engine creating the vertical lift previously described. The secondary engines are operated with differential power on the front and rear quadrants, thus causing the aircraft to assume a horizontal attitude and a further loss of horizontal velocity assuming, as a matter of fact, that there is any horizontal velocity left.

As to phase or zone **1**, namely, the landing phase, uniform power is applied to both primary and secondary engines with the later being controlled to effect stability of the aircraft. The power is decreased to give a satisfactory descent rate and immediately prior to landing the power may be increased somewhat for reducing the vertical rate of descent. This is, of course, under the control of the pilot and as a consequence, the precise degree of engine power applied will depend on the rate of descent required or necessary. Ideally, of course, the rate of descent when touching the ground level will be zero or close thereto.

What we claim is:

1. An aircraft comprising a body, means within said body providing a source of flow of gases, lifting surfaces on said body defined by a plurality of airfoil sections, said airfoil sections being disposed with the leading edge of the second section adjacent to the trailing edge of the first section and the leading edge of the third section adjacent the trailing edge of the second section, with said first, second and third sections being relative to the flow of gases over the airfoil sections, means defining at least one chamber positioned relative to said airfoil sections, outlet means to deliver a flow of gases from said source of flow through said chamber over said airfoil sections, with positioning of said outlet means and the shape of said airfoil sections being such that the resultant flow of gases relative to said lifting surfaces produce a reduced pressure on said lifting surfaces whereby vertical flight takes place when the gases flow, perforated areas in trailing portions of the upper surfaces of each of the airfoil sections communicating with the hollow interiors of the airfoil sections, pressure reducing means for creating an air flow of reduced pressure, and duct means connecting the pressure reducing means to the hollow interiors of the airfoil sections and thus the perforated areas for drawing air from the upper surfaces of the trailing portions.

2. An aircraft comprising a body, lifting surfaces on said body, means on said aircraft providing a source of flow of gases, outlet means to deliver a flow of gases from said source over said lifting surfaces, said lifting surfaces comprising a plurality of airfoil sections disposed with the leading edge of the second section adjacent the trailing edge of the first section and the leading edge of the third section, said first, second and third airfoil sections being positioned relative to the flow of gases over the airfoil sections, means defining at least one chamber positioned relative to said airfoil sections, the positioning of said outlet means and the shape of said airfoil sections being such that the resultant flow of gases relative to said lifting surfaces produces a reduced pressure therebetween so that vertical flight takes place when the gases flow, perforated areas in trailing portions of the upper surfaces of each of the airfoil sections communicating with the hollow interiors of the airfoil sections, pressure reducing means for creating an air flow of reduced pressure, and duct means connecting the pressure reducing means to the hollow interiors of the airfoil sections and thus the perforated areas for drawing air from the upper surfaces of the trailing portions.

3. An aircraft comprising a body, lifting surfaces on said body, means on said aircraft providing a source of flow of gases, outlet means to deliver a flow of gases from said source over said lifting surfaces, said outlet means being positioned to cause said flow of gases to pass in a manner such that some reduction in pressure is created between the flow of gases and the lifting surfaces by virtue of the relative angle of incidence between at least some parts of the lifting surfaces and the flow of gases, said lifting surfaces comprising a plurality of airfoil sections disposed with the leading edge of the second section adjacent the trailing edge of the first section and the leading edge of the third section adjacent to the trailing edge of the second section, said first, second and third sections being positioned relative to the flow of gases over the airfoil sections, means defining at least one chamber positioned relative to said airfoil sections, means on said aircraft to create a reduced pressure, duct means to provide communication between the surfaces of said airfoil sections adjacent the trailing edges thereof with said means to create a reduced pressure whereby some of the air adjacent the boundary of said lifting surfaces is removed continuously during operation to cause a reduction in pressure, and the positioning of said outlet means and said flow-directing means and the shape of said airfoils being such that the resultant flow of gases relative to said lifting surfaces produce a reduced pressure such that vertical flight takes place when the gases flow.

4. An aircraft comprising a body, lifting surfaces on said body, means on said aircraft providing a source of flow of gases, outlet means to deliver a flow of gases from said source over said lifting surfaces, said outlet means being positioned to cause said flow of gases to pass in a manner such that some reduction in pressure is created between the flow of gases and the lifting surfaces by virtue of the relative angle of incidence between at least some parts of the lifting surfaces and the flow of gases, said lifting surfaces comprising a plurality of airfoil sections disposed with the leading edge of the second section adjacent the trailing edge of the first section and the leading edge of the third section adjacent to the trailing edge of the second section, said first, second and third sections being positioned relative to the flow of gases over the airfoil sections, means defining at least one chamber positioned relative to said airfoil sections, means on said aircraft to create a reduced pressure, duct means to provide communication between the surfaces of said airfoil sections adjacent the trailing edges thereof with said means to create a reduced pressure whereby some of the air adjacent the boundary of said lifting surfaces is removed continuously during operation to cause a reduction in pressure, and the positioning of said outlet means and the shape of said airfoils being such that the resultant flow of gases relative to said lifting surfaces produce a reduced pressure such that vertical flight takes place when the gases flow, and said duct means also forming part of the frame of said aircraft.

5. An aircraft comprising a body, means within said body providing a source of flow of gases, lifting surfaces on said body defined by a plurality of airfoil sections, said airfoil sections being disposed with the leading edge of the second section adjacent to the trailing edge of the first section and the leading edge of the third section adjacent the trailing edge of the second section, with said first, second and third sections being relative to the flow of gases flowing over the airfoil sections, means defining at least one chamber positioned relative to said airfoil sections, outlet means to deliver a flow of gases from said source of flow through said chamber over said airfoil sections, with the positioning of said outlet means and the shape of said airfoil sections being such that the resultant flow of gases relative to said lifting surfaces produce a reduced pressure on said lifting surfaces whereby vertical flight takes place when the gases flow, and a series of said lifting surfaces being arranged side by side with the longitudinal axis lying parallel to the longitudinal axis of the aircraft and with the shape of each lifting surface having an airfoil shape both longitudinally and transversely.

6. The aircraft as claimed in claim **1**, wherein said reduced pressure is achieved by means to cause the flow of air to pass through a venturi means so as to cause a reduction in pressure in a part thereof and so that the air drawn from adjacent the surface of said lifting surfaces is admixed with the gases discharged to provide said flow of air.

7. The aircraft as claimed in claim **1**, wherein said aircraft has a central portion and said airfoil sections are formed as annuli around the central portion of said aircraft, with said annuli being positioned one beyond the other.

8. The aircraft as claimed in claim **1**, wherein said aircraft has a central portion and said airfoil sections are formed as annuli arranged around said central portion of said aircraft, said annuli being arranged one beyond the other and in which the upper surface of said annuli looked on as a combination is provided as an airfoil surface whereby flow of air in a plane parallel to said upper surfaces causes lift when the aircraft as a whole is moved in horizontal flight.

9. The aircraft as claimed in claim **7**, wherein means are provided to control the flow of air over parts of said annuli in a manner such that forward motion of the aircraft may be achieved by controlling such flow to give thrust caused by passing the air in one direction only relative to the center of said aircraft.

10. The aircraft as claimed in claim **1**, wherein said means providing a source of a flow of air comprise propulsion means selected from pulse jet means without added ram effect, pulse jet means with added ram effect, turbo-jet engines driving turo-fans and turbo-jet engines alone and venturi means positioned in relation to the outlet means of said pulse jet means so that the flow of gases from said pulse jet means causes a flow of air to flow through said venturi means whereby the volume of gases moved by said pulse jet means is augmented as compared with the volume of gases which would be moved by said pulse jet means alone.

References Cited

UNITED STATES PATENTS

2,821,351	1/1958	Utgoff	244—42 X
2,925,231	2/1960	Pfaff et al.	244—42
2,468,787	5/1949	Sharpe	244—12
2,547,266	4/1951	Hoglin	244—12
2,801,058	7/1957	Lent	244—12
3,237,888	3/1966	Willis	244—23
3,298,636	1/1967	Arnholdt.	

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DISK FLYING CRAFT

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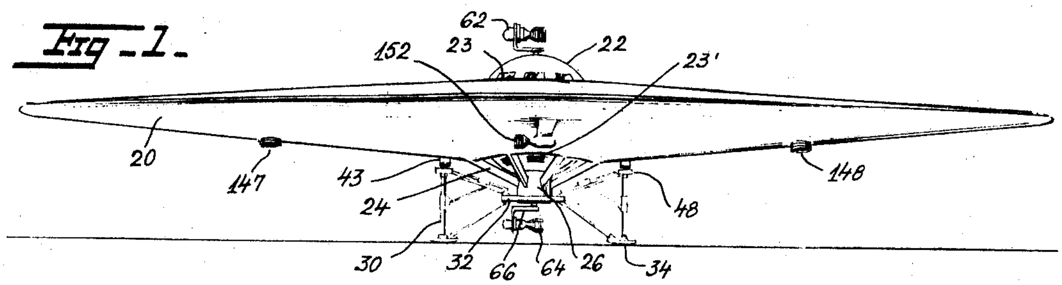
Fig. 1.



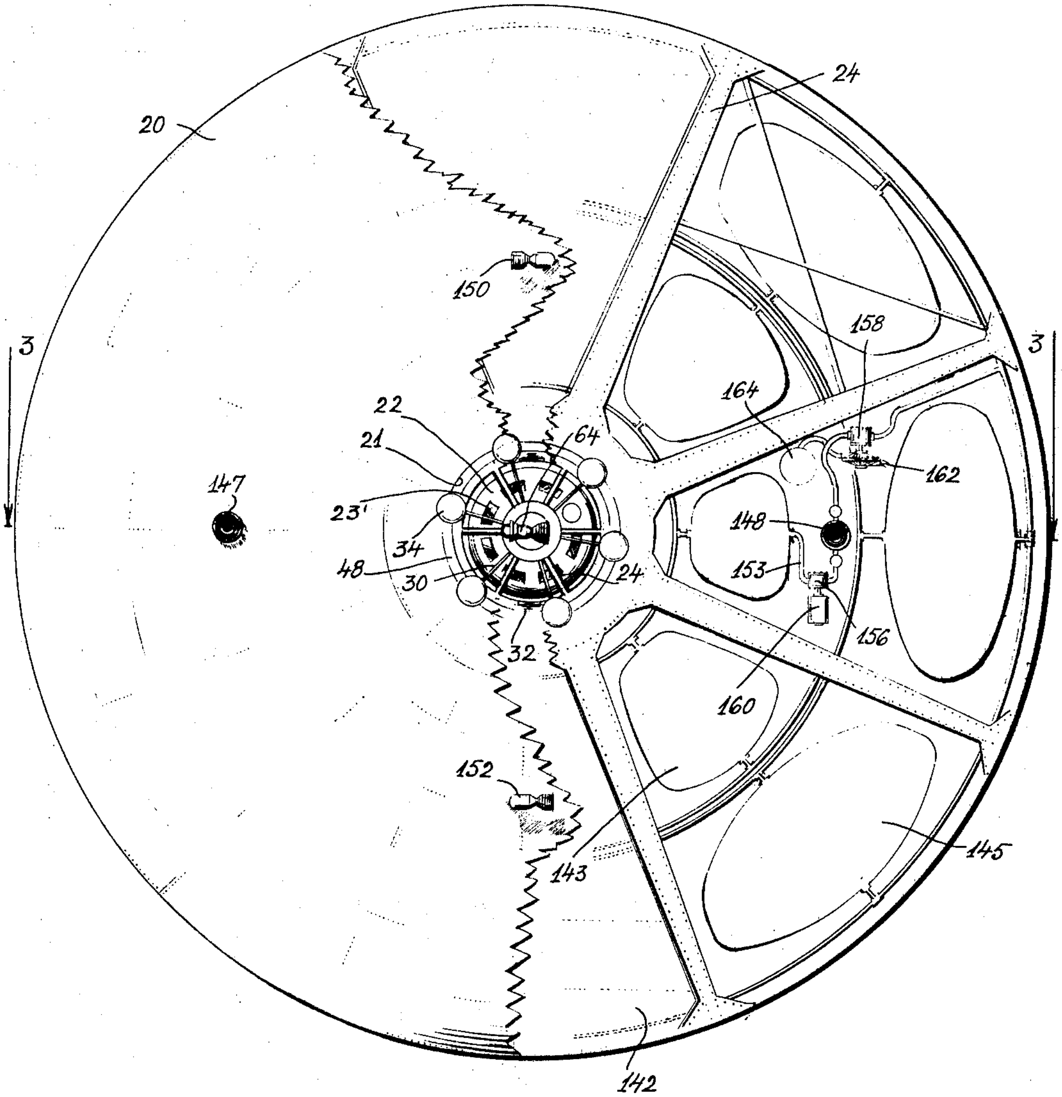


Fig. 2.

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DISK FLYING CRAFT

Filed Feb. 24, 1967 4 Sheets-Sheet 2

Fig. 12.

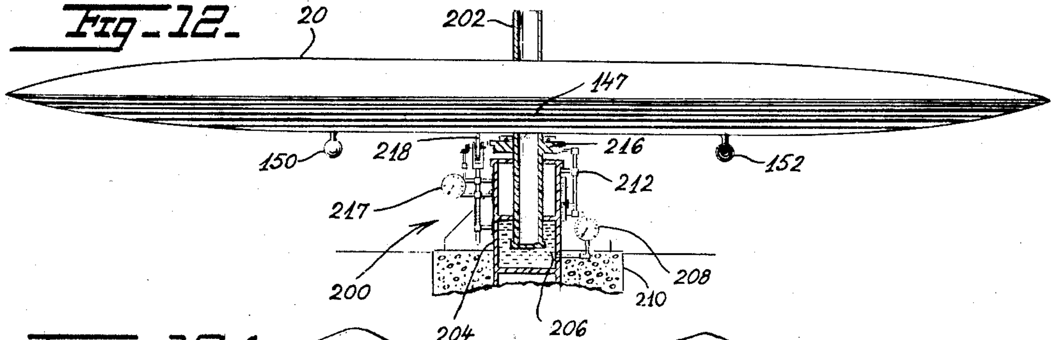


Fig. 12A

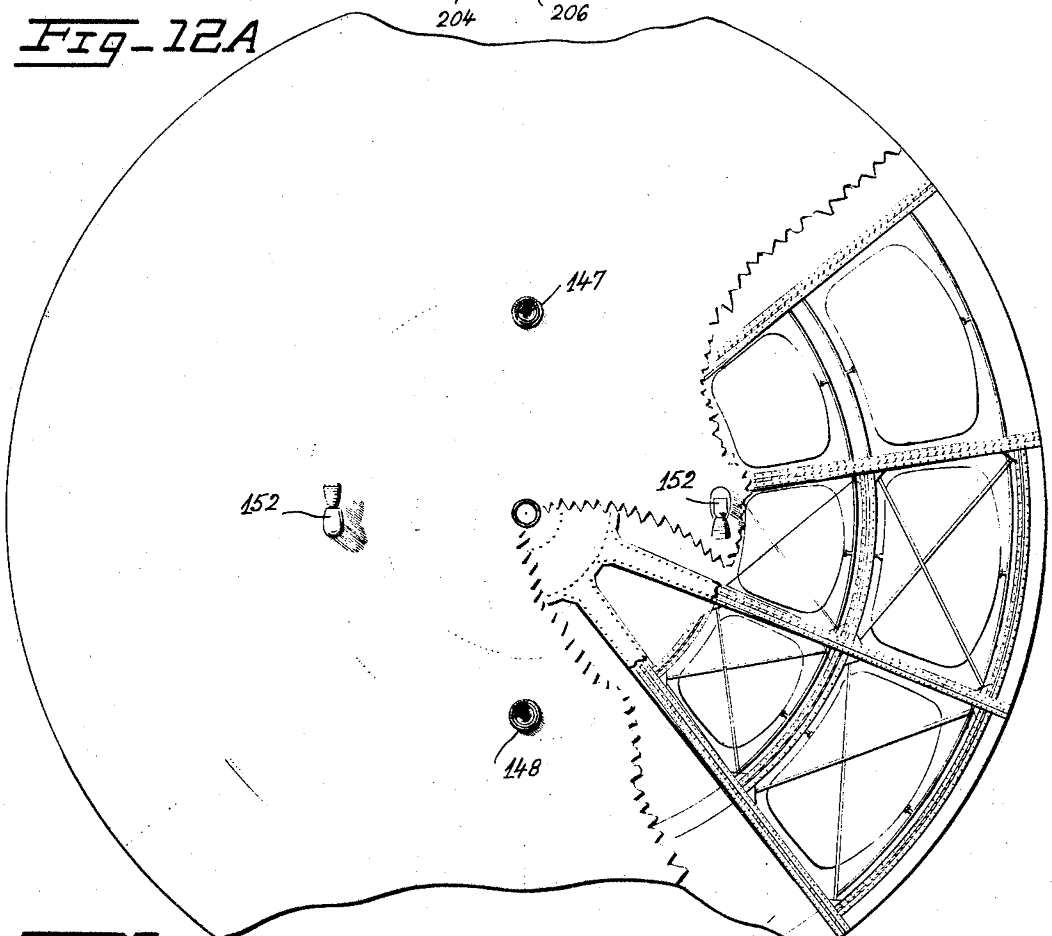
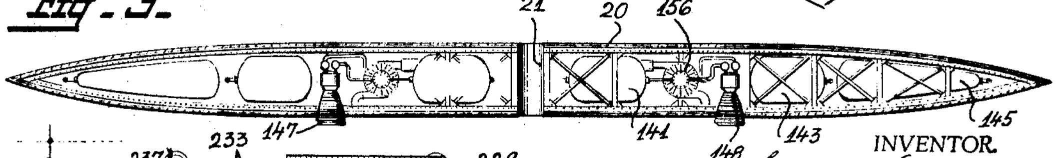


Fig. 3.



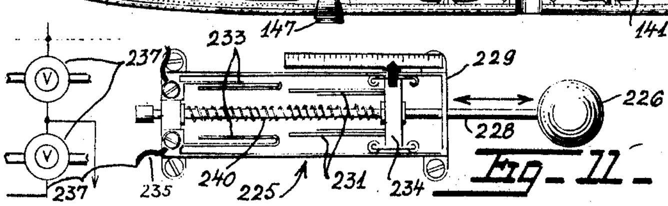


Fig. 11.

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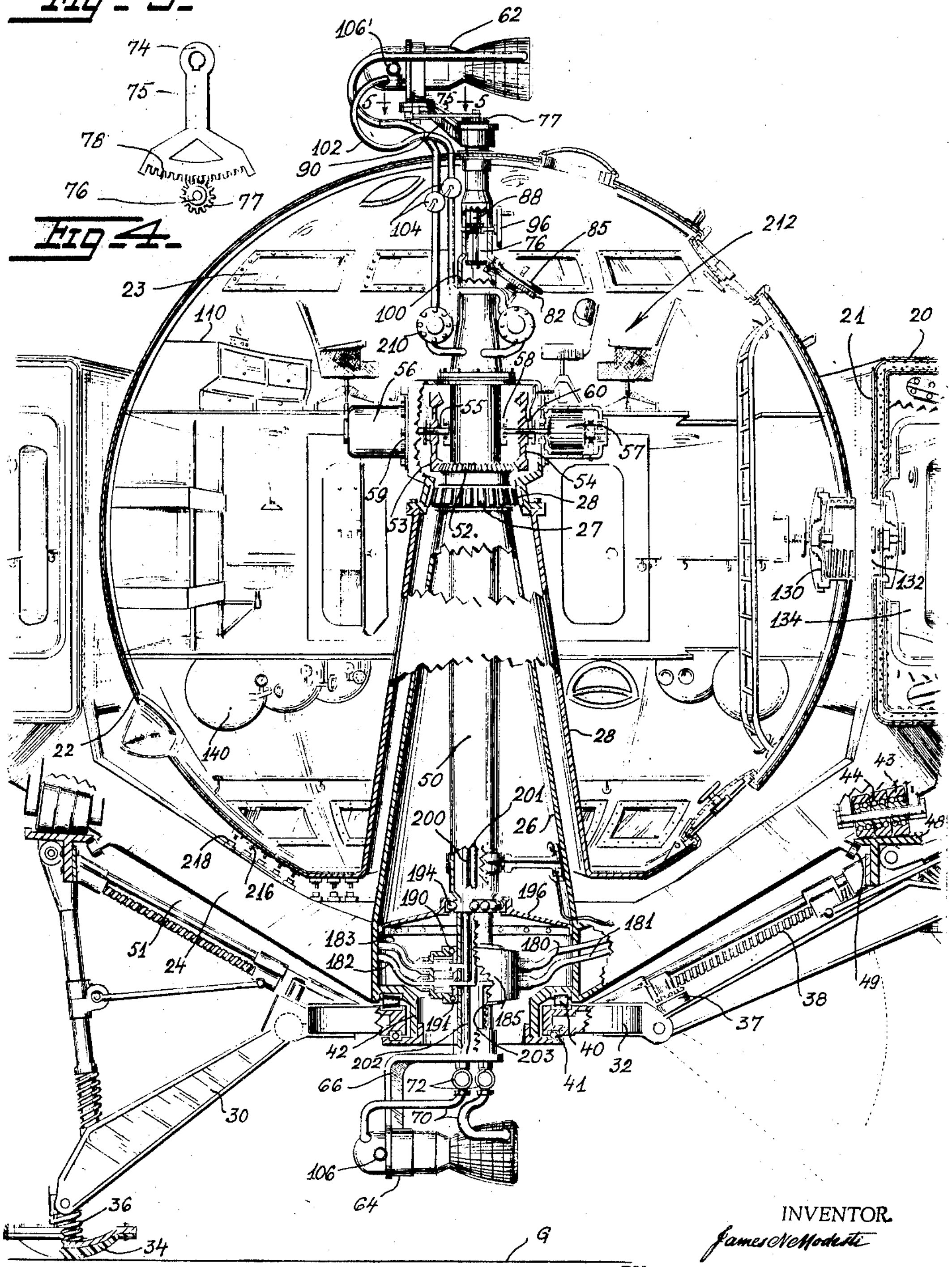
DISK FLYING CRAFT

Filed Feb. 24, 1967 4 Sheets-Sheet 3

Fig. 5.

Fig. 4.



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DISK FLYING CRAFT

Filed Feb. 24, 1967 4 Sheets-Sheet 4

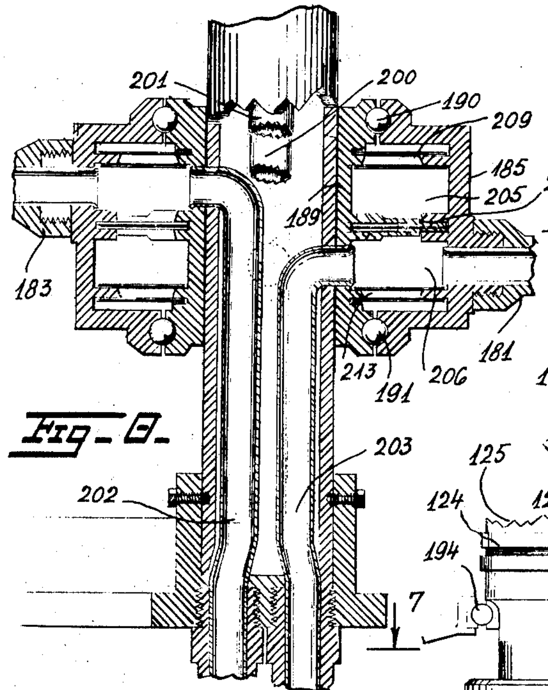

Fig-8.

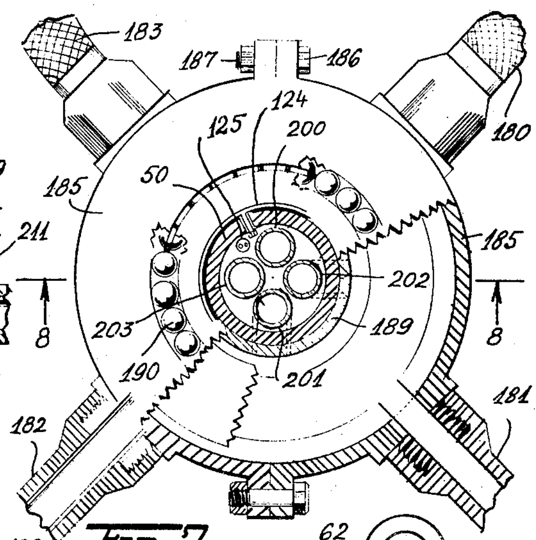

Fig-7.

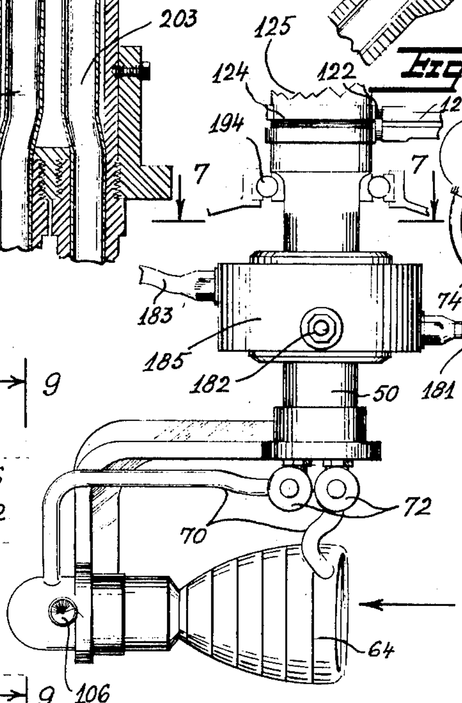

Fig-6.

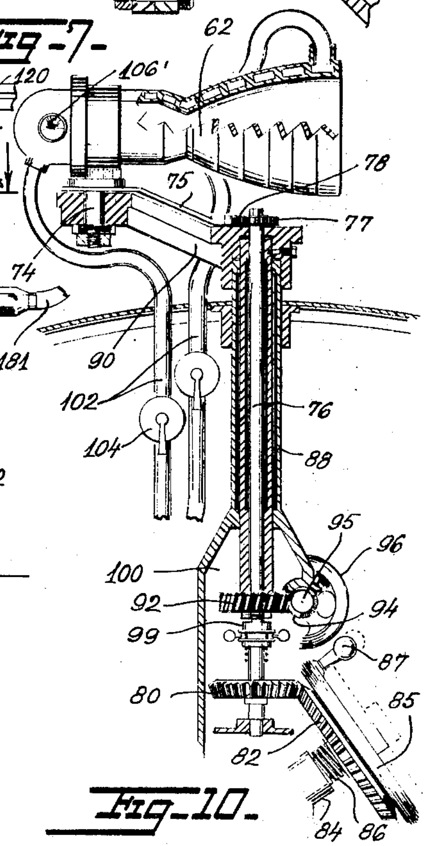

Fig-10.

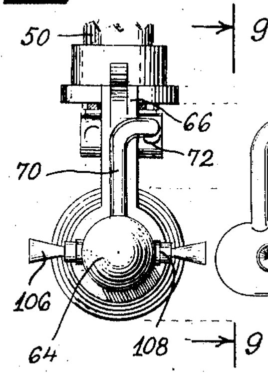

Fig-9.

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Patented Mar. 31, 1970

3,503,573

DISK FLYING CRAFT

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Int. Cl. B64c *29/00, 39/00*
U.S. Cl. 244—12 11 Claims

ABSTRACT OF THE DISCLOSURE

The disclosure describes a flying aircraft or spacecraft having a spinning circular disc shaped wing and a centrally disposed spherical compartment—or cabin. Personnel are housed in the cabin and control operation of the craft. The craft includes retractable landing gear, manually controllable rocket or jet motors, control steering, spinning speed, axial inclination, landing and takeoff.

This invention relates to experimental and manned flying spacecraft and involves improvements over the flying craft described in my prior Patent 3,199,809. According to the invention and as a principal object thereof, there is provided a flying craft or vehicle that can under its own propulsion be launched upwardly from the ground and maneuvered while in flight in any direction by operation of controls inside the vehicle.

A second object is to provide an aircraft which can be launched from its own landing gear, the craft including a disc shaped wing which is spun by horizontally mounted and directed rocket motors and lifted by the rotative force of the disc assisted by vertically disposed and directed rocket motors.

A third object is to provide a flying aircraft or spacecraft having a circular disc spun around a generally spherical cabin, or compartment in which personnel is housed.

A fourth object is to provide a flying craft as described, wherein the cabin has unobstructed windows on top and bottom through which observations can be made.

A fifth object is to provide a flying craft as described, wherein the craft is provided with its own retractable landing and takeoff gear.

A sixth object is to provide a flying craft as described with one rocket or jet motor rotatable and revolvable on top of the cabin for steering the craft when in flight, and operable in cooperation with another fixed rocket motor underneath the cabin.

A seventh object is to provide a flying craft as described in which fuel tanks are contained in the hollow, circular spinning disc, some of the tanks being located closer to the center of the wing than the rocket motors or jet motors and being spun with the disc so that fuel is forced into the rocket motors and/or jet motors under pressure created by centrifugal forces generated by rotation of the disc and tanks.

An eighth object is to provide a flying craft as described, wherein the spherical cabin or compartment has a conical centrally located sleeve receiving and rotatably engaged with a conical post affixed to the circular disc, with synchronized motors for spinning the spherical cabin in a direction opposite to the direction of rotation of the circular wing.

A ninth object is to provide a flying craft as described with a turbine engine driving an electrical generator for powering electric motors on the disc and ball, for operating solenoid valves, for energizing fuel pumps, and for powering other electrical appliances in the craft.

Other objects are to provide a flying craft as described: Two jet nozzles on each guidance rocket motor with lateral pusher rockets on rocket motors; with novel mounting means for a spherical cabin, in a rotating circular disc; with novel steering means for the craft; with novel rotational speed control and stabilizing means; with a ball bearing mounted fuel transfer box for passing fuel from the spinning disc to the ball cabin; with novel means for rotating the cabin in a direction opposite to the direction of rotation of the disc; with novel retractable landing gear including articulated padded radial legs, with a track on which the disc can rotate while the legs bear on the ground; with an airlock door to the cabin and registering doors in the disc through which personnel can pass between the spherical cabin, and disc with means for storing food, liquid, fuel, water and oxygen in the disc and cabin; and with other novel features shown in the drawings and described below.

For a better understanding of the invention, reference is made to the following detailed description taken in connection with the accompanying drawings, wherein:

FIGURE 1 is an elevational view of the flying craft, shown resting on the ground with retractable landing gear in extended position supporting the craft.

FIG. 2 is a bottom plan view of the flying craft, part of which is broken away to show internal constructional details of the rotatable wing.

FIG. 3 is a cross sectional view of the flying craft taken on line **3—3** of FIG. 2, showing structural details of the wing alone, the fuselage or cabin being removed.

FIG. 4 is an enlarged diametral sectional view of the spherical fuselage with adjacent parts of the rotatable wing and landing gear, portions of the landing gear and fuselage being shown in side elevation.

FIG. 5 is a fragmentary sectional view taken on line **5—5** of FIG. 4 showing parts of the mounting structure for the upper rocket guidance motor. All motors are rocket.

FIG. 6 is a side elevational view on an enlarged scale of the propellant passage box, bottom rocket guidance rocket motor and associated parts.

FIG. 7 is an enlarged cross sectional view taken on line **7—7** of FIG. 6, showing the ball bearing mounting of the propellant passage box, parts of the box being broken away.

FIG. 8 is a fragmentary vertical sectional view taken on line **8—8** of FIG. 7, showing internal structure of the propellant passage box and associated parts.

FIG. 9 is a fragmentary and elevational view taken on line **9—9** of FIG. 6, showing structure of the rocket or jet motor at the bottom of the fuselage.

FIG. 10 is a sectional view, partially in side elevation, of the rocket or jet motor on top of the fuselage, with associated operating gear train and manual controls.

FIG. 11 is a plan view of a centrifugally operated switch employed in the flying craft.

FIG. 12 is an elevational view of the circular wing per se without fuselage shown mounted on a testing stand including launching pole and associated gauges to measure weight, lift, height, and spinning speed, and

FIG. 12A is a fragmentary, bottom plan view of FIG. 12.

Referring first to FIGS. 1–4, there is shown a flying craft having a circular disc shaped wing or disc **20**. The disc has a central axial passage **21** in which is a spherical cabin **22**. The cabin is rotatably journaled with respect to the disc. The diameter of the spherical cabin is greater than the maximum axial thickness or height of the disc so that upper and lower portions of the cabin project outwardly of the disc at its center. The disc is provided with a plurality of radially extending spider arms **24** rigidly affixed to the bottom of the disc and carrying an axially extending hollow frustoconical shaft or post **26**; see FIG. 4. The cabin is free at the top so a clear view is had through windows **23**. Other windows **23** are at the bottom of the cabin.

The spherical cabin has a frustoconical sleeve **28** extending axially of the cabin and concentric with post **26**. At its upper end post **26** has roller bearings **27** extending circumferentially and engaged in a circumferential bearing race **28** near the upper end of post **26**. By this arrangement the fuselage and disc are mutually rotatable with respect to each other.

A plurality of retractable legs **30** extend radially of post **26** at the bottom of the disc and cabin. Inner ends of the legs are pivotally attached to a circular rail or track **32**. Outer ends of the legs carry circular pads **34** provided with shock absorbing springs **36**. The legs can be retracted upwardly when the craft is in free flight. When the legs are extended as shown in FIGS. 1, 2 and at the bottom left side of FIG. 4, they elevate and support the disc and cabin above ground G. A motor **37** drives a geared linkage **38** at each leg to retract and extend the leg. Rail **32** has roller bearings **40** on top and ball bearings **41** on bottom. The bearings are engaged in with a channel shaped track **42** so that the post **26** can rotate with the disc when the legs **30** are stationary on the ground. Wheels **43** rotating on ball bearings **44** are provided at circumferentially spaced points near outer ends of the spider arms **24** underneath the disc. These wheels ride on a horizontal circular rail or platform **48** engaged underneath by roller bearings **49** projecting from the arms **24**. The platform **48** is connected by bars **51** to rail **32**. Disc **20** carrying ball cabin **22** can rotate while the legs are stationary and resting on the ground as wheels **43** roll on platform **48**.

A hollow fixed shaft **50** extends axially inside of conical post **26**. Post **26** carries a bevel ring gear **52**. This gear can be engaged by bevel drive **53** or **54** on shafts **55** of two diametrically opposed axially horizontal synchronized motors **56**, **57**. The motors are located just above the center of the spherical cabin on opposite sides of a sleeve extension **59**. The motors will rotate the cabin in a direction opposite to the direction of rotation of disc **20**. Inner ends of shafts **55** are journaled in a bearing race **58** carried by shaft **50**. Gears **53**, **54** are provided with clutches **60** which permit disengagement of the gears from gear **52**. Motors **56** and **57** will be used to turn the fuselage when guidance rocket motors **62** and **64** mounted above and below the fuselage are not running.

Motor **64** is secured to shaft **50** in fixed position with respect to the cabin by an angle arm **66**; see FIGS. 4, 6 and 9. The motor **64** is axially horizontal or perpendicular to the axially vertical axis of the shaft **50**. Fuel is supplied to the motor by conduits **70** via solenoid controlled valves **72**.

Motor **62** best shown in FIGS. 1, 4 and 10 is axially horizontal and is mounted on an axially vertical shaft **74**. The motor can be rotated on stub shaft **74** by a bent arm **75** which extends radially outwardly of a shaft **76**; see FIG. 5. Shaft **76** is axially vertical and carries a gear **77** at its upper end engaged with sector gear **78** formed on the inner end of arm **75**. The lower end of shaft **76** carries a bevel gear **80** engaged with a bevel gear **82** on axially inclined shaft **84**. Gear **82** is normally disengaged from gear **80** by a coil spring **86** on shaft **84**, and is engaged with gear **80** when the pilot of the craft grasps handle **87** on handwheel **85** and presses downwardly on the handwheel.

Shaft **76** rotates inside of a sleeve **88**. This axially vertical sleeve carries a radial crank arm **90** which supports the motor **62** and journals shaft **74**. The sleeve **88** is secured to a gear **92** engaged with a worm **94** on shaft **95**. A handwheel **96** is engaged on shaft **95**. The handwheel **96** can be turned to rotate arm **90** 360° so as to point the rocket motor **62** in any direction in a plane perpendicular to the vertical axis of the ball-cabin and disc. Handwheel **96** serves to align motor **62** axially parallel to motor **64** for all level horizontal flight and to effect other necessary maneuvers. For example by turning handwheel **96** the motor **62** will be properly

oriented with respect to motor **64** to move the craft in for landing. Also it will be set for turning the disc **20** to a position where its diametral plan is horizontal if the craft should become tilted while in flight. It will be understood that it is necessary for the craft to be level when landing before the retractable legs **30** and pads are set down. This is done by pointing the top rocket motor **62** in the direction of the high point of tilt while the bottom rocket motor **64** points in the opposite direction. This will cause the craft to assume a level position. By continuing this maneuver, it is possible to turn the craft completely around while it is in flight. Normally the thrust of motor **64** in cooperation with motor **62** will stabilize the cabin **22** and keep it from turning by counteracting the torque produced by spinning disc **20**.

Handwheel **85** is more frequently used than handwheel **96**. Handwheel **85** is used by the pilot to keep the craft on course.

By turning the handwheel slightly more or less, any deviation in attitude of the cabin can be corrected. The thrust of motor **62** at an angle to the right or left of the axial direction in which motor **64** points will counter any drift of the craft off course. Normally, after use of handwheel **85**, it is left in such a position that the rocket motor **62** is axially parallel to the crank arm **90**. The shaft **76** will be held in the position set by a clutch **99**. Clutch **99** is operated by a small hand lever (not shown). The sleeve **88** and shaft **76** are all rotatably supported inside of housing **100** which is an axial extension of sleeve **28**. Housing **100** together with hollow shaft **50** constitute a central spindle axially of the fuselage and outwardly through upper and lower end portions thereof. Conduits **102** convey fuel to motor **62** via hand valves **104**.

The lower rocket motor **64** as shown in FIGS. 6 and 9 is provided with a pair of diametrically opposed jet nozzles **106** controlled by solenoid valves **108**. These solenoid controlled valves as well as the other solenoid valves mentioned above are all actuated by pushbuttons (not shown) at the control console **110** in the cabin. The jet nozzles **106** can be used to turn the entire fuselage on the vertical axis of the craft. They can be operated independently of the rocket motors **62** and **64** which have their own solenoid controlled valves **72** and **104**. Similar jet nozzles **106'** are provided on motor **62**.

In order to energize motors **56**, **57**, the solenoid valves, electrical lights and other electrical appliances in the fuselage, electric power is generated by a turbine driven electric generator (not shown) in the circular disc. Electric power is delivered inside the fuselage via a cable **120** which passes through one arm **24** and terminates in brush **122** which wipes two conductive rings **124** on shaft or spindle **50**. The rings **124** are insulated from the shaft. Power supply line **125** is connected to the top of rings **124** and serves as the electric power source inside the cabin.

The ball or cabin is provided with an air-lock door **130** which aligns with door **132** to the inside of the disc **20** when the disc is stationary with respect to the ball- or cabin. Doors **132** open into a circular corridor **134** surrounding the inner wall of central passage **21**; see FIG. 4. Normally adequate supplies of air, oxygen, water, etc. are contained in containers or tanks **140** inside the ball cabin. Additional supplies are contained in compartments **142** of the hollow disc which personnel of the craft can enter when the disc is stationary with respect to the fuselage.

The disc contains liquid fuel tanks **141**, **143** and gas propellant fuel tanks **145**. They provide fuel to the rocket motors **62**, **64** on the fuselage and other rocket motors **147**, **148**, **150**, **152** on the disc; see FIGS. 2, 3. Tanks **141** and **143** are located nearer the center of the wing than motors **147**, **148**, **150**, **152** which are connected via pipes **153** and fuel pumps **156**, **158** to the tanks. Motors **147**, **148** are axially vertical and are located in diametrically opposed positions at the bottom of the wing and point downward. When they are running, they serve to lift the entire craft axially. When the disc is spinning liquid fuel can pass to motors **147, 148, 150, 152** under centrifugal force to relieve the fuel pumps.

The two axially horizontal rocket motors **150, 152** are mounted at the bottom of the disc in diametrically opposed positions, and are used to spin the wing. Motors **147, 148** are larger and more powerful than motors **150, 152** because they must supply greater output thrust in lifting the craft. Liquid fuel pumps **156** are driven by electric motors **160**. Pressurized gas propellant tanks **145** have fuel pumps **158** driven by a turbine **162**. The turbine is steam driven by a steam generator **164**.

The manner in which fuel is conveyed to the rocket motors **62** and **64** in the cabin is best shown in FIGS. 4, 7, 8. Pressurized gas and liquid fuel passes via pipes **180–183** to a cylindrical fuel transfer box **185**. The pipes extend through legs **24** anud enter the box at circumferentially spaced points clearly shown in FIG. 7. Box **185** is formed of two semicylindrical sections joined by nuts and bolts **186, 187**. The box rotates with post **26** and wing **20**. The box rotates around sleeve **189** on shaft **50**. Ball bearings **190, 191** above and below the box facilitate rotation of the box. Other ball bearings **194** between shaft **50** and cross plate **196** attached to the base of post **26** facilitate rotation between the shaft and post. Inside of hollow shaft **50** are four pipes **200–203**. Two pipes **200, 201** open respectively into upper and lower chambers **205, 206** in the box **185**. Fuel supply pipes **180, 183** are connected to the upper chamber. Fuel supply pipes **181, 182** are connected to the lower chamber. Pipes **200, 201** extend upwardly to fuel pumps **210** supported outside of housing **100**. Pipes **90** are connected to the fuel pumps **210** and are connected via valves **104** to motor **62**. Pipes **202, 203** open into the upper and lower chambers **205, 206** respectively and extend down through shaft **50** to valves **72**. Pipes **70** convey the fuel to the lower rocket motor **64**. Sealing rings or washers **209, 211, 213** in box **185** seal off the chambers from each other and form the exterior of the box. The fuel supply system is arranged for a dual propellant fuel system. If a monopropellant system is used, the system can be simplified by providing only one chamber in box **185** and only two pipes leading from the box to the upper and lower motors respectively. Of course, if a tripropellant system is used, then another chamber will have to be added to box **185** and further piping will be required. All the valves may be solenoid operated, but the upper valves **104** can be manually operated since they are conveniently accessible inside the control room **212** of the cabin.

When the craft is on the ground, the ball-compartment can be turned a fraction of a turn by operating motors **56, 57** or motor **62**. A plurality of fingers **216** carried by the ball as shown in FIG. 4 will engage trip switches or circuit breakers **218** mounted on one arm **24** of the disc. This will close or operate these switches so as to start the pumps which supply fuel to motors **150, 152**. The disc will then start to turn and will continue turning until a predetermined speed is reached when the motors will be cut off. This is accomplished by a centrifugal switch **225** shown in FIG. 11, cuts off solenoid valves **237**, controlling flow of fuel to motors **150, 152**. These valves are similar to valves **72** shown in FIG. 6 which control flow of fuel to motor **64**. Switch **225** has a ball **226** secured to the end of shaft **228**. Shaft **228** slides in a frame **229** against tension in spring **240**. Ball **226** pulls shaft **228** to the right as viewed in FIG. 11 to close contacts **231** with contacts **233**. Contacts **231** are carried by insulation bar **234** which moves shaft **228**. When the ball moves centrifugally to the right as shown in FIG. 11 due to rotation of switch **225** disc **20**, normally closed contacts **231, 233** open and the power supply circuit of the solenoid valves **237** controlling flow of fuel to motors **150, 152** will open to cut off the motors. Contacts **233** are connected to wires **235** which are in circuit with solenoid valves **237**.

FIG. 12 shows an unmanned circular disc **20** resting on a test stand **200** for test purposes. Stand **200** has an axially vertical pole **202** which extends through the center of the disc. The lower end of pole **202** floats in a closed cylinder **204** containing a suitable liquid **206**. A pressure gauge **208** is connected to cylinder **204** in communication with liquid **206**. The scale reading of the gauge **208** is an indication of the weight of the wing. The cylinder **204** is embedded in a solid concrete base **210** to bear the weight of the wing. A vertical height gauge **212** on the side of the cylinder **204** has a finger engaged with platform **216** on which the disc rests. The liquid **206** can be supplied to cylinder **204** from a supply tank under pressure so that pole **202** and platform **216** will rise with the wing when vertically directed motors **147** and **148** are turned on. Gauge **212** will indicate the extent of lift of the wing. A tachometer **217** is provided on the assembly. This tachometer has a wheel **218** rolling along the underside of wing when it spins. The wing will be spun when horizontally directed motors **150, 152** are turned on. The apparatus shown in FIG. 12 can thus be used to measure weight, lifting action and rotational speed.

It will now be clear, that the flying craft propels itself upwardly by employing its own vertically directed rocket motors. It is kept aloft when in air by forces under the rotating disc. It is steered by operation of the handwheels **85** and **88**. Handwheel **85** is employed like the steering wheel of any conventional vehicle to turn the craft to the right or left when the steering wheel is turned right or left. The craft is brought in for a landing by appropriately controlling the firing of the vertically and horizontally directed rocket motors **147, 148** and **150, 152**. The retractable legs are extended and the craft sets down on its resilient pads, while the wing keeps spinning until it decelerates to a stop. The craft will have to be made of a certain size required for air or space flights to carry as large an operating crew and as many passengers as desired.

While I have illustrated and described the preferred embodiments of my invention, it is to be understood that I do not limit myself to the precise construction herein disclosed and that various changes and modifications may be made within the scope of the invention.

What is claimed is:

1. A flying craft comprising a diametrally-horizontal circular-foil disc, said disc having a central opening extending between top and bottom sides thereof, a spherical or ball-shaped cabin disposed in said opening with diametrically opposite portions of said ball shaped cabin extending outwardly above and below said sides respectively of the disc and coupling means rotatably coupling the disc and ball shaped cabin so that the disc is rotatable around the ball compartment, said coupling means comprising a cone shaped sleeve extending diametrically inward of said ball shaped cabin and terminating at a point above the center of the ball shaped cabin, a plurality of radially-extending arms secured to the underside of the disc and extending underneath said opening, a conical hollow shaft supported by said arms and nested in said sleeve, and bearing means mutually and rotatably engaging apical portions of said shaft and sleeve, so that the disc is journaled to rotate with respect to the ball shaped cabin and vice versa.

2. A flying craft as recited in claim **1**, further comprising rocket motors mounted to the disc and oriented to direct forces in a plane parallel to the diametral plane of the disc for rotating the same around its axis, other rocket motors mounted to the disc and oriented to direct forces in a direction parallel to the axis of the disc for elevating the disc and ball, hollow shaft means defining a central spindle extending axially of the conical sleeve and shaft and outwardly of said opposite portions of the ball shaped cabin, means securing said spindle to the sleeve, other bearing means journaling said shaft to rotate around said spindle, a first directional guidance rocket motor mounted to one end of said spindle underneath the ball shaped cabin, a second directional guidance rocket motor mounted to the other end of the spindle above the cabin, means for revolving at least one of the directional guidance motors a predetermined radial distance from and around the axis of the spindle, and means for rotating said one directional guidance motor around another axis spaced said radial distance from the axis of the spindle, whereby any angle of tilt of the disc from a horizontal position can be corrected, and whereby the craft can be driven in a direction perpendicular to the central axis of the disc, all by cooperative action of the two directional guidance motors.

3. A flying craft as recited in claim **1**, further comprising a plurality of retractable radially extending circumferentially spaced legs underneath the disc for supporting the disc and ball shaped compartment above the ground, a first ring, said legs being pivotally connected to said ring, bearings journaling said shaft rotatably to the ring for rotation thereon, a circular platform, linkage means connecting said legs and platform under the disc, and wheels rotatably supported by said arms and rolling on said platform, so that the disc is rotatably on said ring and platform when the legs are extended and bearing upon the ground.

4. A flying craft as recited in claim **2**, further comprising diametrally opposed synchronized motors supported by said spindle, and gear means driven by the motors and engaged with said shaft so that the spherical-cabin can be spun in a direction opposite to the direction of rotation of the disc for keeping the fuselage stationary with respect to earth when the disc is rotating around the ball shaped cabin.

5. A flying craft as recited in claim **2** further comprising a cylindrical fuel transfer box rotatably journaled on said spindle, fuel storage containers in said disc, pipes connecting said containers to said box, said spindle having lateral openings communicating with said box, and other pipes extending from the openings in the spindle to the directional guidance motors for conveying fuel thereto from the fuel transfer box while the disc is rotating around the ball.

6. A flying craft as recited in claim **1**, wherein said cabin has windows at its upper side above the wing providing views unobstructed by any connections between the ball and disc.

7. A flying craft as recited in claim **1**, wherein said spherical-cabin has at least one air-lock door and said

disc has at least one other door alignable with the air-lock door in the spherical cabin to provide access and passage between for personnel between the ball and disc.

8. A flying craft as recited in claim **2**, further comprising pairs of jet nozzles on the directional guidance rocket motors oriented to direct forces laterally of the directional guidance motors for moving these motors to right or left.

9. A flying craft as recited in claim **2**, wherein the means for revolving said one directional guidance motor around the spindle comprises a crank arm supporting said one direction guidance motor and journaled to rotate on the spindle at its upper end, a sleeve shaft connected to said crank arm and extending axially of the spindle, a manually rotatable hand wheel, and gear means operatively connecting the handwheel to the sleeve shaft, whereby turning the handwheel revolves said one direction guidance motor at the end of and with said crank arm around the axis of the spindle.

10. A flying craft as recited in claim **9**, further comprising a further shaft extending axially of said sleeve shaft, another arm coupled to said one directional guidance motor to rotate the same with respect to the crank arm, other gear means operatively connecting said further shaft and said other sleeve, another handwheel and further gear means connecting said other handwheel and said further shaft, whereby turning the other handwheel rotates said one directional guidance motor with respect to the crank arm.

11. A flying craft as defined in claim **1** wherein means is provided for automatically cutting off the motors driving the disc around, said means including a centrifugal switch having a spring pressed shaft, a ball carried on one end thereof, said ball adapted to pull the shaft in one direction, fixed electrical contacts, movable electrical contacts carried by the shaft and adapted to contact the fixed contacts, centrifugal rotation of the ball in one direction being adapted to open the fixed and movable contacts breaking the electrical circuit controlling the flow of fuel to the motors.

References Cited

UNITED STATES PATENTS

3,199,809 8/1965 Modesti ------------- 244—12

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U.S. Cl. X.R.

244—23

United States Patent

[11] 3,599,902

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[21] Appl. No. 849,685
[22] Filed Aug. 13, 1969
[45] Patented Aug. 17, 1971

[54] **AIRCRAFT**
2 Claims, 7 Drawing Figs.

[52] U.S. Cl. 244/12, 244/43, 244/123
[51] Int. Cl. B64c 29/00
[50] Field of Search 244/12, 23, 123, 43; 60/261

[56] **References Cited**

UNITED STATES PATENTS

2,713,393	7/1955	Isacco	244/43
2,743,072	4/1956	Emmi	244/43
3,065,938	11/1962	Calkins	244/43
3,497,163	2/1970	Wakefield	244/43
3,184,187	5/1965	Isaac	244/123
3,437,290	4/1969	Norman	244/23
3,465,525	9/1969	Cowley et al.	60/261
3,469,804	9/1969	Rowan	244/12

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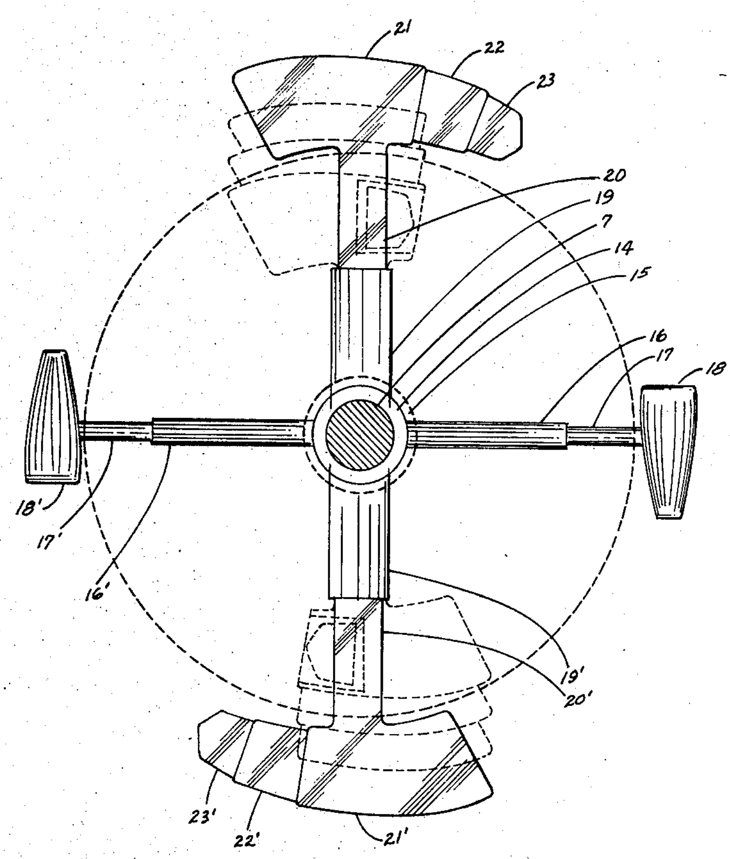
ABSTRACT: An aircraft having a fuselage of generally saucerlike character comprising upper and lower disc components separated by a transverse spacing; said upper component being contoured to provide an aerodynamic surface and merging into an upwardly projecting dome which comprises a portion of the pilot compartment. The maximum diameter of said upper component being substantially equivalent to three times the linear distance between the lower face of said spacing and the uppermost point of said dome. Depending from the lower fuselage section is a motor with a swivelly mounted afterburner for controlling the direction of horizontal flight. Provided within said spacing for rotation about an axis normal to the vertical axis of said aircraft are jet motors and airfoils for controlling vertical flight.



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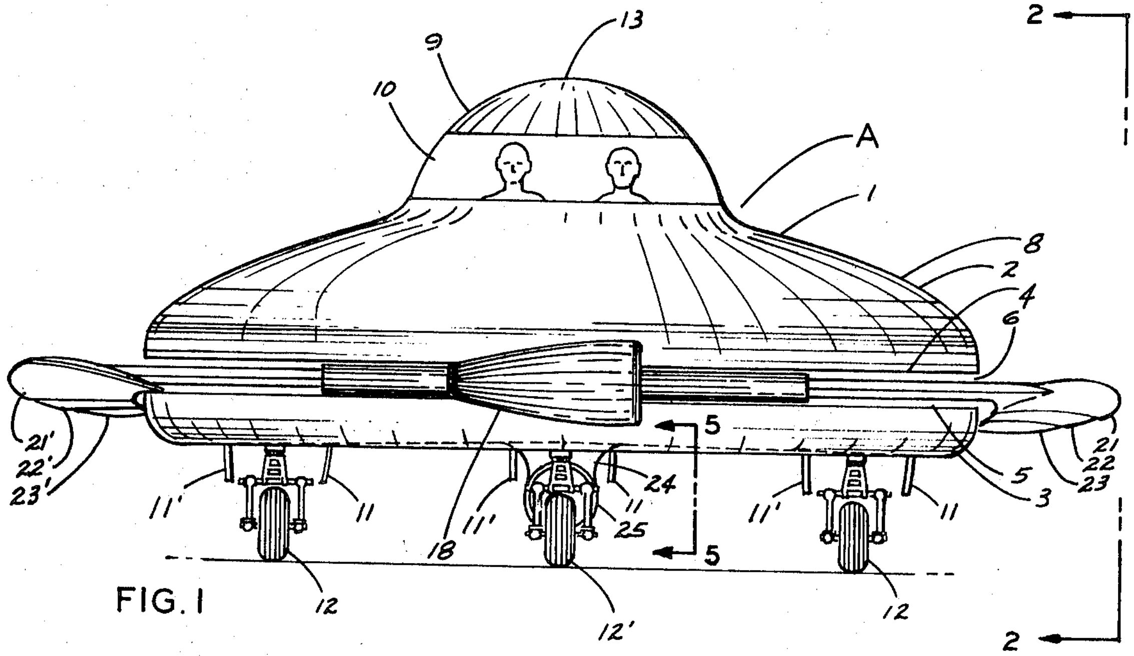

FIG. I

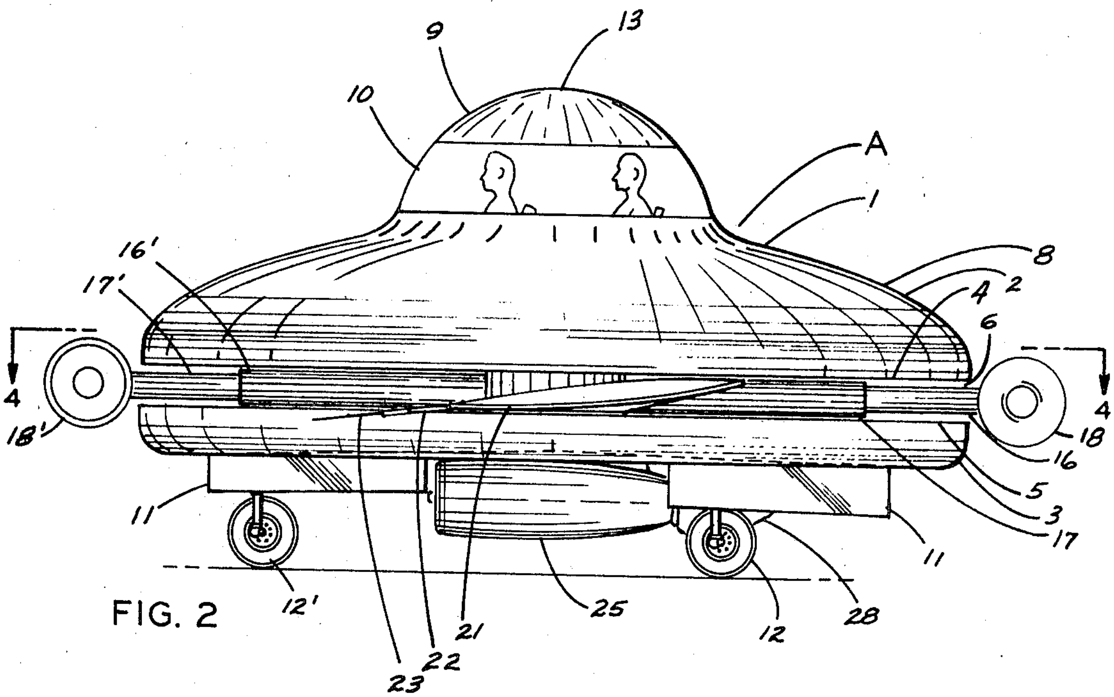

FIG. 2

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BY Ralph W. Kalish

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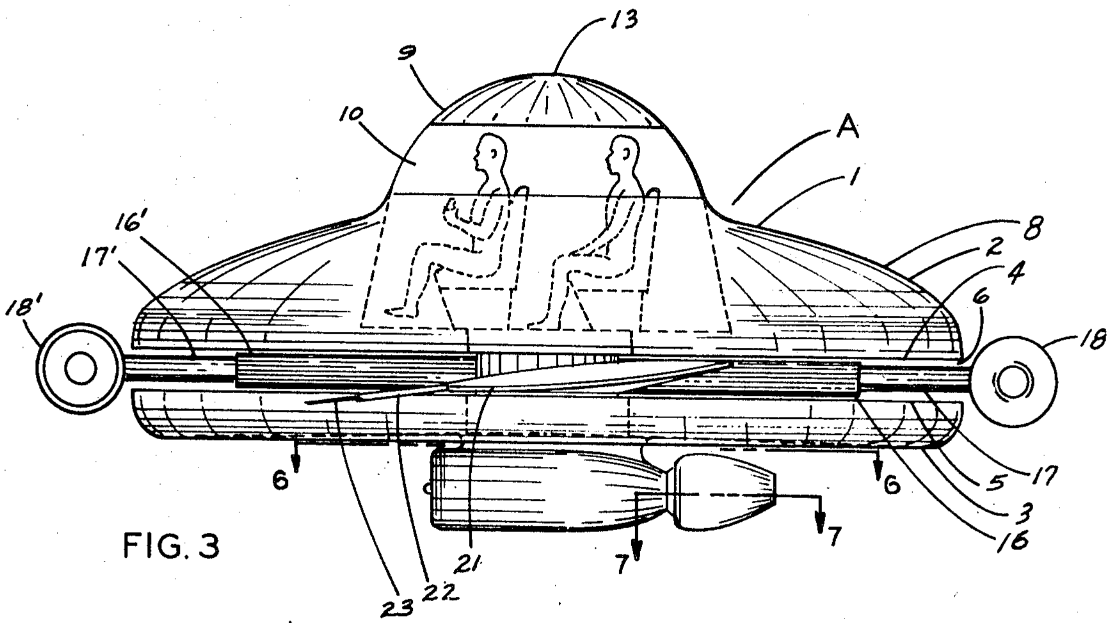

FIG. 3

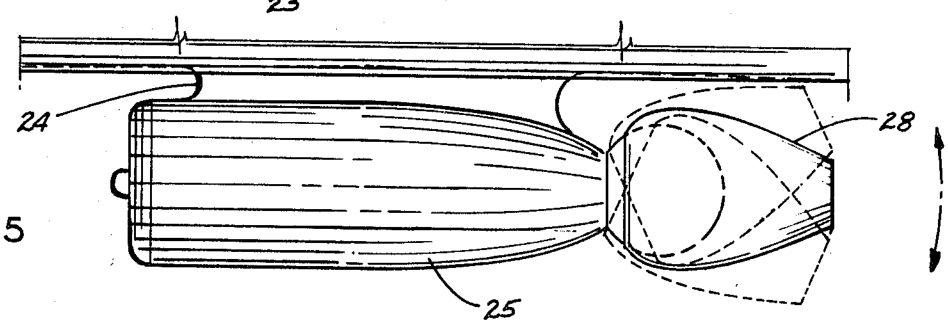

FIG. 5

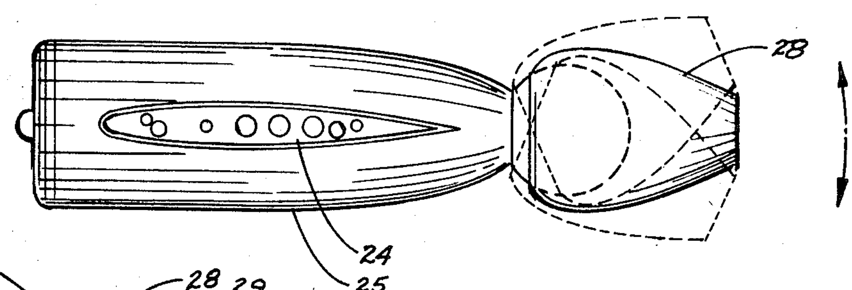

FIG. 6

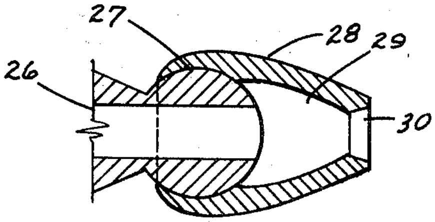

FIG. 7

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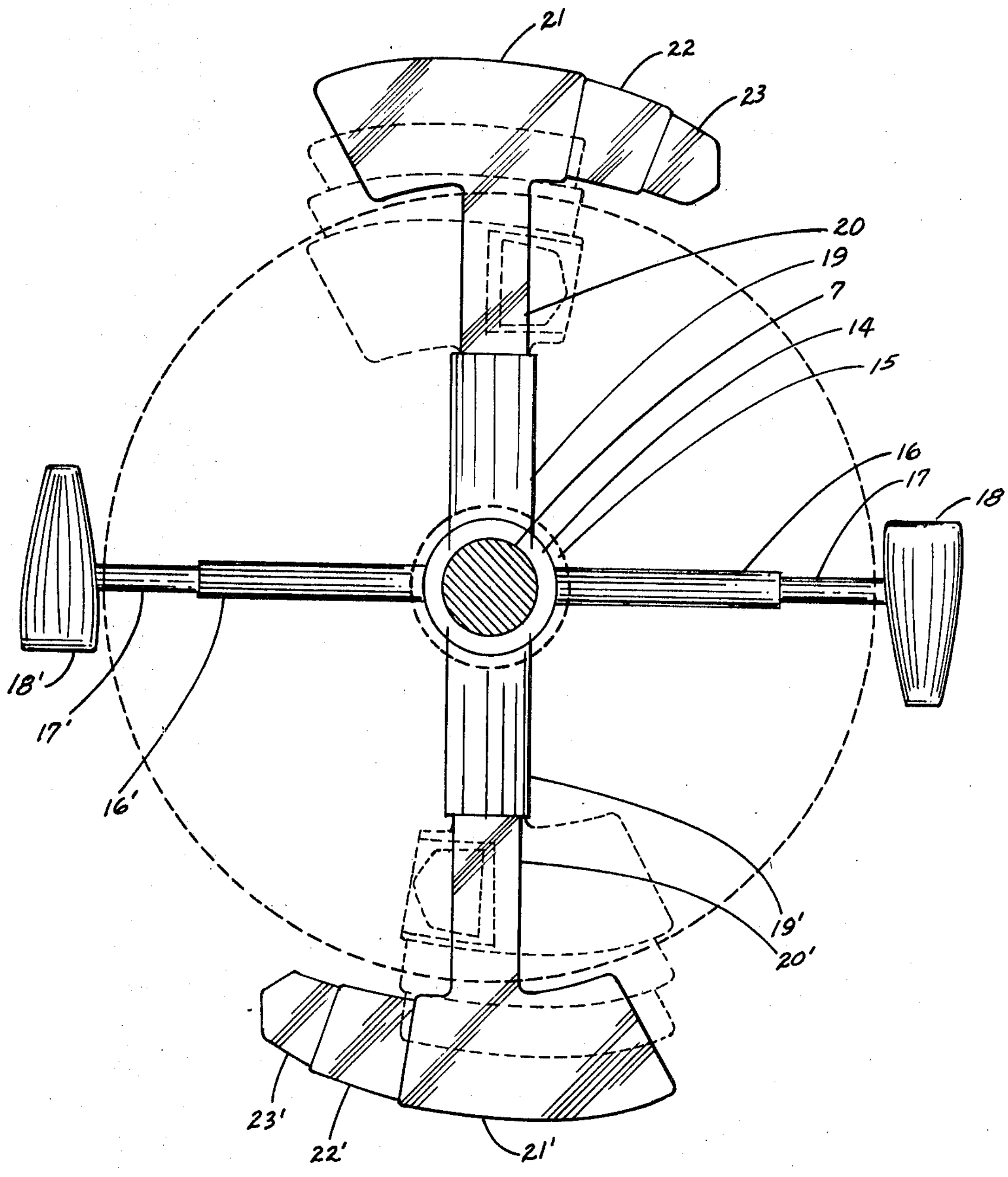

FIG. 4

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AIRCRAFT

BACKGROUND AND SUMMARY OF THE INVENTION

This invention relates in general to aircraft and, more particularly, to a jet-propelled aircraft of general saucerlike design adapted for both horizontal and vertical flight. It is an object of the present invention to provide aircraft of the jet propulsion type incorporating a compact, so-called saucerlike fuselage and having retractable airfoils for takeoff and vertical flight purposes.

It is a further object of the present invention to provide an aircraft of the type stated incorporating a fuselage having critical dimensional characteristics for conducing to a level of operating efficiency heretofore unknown in aircraft of generally related contour. It is a further object of the present invention to provide an aircraft of the type stated incorporating a fuselage having an upper portion with a predetermined camber to produce unusual lift characteristics, whereby a low-pressure area or vacuum is created over substantially the entire upper surface of the craft with resultant lift ability to an extent hitherto unknown.

It is another object of the present invention to provide an aircraft of the type stated involving novel and easily manipulated means for directing the craft in horizontal flight.

It is a still further object of the present invention to provide an aircraft of the jet propulsion type which may be most economically manufactured; which is extremely efficient and low cost in operation; which, by reason of its unique structure, is stable in flight; and which is reliable and durable in usage.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front view of an aircraft constructed in accordance with and embodying the present invention, with the wings extended and with the aircraft supported upon its landing gear.

FIG. 2 is a side elevational view taken on the line 2–2 of FIGURE 1.

FIG. 3 is a side view illustrating the aircraft in flying condition.

FIG. 4 is a horizontal section taken on the line 4–4 of FIG. 2.

FIG. 5 is a fragmentary view taken on the line 5–5 of FIG. 1, illustrating the afterburner of the drive jet in various positions.

FIG. 6 is a horizontal section taken on the line 6–6 of FIG. 3.

FIG. 7 is a horizontal section taken on the line 7–7 of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now by reference characters to the drawings which illustrate the preferred embodiment of the present invention, A generally designates an aircraft having a fuselage 1 of relatively shallow, so-called saucerlike configuration comprising upper and lower, generally disc-shaped portions or shells 2, 3, respectively, having, respectively, lower and upper confronting, coextensive, transversely extending, annular walls 4, 5 in spaced-apart relationship to define therebetween a spacing 6 of shallow, cylindrical form and being open throughout its peripheral extent for purposes presently appearing. Said upper and lower fuselage portions 2, 3 are joined by a column 7 presented centrally of spacing 6 and suitably secured to said upper and lower portions 2, 3 for integrating the aircraft fuselage.

The exterior surface of fuselage upper portion 2 is contoured to develop a camber, as indicated at 8, for providing said portion with unusual aerodynamic characteristics. Upper fuselage portion 2 merges into a central dome 9 which constitutes the exposed portion of a pilot's compartment 10; said dome being designed to permit maximum streamlining for reducing resistance to the relative and true winds. Lower fuselage portion 3 is relatively shallow having a slightly concave lower surface as in the order of one-half to five degrees but with the side of said portion being formed on a substantially same curve as the adjacent, lower section of upper fuselage portion 2. Said lower fuselage 3 in its lower end surface contains, preferably, three sets of swingably mounted doors or panels, as indicated at 11,11′ for accommodating a retractable landing gear 12. It is to be observed that said sets of doors 11,11′ are disposed so as to present the landing gear members 12 in conventional tricycle relationship so that the wheels of one landing gear, as at 12′, will be presented normally forwardly of, and aligned with a point intermediate, the remaining two landing gear members 12,12′. Said landing gear 12 are thus capable of being withdrawn into the interior of fuselage lower portion 3 with the associated doors 11,11′ being closed so as to conduce to streamlining during flight (see FIG. 3), all as is well known with current aircraft.

The diameter of upper fuselage portion 2 immediately adjacent spacing 6, or in other words, its maximum diameter, is of such extent as to be substantially equal to three times the distance between the upper face of transverse wall 5 and the apex or pinnacle of dome 9, as indicated at 13, and measured along a line coaxial with column 7. Experiments have demonstrated that such dimensional relationship conduces to maximum efficiency in operation of aircraft A so that the said relationship, or 3-to-1 ratio, is critical for optimum performance.

Mounted upon column 7 for rotative movement thereabout, by means to be described, is a bearing 14 which may be of the conventional friction-reducing type, such as a roller or ball bearing, comprehending inner and outer races (not shown) with such bearing being supplied with a suitable lubricant, all as is well known in the art. Bearing 14 constitutes the hub of a rotor, generally indicated 15, which comprises a pair of oppositely extending diametrically aligned sleeves 16, 16′ being rigid at their inner ends with bearing 14 and receiving through their outer open ends support arms 17, 17′ which extend beyond the margins of spacing 6 for carrying on their outer end extremities a rocket or jet-type motor 18, 18′ with their burners or exhaust ends directed oppositely so that upon firing the thrust developed will create a torque for effecting rotation of rotor 15. Fuel is supplied to each motor 18, 18′ through lines (not shown) extending from a reservoir or tank (not shown) located within aircraft A, preferably in lower fuselage portion 3; said lines extend through column 7, sleeves 16,16′, and arms 17,17′ in a manner currently accepted. Sleeves 16,16′ are adapted for rotative movement about their longitudinal axes that the related motors 18, 18′ may be adjustable between horizontal and vertical attitude. Control means for presenting motors 18,18′ are manipulatable from remote mechanisms within the pilot's compartment 10. Although the drawings would indicate that the maximum cross section of motors 18, 18′ is greater than the height of spacing 6 so that seemingly retraction of said motors 18,18′ thereinto would not be attainable, it is to be understood that appropriate alteration in such dimensional relationships is within the scope of the present invention so that such motors 18,18′ could be adapted for retraction. Such feature is particularly important when aircraft A is to be used above the earth's atmosphere since in such environment, said motors, as well as wings 21, 21′, will be of no purpose for vehicle propulsion.

Also be reason of the swingability of motors 18,18′ the same may be utilized to continue to provide lift for aircraft A for overcoming any gravitational pull as within the upper reaches of the atmosphere.

Also integrally formed with hub 14 and extending in opposite directions therefrom along an axis normal to that developed by sleeves 16,16′ are cylinders 19,19′ of fluid character and each having a piston 20,20′, respectively, for extension beyond its outer end which terminates spacedly inwardly of the outer margin of spacing 6. Said pistons 20,20′ are of such length that when in extended condition, project on their outer ends beyond spacing 6 and on such ends each mount wings or airfoils 21,21′, respectively, having their major axis along an arc concentric with column 7. It is apparent that wings **21, 21'** are of appropriate thickness so as to be received between confronting walls **4,5** of spacing **6**, inwardly of the outer margin thereof when the related pistons **20,20'** are retracted (as shown in phantom lines in FIG. **4**). Each wing **21,21'** incorporates a pair of telescopic sections **22, 23** and **22', 23'**, respectively, being of understandably relatively decreasing transverse extent; and which are coaxial with the related wing **21,21'**, serving to increase the aerodynamic surface thereof when fully extended (as shown in full lines in FIG. **4**). By means known in the art, pistons **20,20'** are adapted for limited rotation about their major axis so that the related wings **21,21'** may be tilted for altering the angle of attack thereof. It is, of course, recognized that suitable pump mans and fluid reservoir are provided at an appropriate point within fuselage **1** for connection to cylinders **19,19'** for effecting retraction and extension of pistons **20,20'** as required.

Depending from the central portion of the lower end surface of lower fuselage portion **3** is a hollow mounting **24** for a single jet motor **25**, the longitudinal axis of which is aligned with landing gear **12'** for extension fore and aft of said aircraft A. At its rearward end, jet motor or rocket **25**, surrounding its discharge passage **26**, is contoured to form a ball **27** for swivelly mounting thereon in the nature of a ball and socket joint formation, an afterburner **28** having an interior, rearward tapering compartment **29** terminating in an outlet **30** for discharge therethrough, at the expected high velocity, of the burning rocket contents. Such discharge, in accordance with accepted practice, causes a forward thrust to be imparted to the aircraft A thereby constituting reaction propulsion. However, by reason of the swivel mounting of afterburner **28**, the direction of discharge through outlet **30** may be altered in a substantial range so that the reaction force will be in a correspondingly opposite direction thereby serving to control the direction of movement of aircraft A in horizontal flight. Means for operating afterburner **28** for commensurately moving same to effect travel along the desired course, is provided within aircraft A for facile manipulation by the pilot.

In view of the foregoing, it will thus be seen that aircraft A is uniquely adapted for both vertical and horizontal flight and proving efficient movement through the atmosphere by reason of the unique aerodynamic characteristics developed by the contouring of aircraft A.

Thus, with aircraft A supported upon landing gear **12** combustion of fuel within jet motors **18,18'** is initiated so that thrust is developed upon discharge to thereby cause hub **14** with its related structure to rotate about the axis developed by column **7**. It is understood that wings **21,21'** will have been placed in extended position so as to be caused to move in a circular path about fuselage **1** and with such movement creating an area of negative pressure above said wings to impart lift of aircraft A. Upon upward travel of aircraft A the camber of fuselage **1** will conduct to extension of the negative pressure area above the fuselage upper portion **2** and compartment **10** so that maximum lift is developed. After aircraft A has reached a desired altitude, wings **21,21'** may be withdrawn into spacing **6** for removal from path of travel of aircraft A in which such combustion of fuel within jet motor **25** will provide the propulsive force for the horizontal travel of aircraft A. As stated above, such horizontal flight is directionally controlled by appropriate operation of afterburner **28** which is quite easily achieved.

It should be understood, however, that landing gear **12** may be optionally used since aircraft A may rise vertically from the ground without the need of any runway and may also be maneuvered for landing without extension of the landing gear. The same are accordingly provided for operation at the election of the pilot.

In view of the foregoing, it is to be seen that the pilot, through requisite control of jet motors **18,18'** may effect corresponding control of wings **21,21'** so as to have a most fine range of adjustments suitable for takeoff, flight and landing.

Having thus described my invention, what I claim and hope to obtain by Letters Patent is:

1. An aircraft comprising a fuselage having a discrete upper portion and a discrete lower portion, said upper and lower portions having spaced-apart, parallel, confronting walls to define an intervening space; said spacing being open to the atmosphere throughout its peripheral extent; a column provided centrally of said spacing connecting said upper and lower fuselage portions; bearing means provided surroundingly of said column in the region of said spacing; a pair of diametrically opposed fluid cylinders connected to and extending radially outwardly of said bearing means; a piston received within each cylinder; means for effecting extension and retraction of said piston; airfoil lift-producing means operatively connected to the cylinder remote end of each piston; said piston having a length so that upon extension of said airfoil lifting means are positioned outwardly of the peripheral spacing opening beyond said fuselage, and upon retraction, are received inwardly of the peripheral spacing opening between said fuselage upper and lower confronting walls; a pair of diametrically opposed sleeves connected to and extending radially outwardly of said bearing means in circumferentially spaced relationship with said fluid cylinders; a support arm received within each sleeve; means for effecting extension and retraction of said support arm within said sleeve; propulsion means mounted on the sleeve remote end of said support arms for effecting rotation of said airfoil lift-producing means; each of said support arms having a length so that upon extension said propulsion means are positioned outwardly of the peripheral opening of said spacing beyond said fuselage and, upon retraction, are received within said spacing between said fuselage confronting walls.

2. An aircraft as defined in claim **1**, and further characterized by said confronting walls of said upper and lower fuselage portions having a diameter substantially three times the distance between the wall of said lower fuselage portion and the uppermost point of said upper fuselage portion.

United States Patent

[11] 3,612,445

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[21] Appl. No. 773,462
[22] Filed Nov. 5, 1968
[45] Patented Oct. 12, 1971

[54] **LIFT ACTUATOR DISC**
11 Claims, 3 Drawing Figs.

[52] U.S. Cl. 244/12 C, 244/23 C
[51] Int. Cl. B64c 29/00
[50] Field of Search 244/12 C, 23 C

[56] **References Cited**

UNITED STATES PATENTS

2,718,364	9/1955	Crabtree	244/12 C
2,927,746	3/1960	Mellen	244/12 C
2,947,496	8/1960	Leggett	244/12 C

Primary Examiner—Milton Buchler
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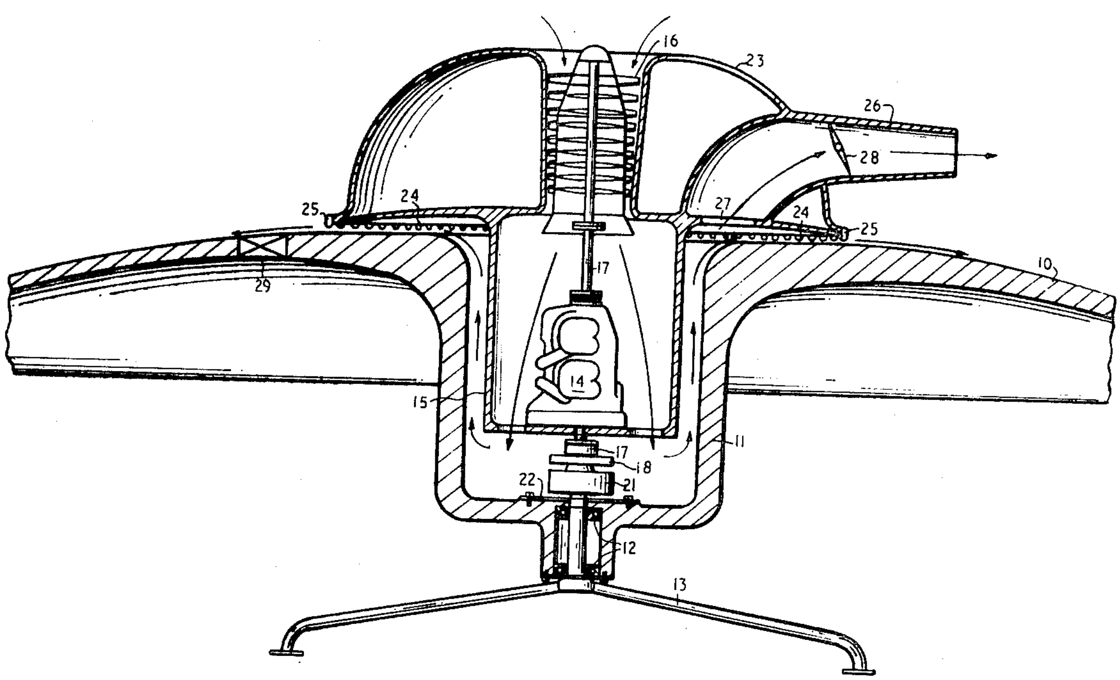
ABSTRACT: A machine such as an aircraft in which lift is produced by directing a fluid such as air in a radial direction along the surface of a disc which is rotated about its polar axis.



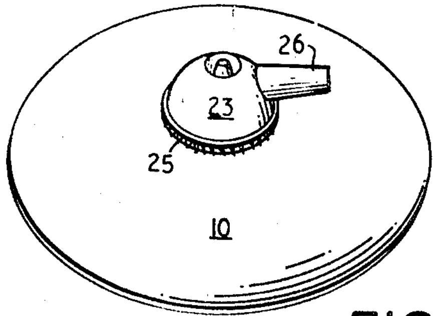


FIG.1

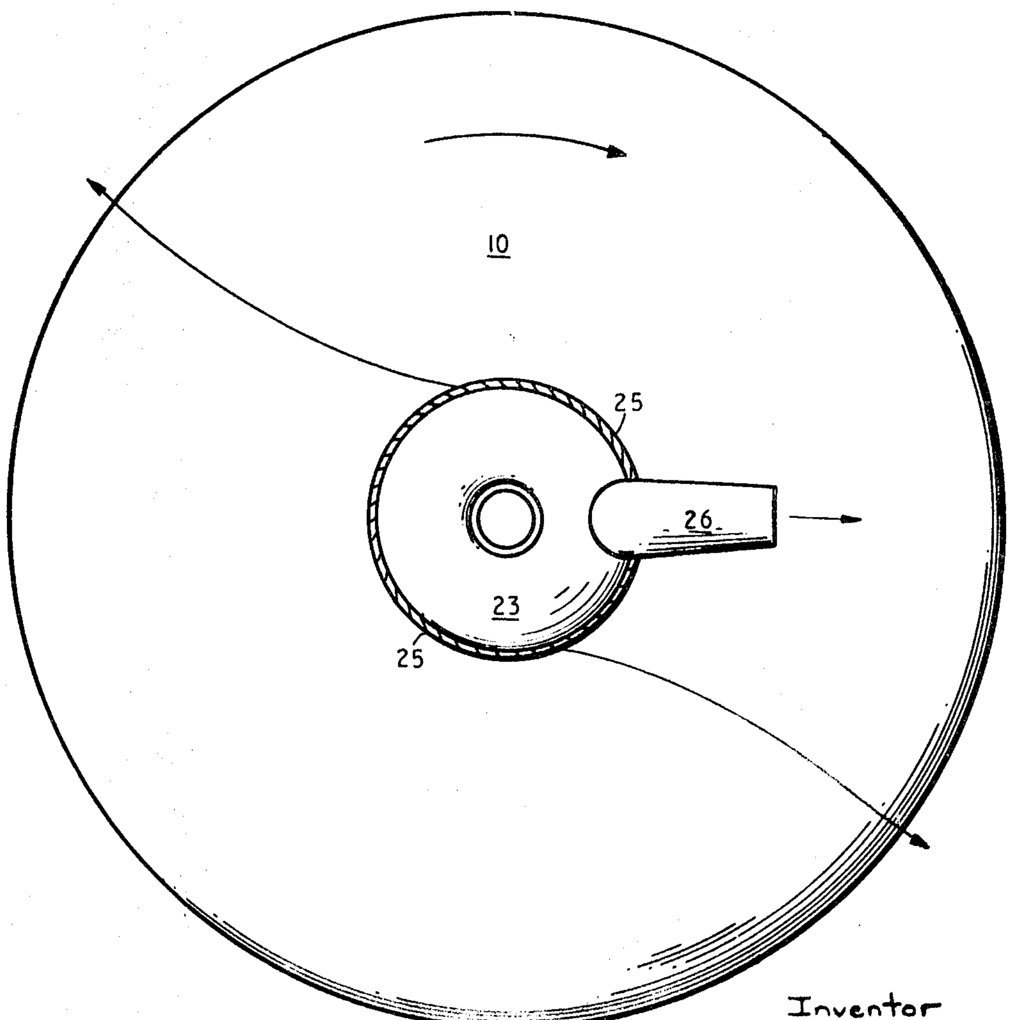


FIG.2

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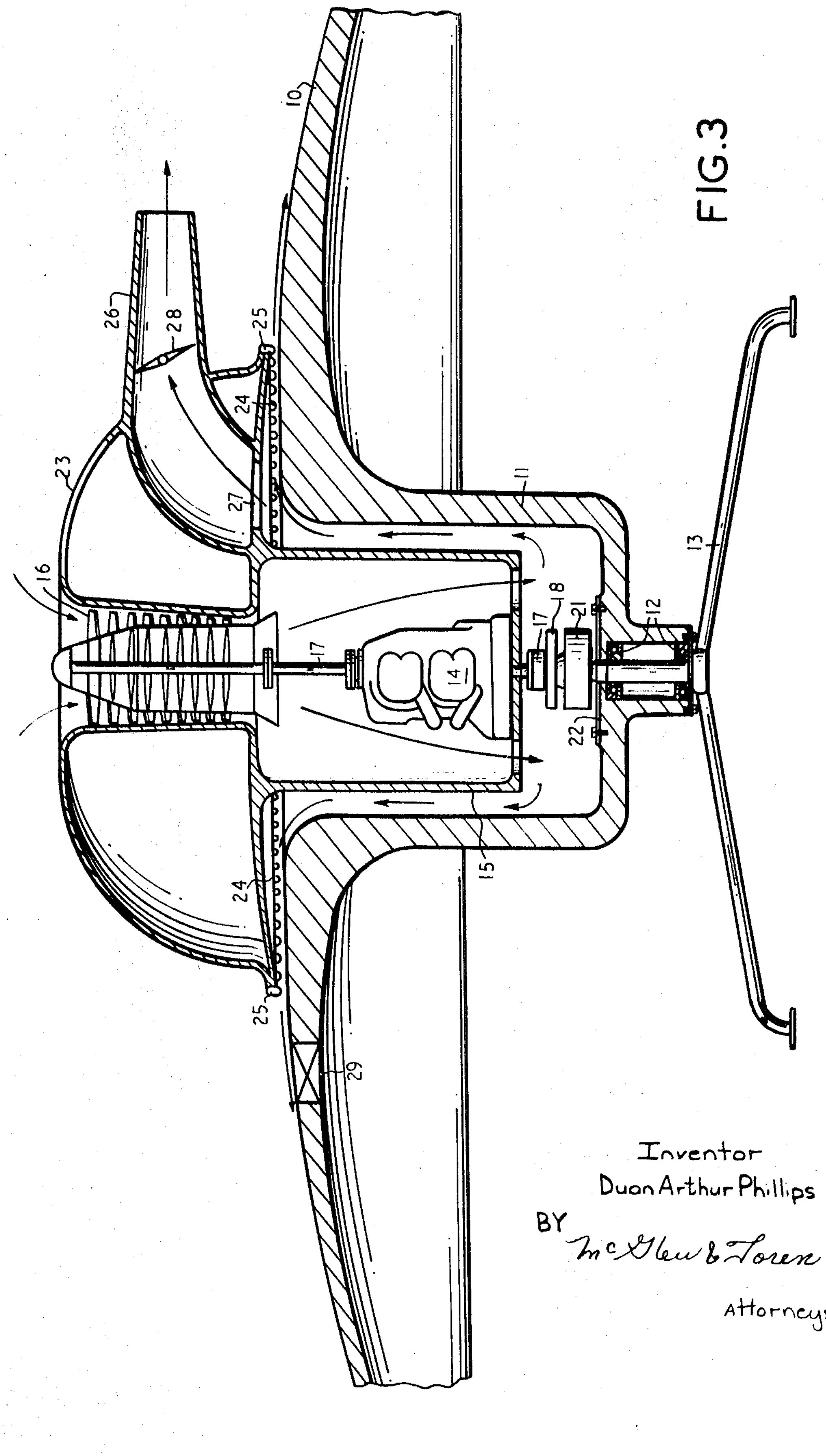

FIG.3

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LIFT ACTUATOR DISC

The present invention relates to a machine capable of deriving lift by the direction of fluid radially along the surface of a disc which is rotated about its polar axis.

While the invention may well be applicable in other fields its principal utility is envisaged in the field of aircraft and for convenience but without limitation of the scope of the invention it will be described as applied to an aircraft.

The invention consists in a machine having a rotatable disc, means to rotate the disc about its polar axis and means to produce a flow of fluid in a radial direction across the surface of the disc whereby a lifting force in the direction of the said polar axis is produced on the disc. In order that the invention may be better understood and put into practice a preferred embodiment of the invention is hereinafter described by way of example with reference to the accompanying drawings in which:

FIG. **1** is a perspective view of an aircraft incorporating the invention,

FIG. **2** is a plan view of the aircraft to a larger scale, and

FIG. **3** is a median sectional elevation of the central portion of the aircraft.

The aircraft shown in the drawings consists of a disc **10** having a convexly curved upper surface and a central well **11** by means of which the disc is rotatably supported on the undercarriage **13** through the bearings **12**.

A powerplant **14** is arranged in the cylindrical compartment **15** and drives an axial compressor **16** through the shaft **17**. The powerplant also rotates the disc **10** through an overrun clutch **17**, a centrifugal clutch **18** and a gear box **21**. A plate **22** connects the drive to the base of the well **11** of the disc **10**.

The compartment **15** supports an annular cabin pod **23** which surrounds the axial compressor **16** and the base of which defines an annular space **24** above the central portion of the disc **10**.

Air from the compressor **16** passes along the paths indicated by the arrows through the space **24** where it is directed in a radially outward direction over the surface of the disc. Vanes **25** are arranged in the airstream and the reaction produced acts to prevent rotation of the cabin pod **23**.

Lift for the aircraft is produced by the interaction of the flow of air from the space **24** and the rapidly rotating disc **10**. The air is picked up along the disc and given an increased velocity radially by virtue of the rotation of the disc giving vectored acceleration to the interfacial air. This results in a low pressure area being formed immediately above the disc and thus the production of lift. The effect is somewhat similar to the Magnus effect.

In order to produce lateral motion of the craft through the air a jet **26** is provided to which a portion of the air flows through the port **27** and is controlled by the butterfly valve **28**. This jet may be replaced by a jet engine or an engine and a propeller. In FIG. 3, the jet **26** is oriented to discharge toward the right side of the figure but control for the purpose of steering may be effected by varying the position of the cabin pod **23** with the jet **26** in respect to its orientation to the disc **10**. This may be readily done by regulating the direction of the exit of the air from the space **24** to the surface of the disc **10** such as with suitable controls (not shown) connected to the vanes **25**.

A hatch **29** is provided in the disc **10** to facilitate access to the cabin pod **23**.

The speed of rotation of the disc and the velocity of airflow over its surface will depend on the size and configuration of the disc and the machine generally.

The present invention is concerned with the general method of producing lift and propelling the machine and constructional and operational details have been included only so far as is necessary for an understanding of the invention.

I claim:

1. An aircraft comprising a rotatable disc having a top surface forming a lifting wing, means to rotate said disc about its polar axis, means near the polar axis of said disc for compressing a fluid, confining means for confining the compressed fluid, inwardly, and guide means on said confining means for

directing the confined fluid in a radial direction across the top exterior of said disc.

2. The aircraft as claimed in claim **1** constructed as an aircraft and wherein the fluid is ambient air.

3. The aircraft as claimed in claim **2**, wherein means are provided for producing a jet directed at an angle to the axis to produce motion through the air.

4. The aircraft as claimed in claim **2**, wherein the surface of the disc over which the fluid flows is curved convexly.

5. The aircraft as claimed in claim **2**, including a cabin arranged at the center of the disc and means for preventing rotation of the cabin including a plurality of vanes against which fluid flowing to the surface of the disc reacts.

6. The aircraft as claimed in claim **2**, wherein the disc is provided with a central well containing a powerplant arranged to rotate the disc and to drive an axial compressor to produce the said flow of fluid.

7. An aircraft comprising a rotatable disc having a top surface forming a lifting wing, a body rotatably supporting said disc, means near the Polar axis of said disc for compressing a fluid, confining means for confining the compressed fluid inwardly, and guide means on said confining means for directing the confined fluid over the surface of said disc, and a motor connected to said disc to rotate said disc about its polar axis to accelerate the confined fluid air moving over the surface and to produce a low pressure above said disc thereby and to impart lift to said aircraft.

8. An aircraft comprising a rotatable disc having a top surface forming a lifting wing, a motor connected to said disc to rotate said disc, a body mounting said motor and rotatably supporting said disc, means for directing air over the surface of said disc while it is rotated to accelerate the air moving over the surface and to produce a low pressure above said disc thereby and to impart lift to said aircraft, said disc having a central well, said body being located in said well, said motor being supported centrally on said body, a cabin pod defined over said motor, an air compressor driven by said motor and drawing air inwardly centrally above said disc and over said motor and for discharging the air over the surface of said disc, said body having vanes directly above the surface of said disc, through which said air is directed, being oriented to maintain a selected position of said body in respect to said disc.

9. An aircraft, according to claim **8**, including a jet nozzle carried on said body and having an inlet located to receive air discharged by said air compressor and to direct it outwardly substantially radially in respect to the axis of said disc but spaced above said disc and oriented in a selected direction dependent upon the position of said body relative to said disc for the purpose of moving said aircraft laterally.

10. An aircraft comprising a rotatable disc having a top surface forming a lifting wing, a motor connected to said disc to rotate said disc, a body mounting said motor and rotatably supporting said disc, means for directing air over the surface of said disc while it is rotated to accelerate the air moving over the surface and to produce a low pressure above said disc thereby and to impart lift to said aircraft, said body being located centrally of said disc, a nozzle member carried by said body having means for directing air outwardly radially in respect to the axis of rotation of said disc, said body including vane means in the path of flow of the air directed over the surface of said disc and being influenced by the air flow for controlling the position of said body relative to said disc and the direction in which the air is directed outwardly from said jet nozzle.

11. An aircraft, according to claim **10**, including an undercarriage having an upright supporting journal, bearing means on said journal rotatably supporting said disc, said body including a closed member rotatably mounted on said journal centrally within a recess of said disc, said body including a peripheral portion extending over the surface of said disc and being spaced slightly thereabove and having vane means thereon, said means for directing air over the surface of said disc directing the air through said vanes for controlling the position of said body in respect to said disc.

United States Patent

[11] 3,614,030

[72] Inventor Paul S. Moller,
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[21] Appl. No. 883,980
[22] Filed Dec. 10, 1969
[45] Patented Oct. 19, 1971

[54] **AIRCRAFT**
3 Claims, 5 Drawing Figs.

[52] U.S. Cl. .... 244/23 C
[51] Int. Cl. B64c 29/04
[50] Field of Search 244/12, 23

[56] **References Cited**

UNITED STATES PATENTS

3,082,977	3/1963	Arlin	244/12 C
3,161,374	12/1964	Allred et al.	244/12 B
3,432,120	3/1969	Guerrero	244/93
3,241,771	3/1966	Erwin	239/265.25

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Assistant Examiner—Steven W. Weinrieb
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ABSTRACT: A disclike aircraft body is substantially a figure of revolution about a main axis and has a plurality of air ducts extending through the body in a direction parallel to said axis, the ducts being arranged in arcuate series except in the foremost and rearmost positions. Each of the ducts has individually controlled means for inducing airflow downwardly therethrough such as a fan rotating on an airflow axis parallel to the main axis or a thrust augmentor supplied with pressure gas from a common source. Downstream of the inducing means is an individually controlled rotary member movable about the airflow axis and having deflectors movable about transverse axes to govern the discharge of air from the ducts.

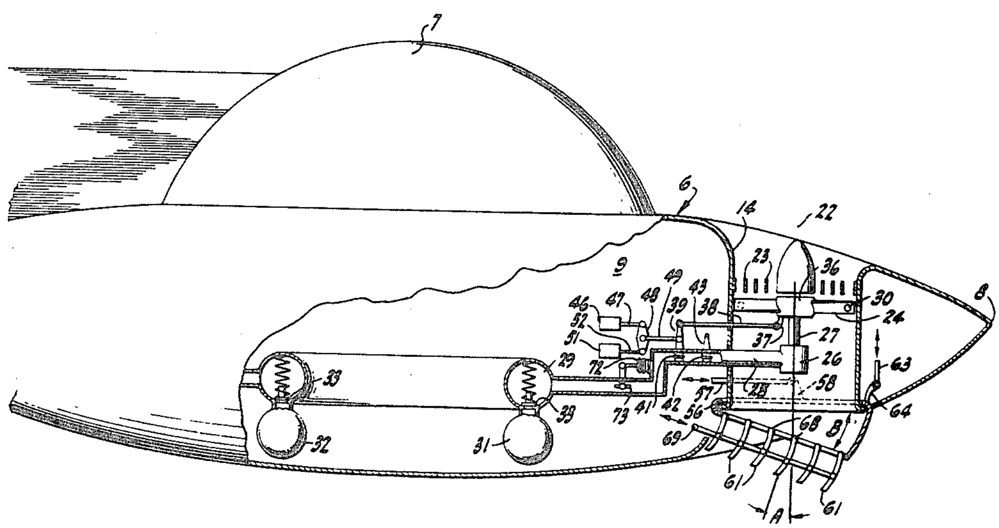
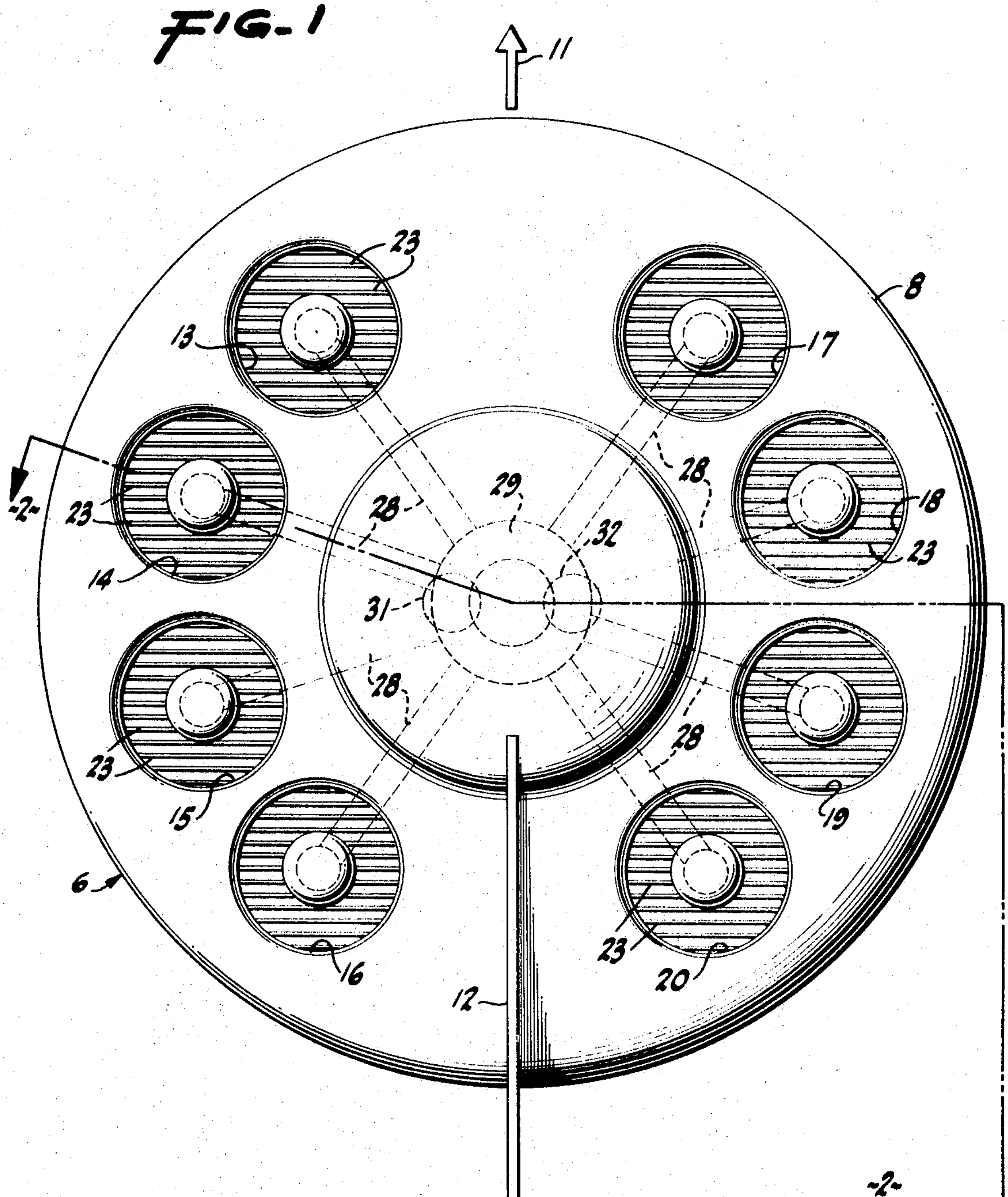


FIG-1



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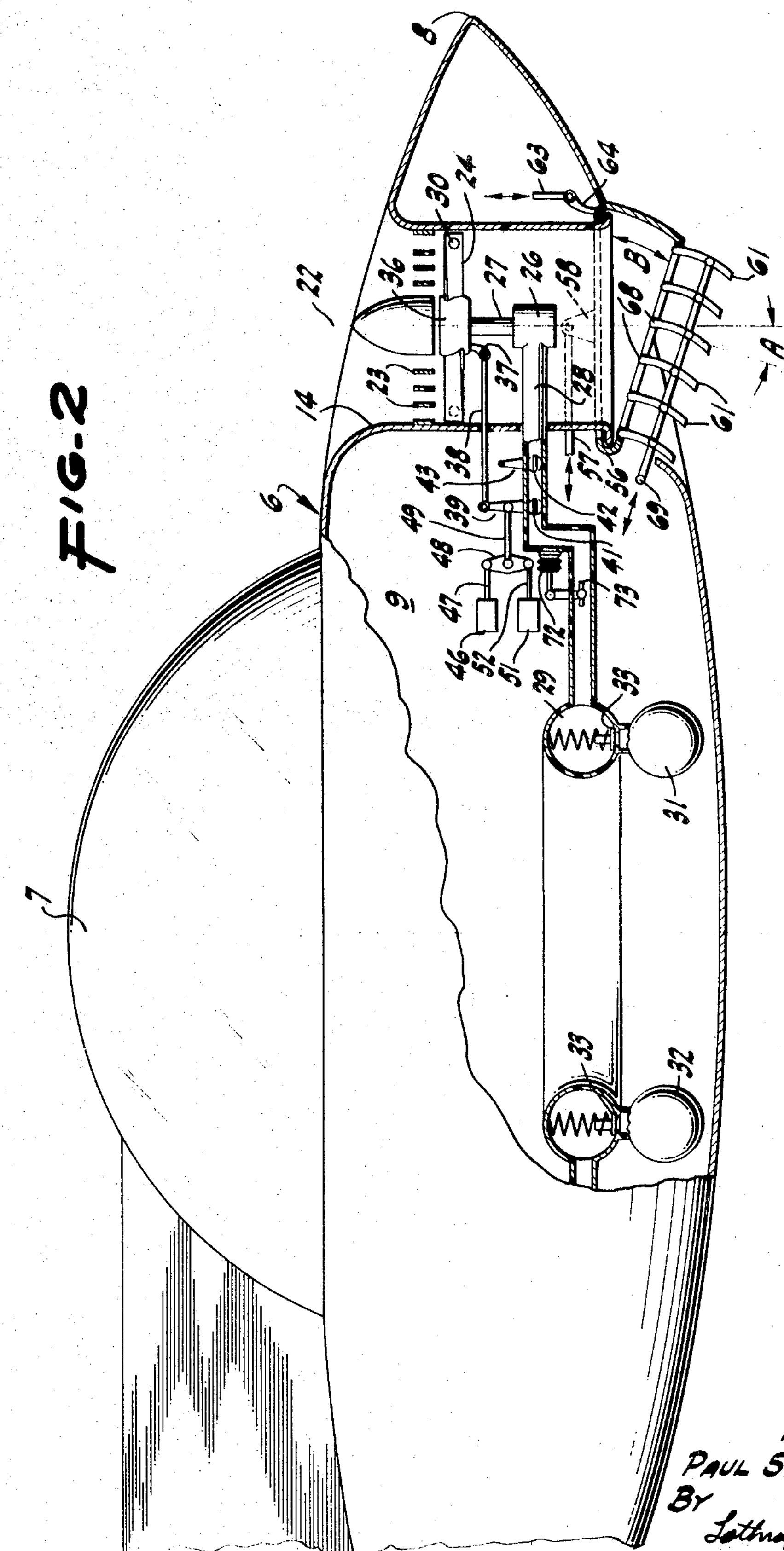

FIG-2

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FIG-3

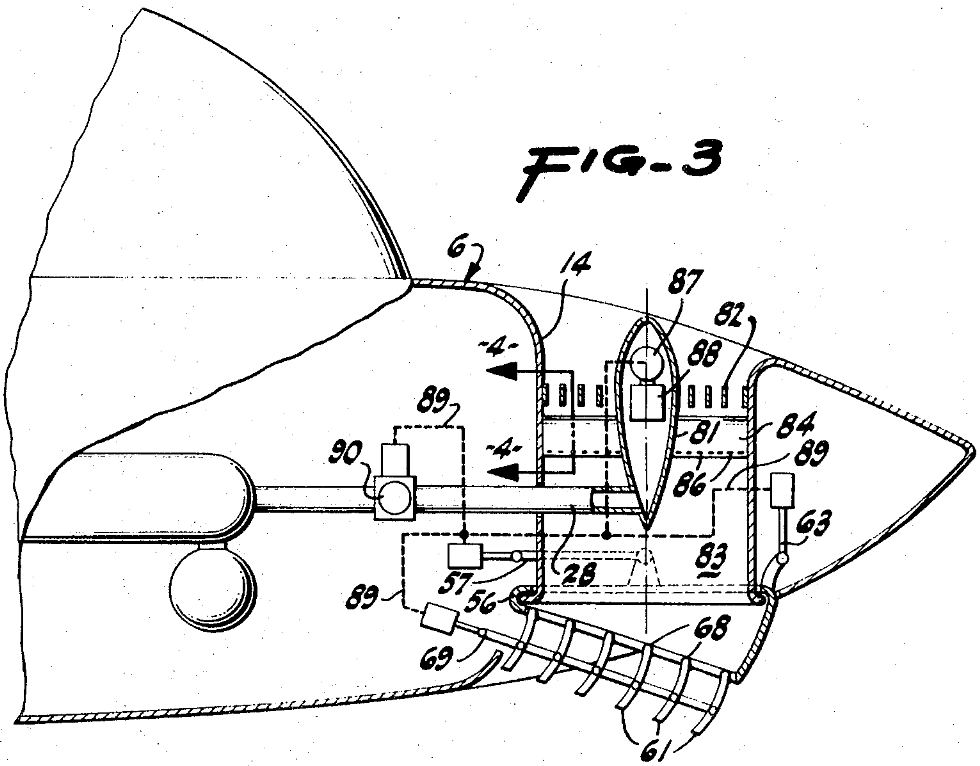
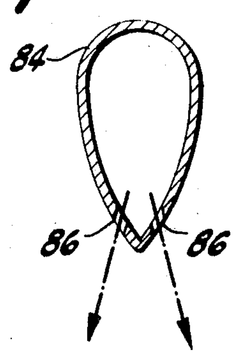


FIG-4



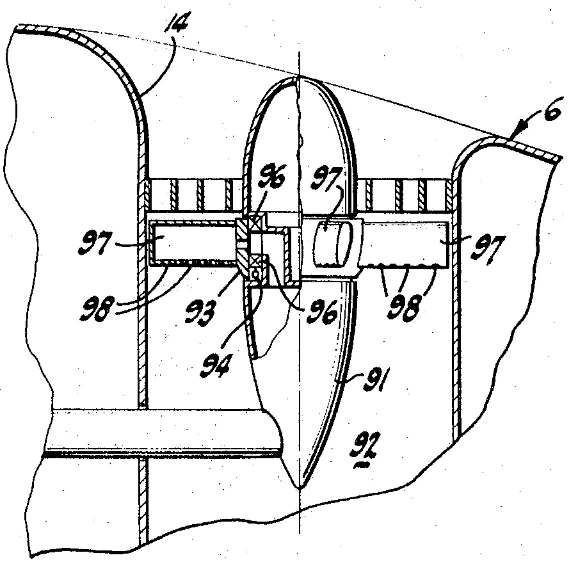


FIG-5

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AIRCRAFT

There is always need for an aircraft which is particularly suitable for certain characters of work, particularly in the relatively light field in which a vehicle is especially adapted to carry payloads around 1,000 pounds and have an air speed around 300 miles per hour. It is likewise a desideratum to afford such a vehicle which is stable, is easily controlled, has high efficiency, and is so constructed as to be safe.

It is therefore an object of the invention to provide an aircraft with the foregoing characteristics and advantages as well as certain others.

Another object of the invention is to provide an aircraft related to the aircraft shown in my U.S. Pat. No. 3,410,507, issued Nov. 12, 1968.

Another object is in general to improve aircraft.

The foregoing and other objects are attained in the invention embodiments described in the accompanying description and illustrated in the accompanying drawings, in which:

FIG. 1 is a diagrammatic plan of an aircraft embodied pursuant to the invention;

FIG. 2 is a diagrammatic, symmetrical cross section, the plane of section being indicated by the line 2—2 of FIG. 1 and having parts broken away for size reduction;

FIG. 3 is a partial cross-sectional view, like FIG. 2, showing diagrammatically an aircraft modified to use thrust augmentors; and

FIG. 4 is a cross section, the plane of which is indicated by the line 4—4 of FIG. 3.

FIG. 5 is a side elevation, portions being broken away of a modified form of thrust augmentor.

While there are many variants possible in embodying the present invention, my present preference is to construct an aircraft substantially in accordance with the particular embodiments disclosed herein.

In this instance the aircraft includes a main body 6 formed as a figure of revolution about a generally vertical main axis 7. The body is a somewhat flattened disc having a rim 8 and a generally hollow interior 9 in which machinery is installed and in which the passengers and other load are housed.

The shape involved is capable of operating at various attitudes and in all directions from the axis 7. For the most part the aircraft is intended to travel in a forward direction as indicated by the arrow 11 of FIG. 1 and so the body is provided with a fore and aft fin member 12 for yaw stability and control.

Pursuant to the invention the disc is provided with a generally circular array of air ducts 13, 14, 15 and 16 on one side and 17, 18, 19 and 20 on the other side. The ducts extend entirely through the disc body 6, each on its individual one of a number of airflow axes 22, all of which are parallel to the main axis 7. The ducts are arranged adjacent to each other in a circle except that in the forward and rearward portions of the body there is left an uninterrupted body area in order to allow for adequate air movement into the base region to prevent aerodynamic base drag. Since the vehicle relies upon air propelled downwardly through the various air ducts and issuing therefrom in the form of jets, I often refer to this aircraft as a "discojet" since it is of a discoid configuration and relies upon jets for its lift.

In the usual construction, all of the ducts are substantially the same in their functioning and mode of operation, and a description of one is intended to apply equally to all of the others.

Since airflow is into the duct 14, for example, (FIG. 1 and FIG. 2) from the top, there is a corresponding opening in the shell of the body 6. The opening is almost immediately screened by entrance vanes 23 acting not only as air guides but likewise as a mechanical barrier to the entry of large foreign material.

Means are provided to induce air to flow downwardly through the ducts. As shown in FIGS. 1 and 2, each duct has mounted therein a propeller 24 or fan designed to rotate around the axis 22 beneath the vane 23. The fan 24 is supported to revolve generally about the axis 22. Each fan is provided with its own drive motor 26 operated by pressure gas and connected to the fan through an axial shaft 27. The drive motor 26 is diagrammatically illustrated and represents any one of various different forms of driving mechanism. Alternatively, the drive motor 26 can be replaced by tip turbines 30 at the ends of the fan blades, the tip turbines being supplied with the pressure gas that otherwise would supply the motor 26.

In the present instance it is preferred that the motor 26 be operated by hot gas received through a pipe 28. For safety and for other operating reasons the individual motors have individual pipes 28, but each pipe extends to and connects with a generally annular plenum chamber 29 in turn connected to a plurality of hot gas sources 31 and 32. The precise nature of the source of propulsive force is subject to engineering selection and the hot gas generators 31 and 32 are utilized primarily as examples. The arrangement is such that while normally both (or all, if there are more than two) of the gas generators 31 and 32 operate at once and are effective to supply all of the various motors 26, it is still possible for the vehicle to operate if one or a few of the gas motors or generators are disabled. Should that occur, it is desirable to prevent adverse or backflow from the active gas generator or generators into the inactive one. For that reason between each of the gas generators and the plenum there is provided a check valve 33. This is pressure actuated and effectively isolates its own gas generator in the event there is a failure therein.

The plenum 29 is large enough so that all of the pipes 28 are well supplied from the gas generators, the main point being to assure an adequate supply of motive fluid even under adverse conditions.

In the preferred operation, the gas generators supply all of the motors 26 so that all of the fans or propellers 24 operate at substantially the same speed and preferably all in the same direction of rotation. Because of the large number of individual fans or propellers and the distribution of the various pipes with respect to the body, there is not only provided a lift center substantially on the axis 7, but also the amount of angular momentum derived from the operation of all of the fans in one direction is sufficient to provide gyrostabilization. This by itself may be the simplest manner in which to afford sufficient stability of the vehicle, but I contemplate additional or alternative means for this purpose.

For example, the fan 24 may not be mounted directly on the shaft 27 but instead may have a gimbal mounting 36 with respect thereto. Thus, the axis of rotation of the fan can depart by a matter of a few degrees, say 2° or 4° from the axis 22 of the duct. The fan is free to rock to this limited extent in response to various motions of the body 6 in the air. The gimbal motion between the fan and its surroundings is utilized to actuate additional controls for stability.

For one instance, the tilting of the fan is communicated by a connecting lever 37 to a rod 38 which, through an intermediate lever 39, actuates a throttle 41 in the pipe 28 leading to the fan motor 26. When the fan 24 is not in its normal position; that is, does not have its plane of rotation normal to the axis 22, then there is corresponding throttling in the pipe 28, and the motor 26 and the fan 24 are slowed. The throttling effect occurs in each individual pipe in accordance with the response of each individual fan to local disturbing forces. The throttling of an individual pipe slows its own individual fan and results in a redistribution of the hot gases in the plenum 29 so that the other corresponding motors are maintained at speed or may even be increased in speed. This tends to compensate for unwarranted local excursions from the desired attitude of the craft.

Also in the pipe 28 is a shutoff valve 42 controlled by an operator 43 so that, if desired, the motor 26 can be throttled back or can actually be shut down. This is not an automatic control function but is a means for reducing the number of motors and fans in operation.

In addition to the control which is afforded by the gimbal-mounted or rockable fan I provide a trim control 46 which can be manually set to any desired position for relatively long term operation and to afford compensation for any unusual long term undesired attitude of the craft. The control 46 is connected by a rod 47 to a balance lever 48 joined at its center by a rod 49 to the lever 39. The operation of the trim control 46 effects a tilting of the fan 24 with respect to its duct and thus provides a correcting component to the attitude of the craft. There can be individual controls such as 46 for each of the fans or adjacent fans can be coupled with a similar control.

In addition to the relatively long term trim control 46, I also provide a relatively short term trim control 51. This is joined by a rod 52 to the other end of the balance lever 48 and can independently introduce an attitude correction through the fan 24. Preferably the manual controller for the long term trim control 46 is an adjustable wheel or the like, whereas the short term trim controller 51 can be connected conveniently to thumb buttons on the control stick for the entire craft. The operator by moving his thumb fore and aft can influence the short term controls related to the fans in the ducts 13 and 16 on one side and 17 and 20 on the other, for example. By moving his thumb sideways he can actuate similar controls connected to the fans 14 and 15 on one side and 18 and 19 on the other. In this way the operator can introduce and remove instantaneous correctional thrust vectors from the individual fans.

As an additional control of the jet issuing from each duct, I provide at the lower end of the duct an adapter 56 in the nature of a ring which can be rotated around the axis 22 by means of a control rod 57 joined to an upstanding anchor 58 on one portion of the adapter 56. This rod 57 is for the purpose of producing rotation of the adapter 56 about the axis 22 as a center so that a number of diametrically extending parallel vanes 61 can be oriented in any direction desired. In this fashion the craft can be directed forwardly, rearwardly or laterally in either direction. In fact, the control is preferably such that some of the adapters 56 can be directed together in one direction whereas others can be directed in somewhat different directions. For example, at low speeds it is usually arranged that the ducts 14 and 15 on one side and 18 and 19 on the other side are directed substantially backward or aft, and then at high speeds all of the adapters are directed aft so that all of the jets cooperate to propel the craft in the forward direction. At low speeds the adapters not oriented for forward propulsion may be turned slightly to assist in correcting for yaw or for producing maneuvering deviations from a normal straight flight path.

The adapter 56 is additionally provided with a control rod 63 connected to an anchor 64 on the adapter, so that by moving the rod 63 up and down the adapter can be rocked about the interconnection of a flange 66 at the bottom of the duct and an encompassing rim 67 on the adapter. As shown in FIG. 2, the adapter is in a lower position so that the upper ends of all of the vanes 61 lie in the plane making an angle B with the plane at the bottom of the duct and normal to the axes 22 and 7. As the rod 63 is raised and lowered the effective cross section of discharge of the jet is varied from its maximum amount when the angle B is zero to its minimum amount when the angle B is as shown in FIG. 2. Since a maximum jet downward thrust is required for lift, especially initial lift, the maximum cross-sectional area of efflux is then employed by having the angle B zero. On the contrary, for forward flight a considerably less area of efflux is desirable. Then the angle B is made maximum or some large fraction of maximum, so that there is not only a downward but also a rearward component, and so that the area of efflux is considerably less than maximum.

The vanes 61 are in part flexible but at their upstream ends 68 are fixed to the adapter 56. The flexible downstream vane ends are moved jointly by a control rod 69 movable to and fro. The vanes can be flexed at their trailing ends with respect to the adapter. Since the vanes can be so flexed relative to their fixed ends 68, they can be bent through various angles A as measured between the axis 22 and the general plane of the vane. In this way, by having the two control rods 63 and 69 it is possible to vary the area of the outlet of the duct and also independently to vary the discharge direction of the vanes. The flexed direction of the vanes 61 is important in altering the direction of efflux of the air. Thus by rotating the adapter 56 through the rod 57, by rocking the adapter 56 by moving the rod 63 up and down, and by changing the flex angle of the vanes 61 by moving the rod 69 to and fro, it is possible to provide an optimum discharge from each duct and to control the direction of such efflux and its quantity in order to govern the operation of the vehicle.

As a matter of additional safety, in the event one of the motors 26 should fail and should release large quantities of hot gas to the atmosphere or should a pipe 28 similarly fail, I preferably provide in each one of the pipes 28 a pressure-responsive cell 72 connected to a damper 73 in the duct adjacent the plenum 29. The cell 72 is effective when the pressure within the pipe between the plenum and the motor drops abruptly to close the damper 73 and prevent loss of propulsion gas. Because of the relatively large number of engines, the loss of one is not unduly serious because the propulsive gas which normally would go to it is distributed to the remaining engines and causes them to operate to a somewhat greater effect.

Instead of using propellors or fans as means for inducing airflow through the ducts, I can alternatively use thrust augmentors as shown in FIGS. 3 and 4. In this instance the construction of the aircraft, unless specially noted, is the same as previously described. In each of the ducts, such as 14, however, there is provided a streamlined chamber 81 coaxially mounted and having a grid 82, such as a honeycomb, spanning the annular channel 83 between the body 6 and the chamber 81. Just beneath the grid 82 is an array of radially disposed pressure gas nozzles 84. These are all alike and each is a hollow streamlined body having one or more series of jet discharge apertures 86 along or near its lower edge. Each of the nozzles 84 in a particular group is connected to the supply pipe 28 extending to the plenum 29 as a source of pressure gas. The issuance of the numerous gas jets downwardly from the nozzles 84 induces a related downflow of atmospheric air through the duct 14 and in a simple and efficient way affords lift for the vehicle.

Since one of the main aims of the invention is to provide excellent stability and control, it is arranged that the nozzles 84 in any one duct be controlled as an individual group. For example, a number of control gyros 87 can be provided each one being disposed adjacent its respective one of the ducts such as 14. The gyros 87 are duplicates and each is driven by its own electric motor 88 to afford a highly redundant system. Each gyro 87 through a path 89 exerts control of a flow valve 90 in the pipe 28 to vary the amount of pressure gas supplied to the adjacent nozzles 84 and so controls the resulting amount of thrust. Also, if desired, the control path 89 can be extended to the rods 57 and 63 as well as to the control rod 69. Thus deviations from the set or desired conditions at each of the ducts, such as 14, is effective upon the local gyro 87 to provide appropriate and unique compensation.

The thrust augmentors of FIGS. 3 and 4 can be modified, as shown in FIG. 5, for improved results in many cases. Each duct 14 has a chamber 91 fixed therein and defining an annular channel 92 between the chamber and the body 6. A nozzle ring 93 is mounted to rotate on the chamber 91 by means of a bearing 94 and is closed by seals 96. The supply pipe 28 opens into the chamber 91 and gas flows from the chamber through openings in the ring into hollow pressure gas nozzles 97. The nozzles are inclined so that when gas issues from discharge apertures 98 therein, the nozzles and ring are rotated.

It will be appreciated that since there is a large number of individually operable jet airstreams through the body of the craft, and since each one of the jet streams can be variously controlled, directed and regulated, it is possible to provide an extremely safe and versatile control for the craft. It will also be appreciated that these controls can be interrelated in various different ways, some of the controls being paired, some being individually operable, and some being combined in larger numbers. It is even possible to provide a programmer for virtually all of the controls except for the manual override retained by the operator.

What is claimed is:

1. An aircraft comprising a disclike body that is substantially a figure of revolution about a main axis, a plurality of air ducts extending through said body in a direction parallel to said axis, said ducts being arranged in an arcuate series, a plurality of airflow-inducing means, means for mounting each of said inducing means in a respective one of said ducts for rotation about an airflow axis parallel to said main axis, and in which each of said airflow-inducing means includes a fan connected to power-driving means, means mounting said fan in gimbals to swing freely through a limited range relative to said body, and means responsive to the swinging movement of said fan relative to said body for controlling said power driving means, a plurality of rotary members, means for mounting each of said members on a respective one of said ducts downstream of said inducing means therein and for rotation about said airflow axis, parallel deflector vanes extending transversely of each of said rotary members, and means for deflecting said deflector vanes.

2. An aircraft as in claim 1 in which each of said airflow-inducing means is movable independently of the other airflow-inducing means.

3. An aircraft as in claim 1 including means associated individually with each one of said airflow-inducing means and responsive to shifting of the axis thereof in one plane out of parallelism with said main axis for controlling operation of said one of said airflow-inducing means.

United States Patent

[11] 3,630,470

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[21] Appl. No. 11,066
[22] Filed Feb. 13, 1970
[45] Patented Dec. 28, 1971

[54] VERTICAL TAKEOFF AND LANDING VEHICLE
10 Claims, 5 Drawing Figs.

[52] U.S. Cl. .... 244/21, 244/12 C, 244/23 C
[51] Int. Cl. B64c 27/00
[50] Field of Search 244/10, 19, 21, 12, 23, 42.50

[56] **References Cited**

UNITED STATES PATENTS

1,432,787	10/1922	Reyes	244/12
2,417,358	3/1947	Grose	244/21
3,071,334	1/1963	Barnes	244/23

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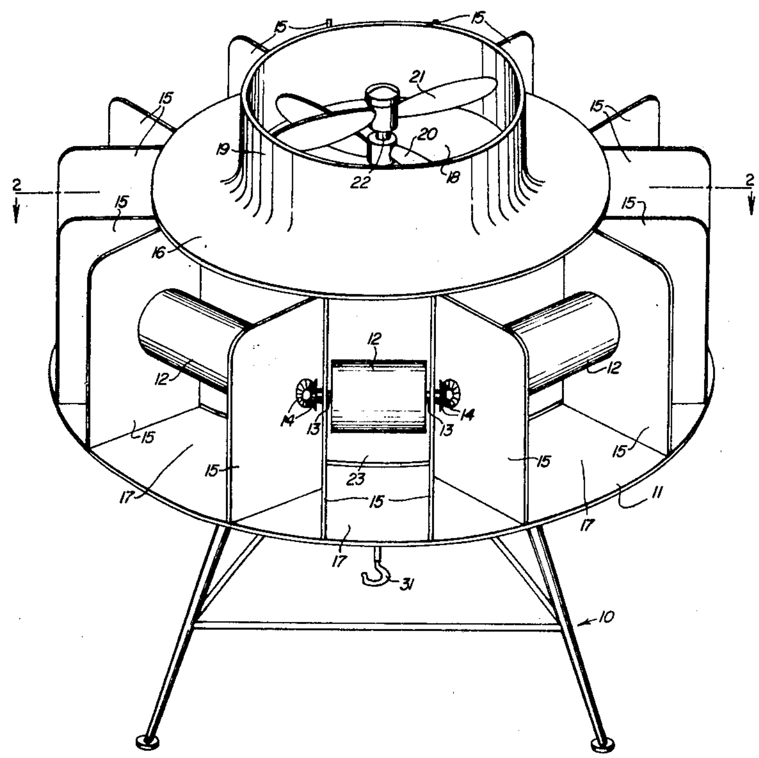
ABSTRACT: A vertical takeoff and landing vehicle utilizing the Magnus effect to lift the vehicle vertically through a fluid medium, usually air but conceivably other gaseous atmospheres as well as water. A plurality of horizontal, rotatable cylinders are arranged, preferably in opposite pairs, about the surface of a normally horizontal support member near the perimeter thereof. Drive means are provided for rotating the cylinders simultaneously in an upward and outward direction toward the periphery of the support member. A cover member is disposed above the cylinders to define a plenum chamber therewith. The cover member has a center aperture provided with means to draw a stream of fluid into the plenum chamber and force it laterally across the upper and lower surfaces of the rotating cylinders. If desired, drive means can be provided for moving the vehicle in a lateral direction.



Patented Dec. 28, 1971 3,630,470

2 Sheets-Sheet 1

FIG. 1.

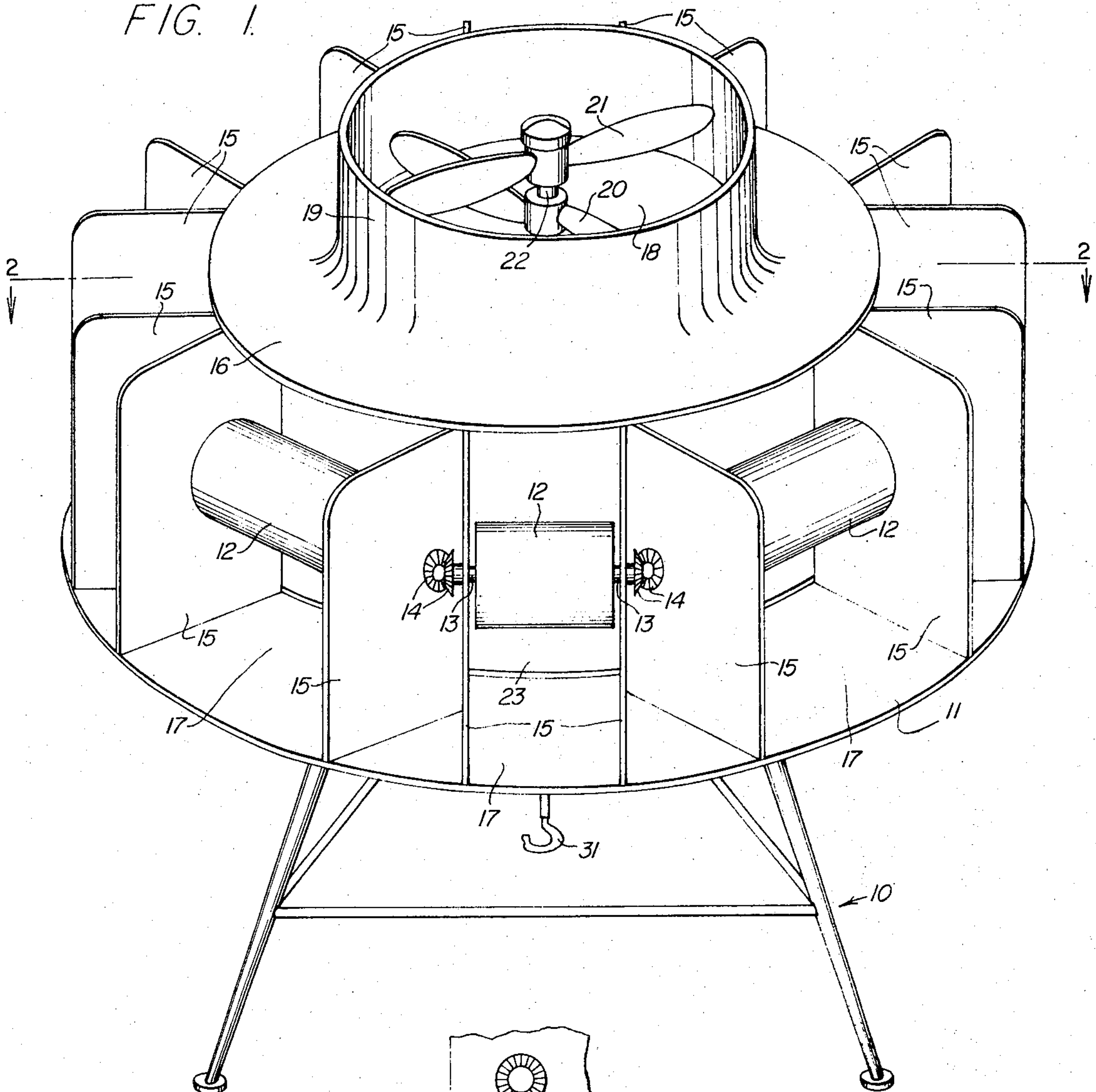
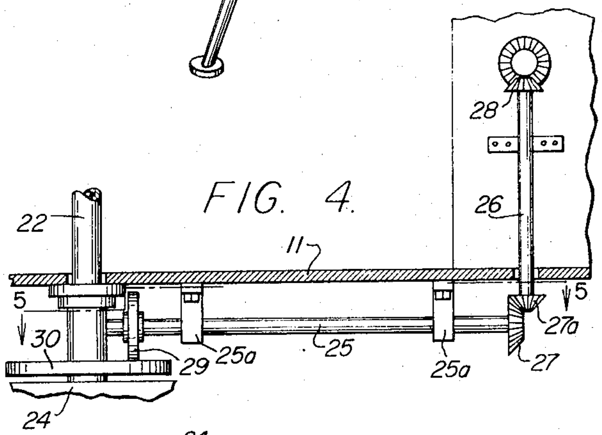


FIG. 4.



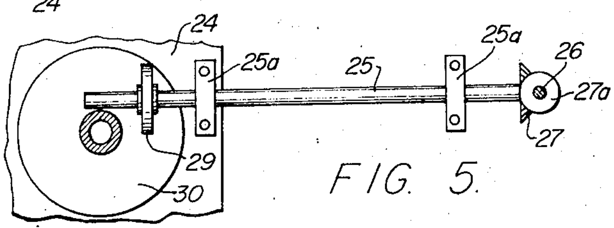


FIG. 5.

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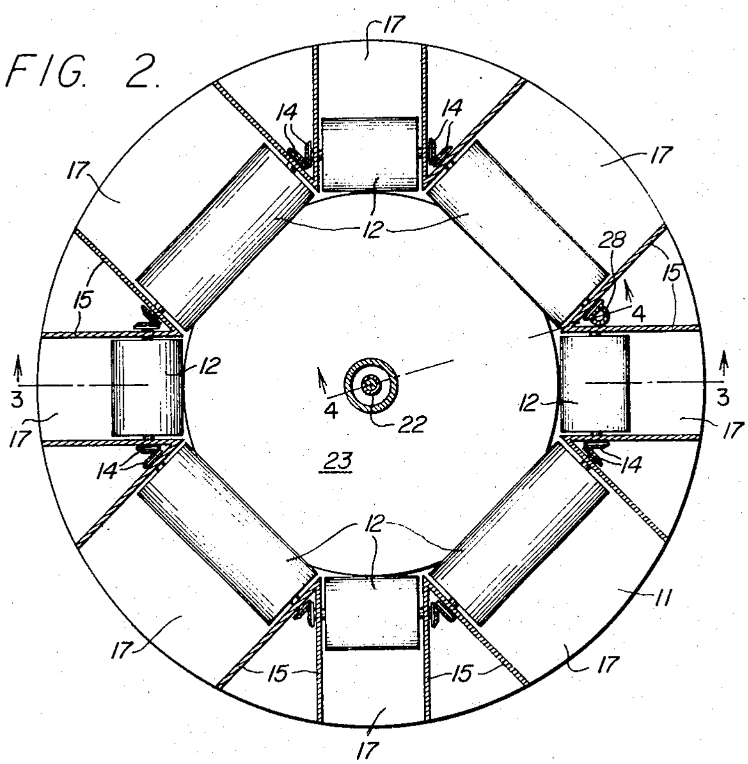

FIG. 2.

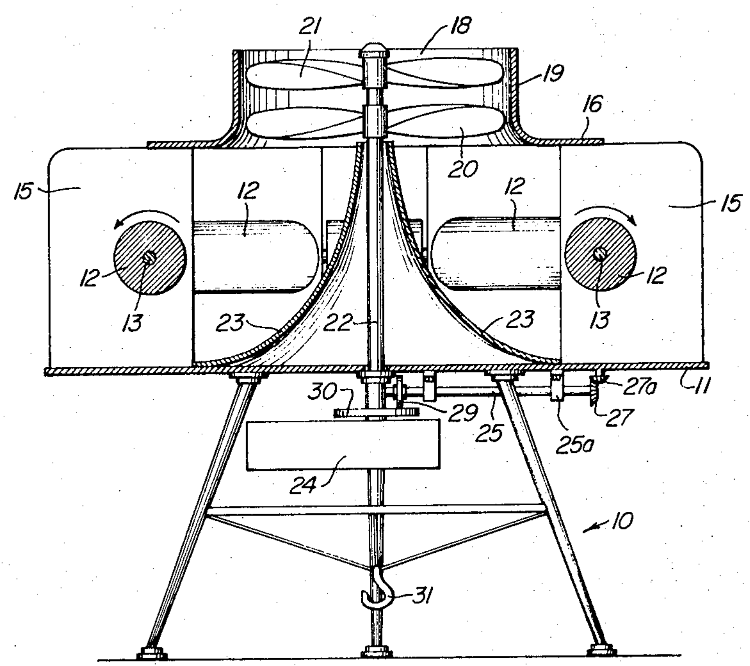

FIG. 3.

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VERTICAL TAKEOFF AND LANDING VEHICLE

BACKGROUND OF THE INVENTION

1. Field

This invention relates to vehicles for vertical takeoff and landing utilizing the Magnus effect in a fluid medium.

2. State of the Art

The Magnus effect is based upon the observation that a lateral fluid flow, such as an air current, striking a rotating horizontal cylinder causes a buoyant or lifting effect on the cylinder. The buoyant effect is due to reduction of pressure on the upper portion of the rotating cylinder by reason of an increase in the velocity of the airstream flowing over such upper portion when the skin convection current thereover is in the same direction as the airstream. The velocity of the airstream flowing along the underside of the rotating cylinder is correspondingly less, since the underside skin convection current is in opposition to such airstream. The net effect is a reduced pressure on the upper portion of the cylinder.

Numerous attempts have been made to utilize this principle in propelling aircraft and marine vehicles. Examples have been documented in the following patents: 1,779,054; 1,845,616; 2,065,254; 1,820,919; 2,344,515; and 2,985,406. However, to date no known attempt has been commercially successful.

3. Objectives

It was an objective in the development of this invention to provide a vehicle capable of taking off and landing vertically in a fluid medium, utilizing the Magnus effect for the purpose.

SUMMARY OF THE INVENTION

The vehicle of the invention utilizes the Magnus effect to provide vertical takeoff and landing capability coupled with the ability to hover in a fluid medium, such as air or water, for sustained periods of time. The vehicle includes a plurality of rotatable cylinders mounted on horizontal axes and disposed near the perimeter of a supporting surface which is usually horizontal when in operation. The cylinders are preferably arranged annularly in opposite pairs about the support surface. Drive means are provided for simultaneously rotating the cylinders in an upward and outward direction toward the periphery of the supporting surface. Disposed above the cylinders is a cover member, which completes the enclosure of a plenum chamber between the supporting surface and the cylinders. The member has an aperture at its center, which accommodates means for drawing a stream of the fluid medium downwardly into the plenum chamber and laterally across the upper and lower surfaces of the cylinders. This creates a reduced pressure on the upper surfaces of the cylinders and causes a lifting effect on the vehicle. By varying the relative velocities of rotation of the cylinders and of the incoming fluid medium, the vehicle can be made to rise vertically and hover for an indefinite period of time.

It is preferred to provide a downwardly and outwardly diverging member at the center of the supporting surface to divert the incoming fluid stream laterally over the upper and lower surfaces of the cylinders. If desired the vehicle can be provided with drive means for lateral movement of the vehicle in the fluid medium.

DESCRIPTION OF THE DRAWINGS

A construction constituting what is presently regarded as the best mode of carrying out the invention is illustrated in the accompanying drawings, in which:

FIG. 1 is a view in perspective of the vehicle looking from one side thereof;

FIG. 2, a horizontal section taken along the line 2—2 of FIG. 1;

FIG. 3, a vertical axial section taken along the line 3—3 of FIG. 2;

FIG. 4, a fragmentary vertical section taken along the line 4—4 of FIG. 2 to show the drive mechanism; and

FIG. 5, a fragmentary horizontal section taken along the line 5—5 of FIG. 4.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

In the illustrated embodiment, the vehicle is intended to operate in air as the fluid medium. The supporting surface of the vehicle comprises a disc-shaped member 11 which preferably rests in a horizontal position upon a support structure 10. The support structure 10 is illustrated as being in the form of a tripod; however, any other form of support structure can be employed consistent with the type of terrain upon which the apparatus is to be used. For example, if the vehicle is to be used on water, in swamps, snow, or the like, the support structure 10 can be provided with pontoons, oversized wheels, or skiis. The supporting disc 11 can be fabricated of any suitable material, e.g., a light metal, plastic or the like, but the material must be capable of withstanding the pressure of high-velocity airstreams.

Eight rotatable cylinders 12 in this embodiment are mounted on horizontal axes 13 and are disposed in opposite pairs, in end-to-end relationship, annularly about the supporting disc 11. The cylinders 12 preferably have a roughened surface to increase the skin convection current as they rotate simultaneously at the same velocity in an upward and outward direction. The direction of rotation causes the skin convection current to flow from the upper sides of the cylinders 12 toward the periphery of the supporting disc 11. The arrangement of the cylinders in opposite pairs provides stability and balance in the vehicle since each cylinder 12 in a pair rotates counter to the other, i.e., toward the periphery of the disc 11. This creates stabilizing, counterforces to prevent unintentional lateral drift of the vehicle from a true vertical course. There can be any number of cylinders 12 arranged around the perimeter of the supporting disc 11, but they are preferably arranged in opposite pairs to achieve the stabilizing effect. If the vehicle is to be used for lateral travel and is equipped with other means for achieving the lateral movement, the cylinders 12 can be arranged so as to lessen or remove any interference with the lateral travel of the vehicle. For example, the cylinders can be disposed in opposing pairs arranged parallel to the direction of lateral travel. The cylinders 12 are conveniently rotated simultaneously through a series of interconnected beveled gears 14 attached to each end of each cylinder 12 and rotated by a drive mechanism described in detail below.

It has been found advantageous to provide an upright air baffle or partition 15 at each end of each cylinder 12 to channel the incoming airflow directly over the rotating surfaces of the cylinders 12 and to prevent loss of air current over the ends of the cylinders 12.

Disposed above the cylinders 12 and attached to the upper ends of the baffles 15 is a cover member, here shown in the form of a disc 16 which is preferably smaller in diameter than the supporting disc 11 to permit a free flow of air over the upper surface of the cylinders 12 and to reduce the vacuum created on the underside of the cylinders 12. As shown in FIG. 3, the circumference of the covering disc 16 advantageously reaches approximately the outer circumferential edge of the cylinders 12. The space enclosed by the covering disc 16, the supporting disc 11, and the annular arrangement of the rotatable cylinders 12 defines a plenum chamber 17 which contains air under higher pressure than the surrounding atmosphere when the vehicle is in operation.

The cover disc 16 is provided with an annular aperture 18 in the center thereof. A tubular member 19 is preferably attached to the upper edge of the aperture 18 and extends upwardly above the covering disc 16. The tubular member forms a cylindrical channel through which the incoming air is drawn into the plenum chamber 17. As illustrated, a preferred means of drawing a stream of air into the plenum chamber 17 comprises two counterrotating horizontal propellers 20, 21 rotatably mounted within the tubular member 19. Although a single propeller 20 can be used, increased stability and higher airstream velocities are achieved through the utilization of two counterrotating propellers. In the illustrated embodiment, the propellers 20 and 21 are mounted on a vertical shaft 22 which extends downwardly to the drive mechanism disposed below the supporting disc **11**. As a convenient means for changing the direction of the incoming airstream from a downward movement to a laterally directed movement over the surfaces of the cylinders **12**, it is preferred to mount a downwardly and outwardly diverging air guide **23** in the center of the supporting disc **11**. In the illustrated embodiment the air guide **23** is frustoconical in shape and is disposed about shaft **22**.

Power to rotate propellers **20, 21** and cylinders **12** is provided by a drive mechanism which is here shown, FIGS. **4** and **5**, as a motor **24** connected to propellers **20** and **21** by propeller shaft **22**. Power to rotate cylinders **12** is supplied through a lateral drive shaft **25** which is rotatably mounted on the underside of supporting disc **11** by means of brackets **25*a***, and is rotatably connected at one end with a vertical shaft **26** through a pair of beveled gears **27** and **27*a*** attached respectively to shaft **25** and shaft **26**. Vertical shaft **26** transfers power from lateral shaft **25** to beveled gears **14** and cylinders **12** through the beveled gear **28** fixably attached to the upper end of shaft **26**. The lateral drive shaft **25** is connected near its opposite end to motor **24** through a drive disc **29** attached to drive shaft **25**. Drive disc **29** is in frictional contact at its outer circumferential edge with a clutch plate **30** mounted on vertical shaft **22**. Drive disc **29** is adjustable along the length of drive shaft **25** to permit movement of the drive disc **29** across the face of revolving clutch plate **30** to increase or decrease the rotational velocity of cylinders **12**. In this manner, the comparative velocities of propellers **20** and **21** and cylinders **12** can be adjusted to achieve maximum lifting power when desired.

The vehicle can be provided with a downwardly directed hook **31** attached to the support structure **10**, so that the vehicle can be used to lift cargo into the air from virtually any surface.

In addition to its capacity for vertically taking off and landing, the vehicle can be provided with means for lateral movement to permit it to maneuver about in one location or to travel greater distances, such means being any one of the various conventional propulsion means.

I claim:

1. Vertical takeoff and landing vehicle, comprising:

means defining a horizontal surface; a plurality of horizontal, rotatable cylinders disposed about the perimeter of the supporting surface;

drive means for rotating the cylinders simultaneously in an upward and outward direction toward the periphery of the supporting surface;

a cover member disposed above the cylinders, said cover member having an aperture in the center thereof, and forming a plenum chamber with the supporting surface and the cylinders;

means for drawing a fluid stream downwardly through said aperture into the plenum chamber and forcing said stream laterally across the upper and lower rotating surfaces of the cylinders to create a lifting effect on the upper surface of the cylinders.

2. Vertical takeoff and landing vehicle as set forth in claim 1, wherein upwardly extending baffles are disposed at each end of each cylinder perpendicularly of the length of the cylinder.

3. Vertical takeoff and landing vehicle as set forth in claim 1, wherein said means for drawing a fluid stream into the plenum chamber comprise a horizontal, rotatable propeller and means for rotating said propeller.

4. Vertical takeoff and landing vehicle as set forth in claim 3, having two counterrotating propellers.

5. Vertical takeoff and landing vehicle as set forth in claim 3, having a tubular member extending upwardly from, and surrounding, said aperture in the cover member.

6. Vertical takeoff and landing vehicle as set forth in claim 1, having a downwardly and outwardly diverging member disposed in the center of the supporting surface for diverting the incoming fluid stream from downward movement to lateral movement outwardly over the upper and lower surface of the cylinders.

7. Vertical takeoff and landing vehicle as set forth in claim 1, wherein the cylinders are arranged in opposite pairs in end-to-end relationship around the supporting surface.

8. Vertical takeoff and landing vehicle as set forth in claim 1, wherein the perimeter of the cover member extends to approximately the outer periphery of the circumference of the cylinders.

9. Vertical takeoff and landing vehicle as set forth in claim 1, having driving means for lateral movement.

10. Vertical takeoff and landing vehicle as set forth in claim 1, wherein the fluid is air.

* * * * *

United States Patent

Jaeger

[15] **3,640,489**

[45] **Feb. 8, 1972**

[54] **VERTICAL TAKEOFF AND LANDING AIRCRAFT**

[72] Inventor: **Karl Jaeger,** Im Stillen Winkel 21, 43 Essen-Margarethenhohe, Germany

[22] Filed: **July 28, 1969**

[21] Appl. No.: **845,242**

[30] **Foreign Application Priority Data**

July 26, 1968 Germany ....P 17 56 879.5

[52] **U.S. Cl.** ....**244/23 C**

[51] **Int. Cl.** **B64c 29/00**

[58] **Field of Search** 244/12, 23, 3.24; 239/265.35

[56] **References Cited**

UNITED STATES PATENTS

3,238,875	3/1966	Stadler et al.	244/3.24
3,390,899	7/1968	Herbert et al.	239/265.35
3,416,754	12/1968	Pinaire et al.	239/265.35
2,947,496	8/1960	Leggett	244/12
2,990,137	6/1961	Willis	244/12
3,082,977	3/1963	Arlin	244/12
3,162,011	12/1964	Mullins et al.	244/23
3,465,989	9/1969	Bowshier	244/23

Primary Examiner—Trygve M. Blix
Assistant Examiner—Steven W. Weinrich
Attorney—Karl F. Ross

[57] **ABSTRACT**

A vertical takeoff and landing (VTOL) aircraft has a discus-shaped fuselage with a plurality of angularly equispaced lift-generating assemblies. Each assembly comprises a rotor above or flush with the fuselage, a compressor in the fuselage drawing air in from above, and a nozzle below the fuselage for expelling the air from the compressor in a jet. The nozzles can be rotated to point in any direction. Thus, according to the settings of the nozzles, the aircraft can rise or sink vertically and move in any horizontal direction.

7 Claims, 4 Drawing Figures

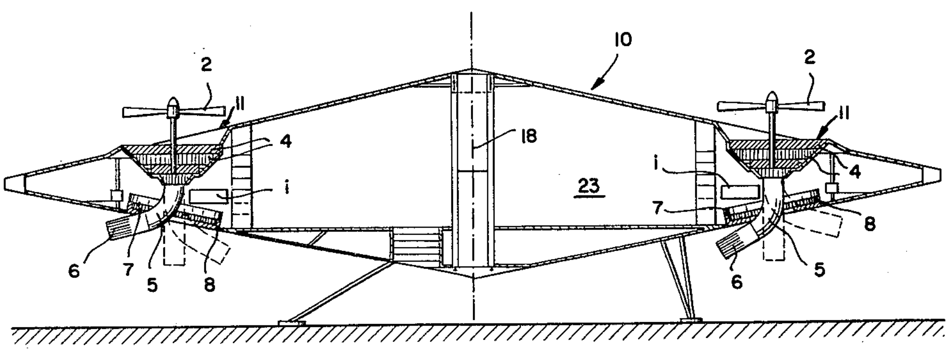


FIG. 4

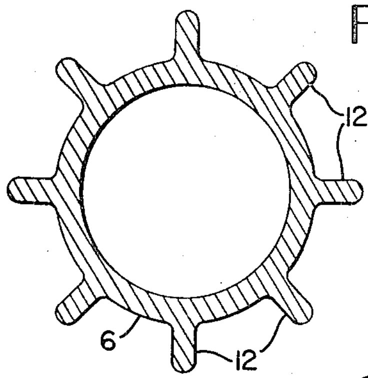
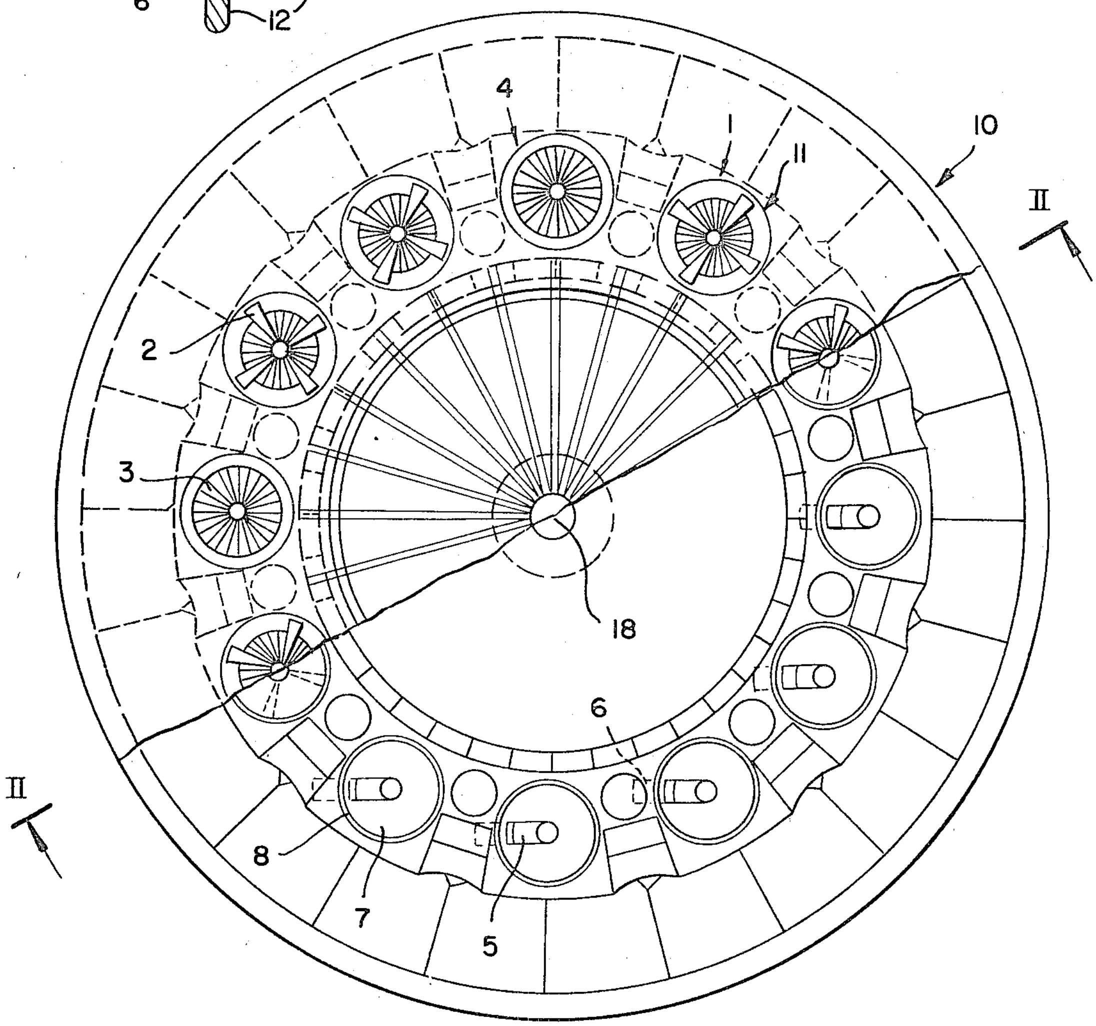


FIG. 1



INVENTOR.
BY KARL JAEGER

Karl F. Ross
ATTORNEY

PATENTED FEB 8 1972 3,640,489

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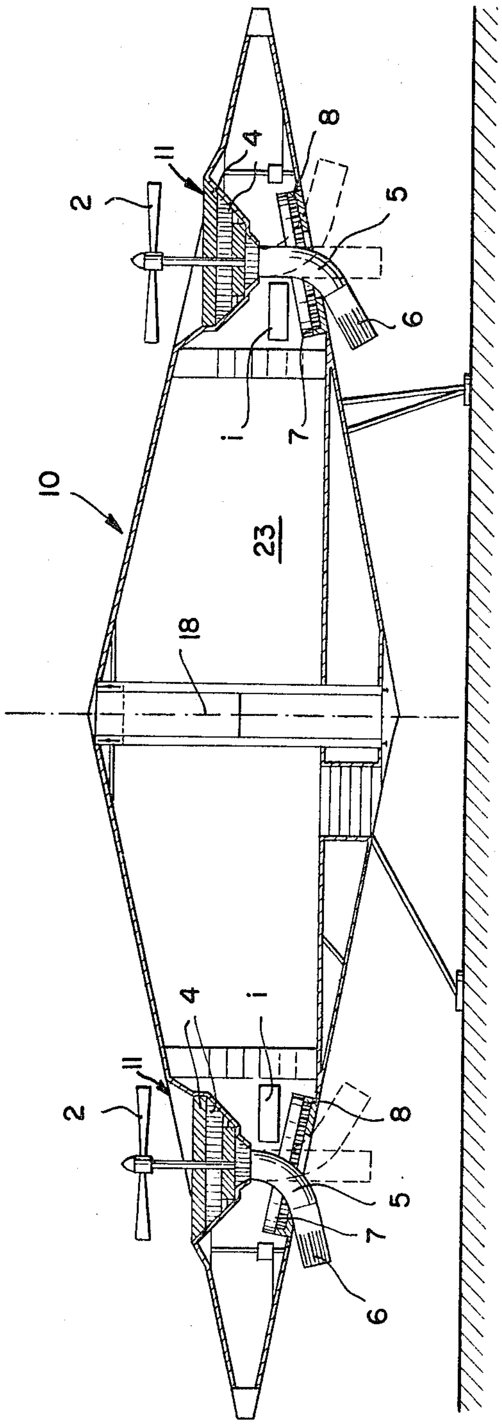

FIG. 2

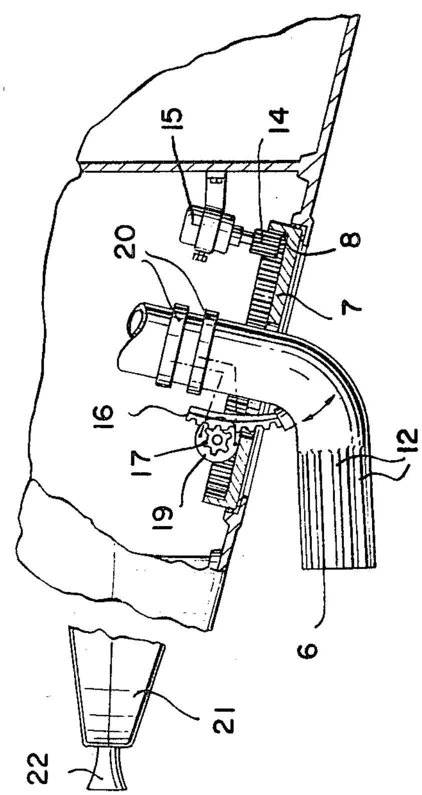

FIG. 3

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ATTORNEY

VERTICAL TAKEOFF AND LANDING AIRCRAFT

FIELD OF THE INVENTION

The present invention relates to an aircraft and, more particularly, to an aircraft of the vertical takeoff and landing (V-TOL) type.

BACKGROUND OF THE INVENTION

There are two general types of aircraft: those which use air currents passing over relatively fixed airfoils for lift, and those using substantially horizontal fans or screws to mount in the air. Both types offer particular advantages and disadvantages. The conventional airplane is relatively inexpensive and can attain great speeds with large payloads; however, it requires extensive takeoff and landing facilities and is adversely affected by many wind conditions. Those aircraft of the helicopter type can take off and land vertically on any more or less flat and solid surface; but they are very expensive, can only attain relatively low cruising speeds, and cannot carry large payloads.

Solutions to the above-mentioned difficulties have been attempted in the form of hybrid aircraft supposedly combining the advantages of the two types while obviating their disadvantages. One such essay is an aircraft equipped with horizontally oriented screw propellers that are used only on takeoff and landing and are folded back during normal flight wherein conventional wings and vertically oriented fans are used. Sometimes the entire wing-and-propeller assembly is rotatable through 90° to make this possible. Such an aircraft has certain advantages, yet it still uses the principle of lift generated by airflow over an airfoil for conventional flight and has, therefore, several disadvantages. Namely, such a vehicle must attain a certain horizontal velocity before it can be converted from one mode to the other, a speed often very difficult to obtain with the means at hand. Furthermore such aircraft are complicated and expensive in the extreme and, thus, troublesome and often dangerous.

OBJECTS OF THE INVENTION

It is, therefore, the general object of the present invention to provide an improved aircraft.

A more specific object is to provide an aircraft of the VTOL type which overcomes the disadvantages of the above-described aircraft.

SUMMARY OF THE INVENTION

The above objects are attained, in accordance with some of the features of the present invention, by an aircraft having a discus-shaped fuselage mounting a plurality of circumferentially spaced lift-generating assemblies and thereby being a sort of flying saucer. Each assembly comprises a rotor above or flush with the fuselage and oriented in a generally horizontal plane, means for rotationally driving the rotor, preferably in the form of a radial-piston engine, and a compressor below each rotor sucking air in from above and expelling it below through a nozzle. Control means is provided to turn the nozzles individually or jointly in any substantially horizontal direction and to turn them through substantially 90° so that they can point straight down, or off to any side.

Such an aircraft can take off or land vertically, the lift being generated substantially by the rotors and by the air being expelled in high-pressure jets from the bottom of the aircraft. Once airborne, the craft can be displaced horizontally by pointing the nozzles back, in the direction of travel. Simple alteration of motor speed and orientation of the nozzles thus controls the craft fully. The rotors above the fuselage virtually eliminate drag during takeoff, and permit such takeoff regardless of wind direction.

According to an important feature of this invention, the fuselage is defined between an upper and a lower conical surface (of the upper and lower halves of the airframe) centered on the vertical axis of the aircraft so that the fuselage tapers radially outward, the structure having its center of gravity located along the vertical axis and preferably at the lower third of the latter so that disturbances of the aircraft in flight, e.g., as a result of air turbulence will immediately result in a compensating movement of the aircraft to restore its horizontal position with the center of gravity located in the same vertical line with the top of the aircraft. It is important also to note that the lift-generating means act along the upper surface of the fuselage and thereby provides a lever type of action to restore aircraft stability.

An important aspect of this invention resides in the provision, in addition to airscrews (propellers), lift-generating fans with air increase formed by openings in the upper conical surface of the fuselage while the nozzles discharge high-velocity jets of air along the lower conical surface. The advantages of an arrangement of this type are that it may make use in a novel manner, of principles which have already been recognized in fixed-wing aircraft. Thus it is known to reduce the viscous drag or air resistance along the leading edge and upper skin of a fixed airfoil by providing openings in the latter through which the boundary layer is drawn and discharged below the airfoil or at its trailing edge, thereby eliminating the turbulence along the airfoil surfaces and increasing both propulsion and lift efficiency. In accordance with this principle, the fans draw air from along the upper surface and feed the air to the nozzles directly or through a compressor which may be driven on the same shafts as the fans, turbulence along the upper surface of the fuselage is minimized and air resistance reduced. The fans, moreover, may alternate with individual airscrew arrangements and/or pairs or triplets of such airscrews and may be driven by any convenient prime movement. The airscrews or propellers are advantageously spaced above the surface so that immediately below that there may be provided the open mouth or inlets of the compressors which are coupled with the propellers.

I have found, most surprisingly, that high stability can be assured and simple steering or rudder control accomplished by providing the discharge nozzles as flexible ducts whose upper portions extend axially and thus are aligned with the shafts of the respective compressors, propellers and fans, while the lower portion of each duct is bent in a form of an elbow to provide a discharge and extending generally radially with respect to the axis of the upper portion of the duct. The elbow is lodged in a control disk which is generally planar and lies along the upwardly and outwardly inclined frustoconical underside of the fuselage so as to be rotatable about an axis intersecting the axis of the respective propeller, fan, or compressor and extending perpendicular to the underside of the fuselage. An especially important characteristic of this invention is that the depending portion of the elbow, which extends more or less radially as noted above, is formed with longitudinally extending fins performing a rudder function.

DESCRIPTION OF THE DRAWING

The above and other objects, features, and advantages will become more fully apparent in the following description, reference being made to the accompanying drawing, in which:

FIG. 1 is a diagrammatic top view partly broken away and partly in section of an aircraft according to the present invention;

FIG. 2 is a section along the line II—II of FIG. 1; and

FIG. 3 is a vertical section showing details of FIG. 1 in enlarged scale;

FIG. 4 is a cross section view of the aircraft's rotatable nozzles disclosing the stabilizing fins in enlarged scale.

SPECIFIC DESCRIPTION

As shown in FIGS. 1–3 the aircraft has a fuselage **10** shaped like a discus with upper and lower conical faces, thereby making the craft into a sort of flying saucer. Spaced around this fuselage **10**, equidistant from a center axis **18** and angularly equidistant from one another are a plurality, here **12**, of lift-generating assemblies **11**. Each assembly has a rotor in the form of an airscrew propeller **2** or a lift fan **3**, the distribution depending on the size and weight of the craft. The airscrews **2** are substantially above the fuselage **10**, while the fans **3** are virtually flush therewith.

Below each rotor, mounted in the fuselage **10**, is a compressor **4** which draws air in from below the rotor and expels it through a flexible tube **5**. This compressor **4** is mounted on the same shaft with the rotor which is itself driven by a radial-piston engine **1**.

FIG. 3 shows more details of the craft. Mounted on the end of the tube **5** is a nozzle **6** provided with longitudinal laterally projecting fins **12** acting as rudders or stabilizers. The tube **5** is fitted through a disk **7** formed with an internal gear **8** which meshes with a pinion **14** on an electric motor **15**. This arrangement, with motor **15**, allows the nozzles **6** to be pointed in any horizontal direction. The nozzle **6** further mounts an arcuate rack **16** which meshes with a pinion **17** of a motor **19** connected through sliprings **20** to a source of power. This motor **19** adjusts the inclination to the vertical of the nozzle, thereby allowing it to point straight down or, as shown in FIG. **2**, to the side.

The fuselage has an extreme edge **21**, as shown in FIG. **3**, which may carry a ramjet **22** used during flight for extra speed.

In order to take off, the nozzles **6** are either pointed straight downward, or directed somewhat inwardly toward one another. Once the vehicle is airborne, the nozzles **6** are directed to a side, all in the same direction, to displace the craft in the opposite direction. The jets **22** along one portion of the edge **21** assist the flight in the horizontal.

The center of gravity of the loaded craft is advantageously held in the lower third of a center region **23**. In this manner, the lift caused by the assemblies **11** is distributed all around the load and mostly above it, thereby giving the craft great stability. Indeed, the craft's normal center of gravity is exactly in the center, due mainly to the symmetrical construction, so that this stability is built in. Furthermore, change in speed of any of the motors **1** can be effected to raise or lower an edge of the craft, if desired.

I claim:

1. An aircraft comprising:

a closed-skin discus-shaped fuselage of circular outline having conical upper and lower halves centered on an axis and defining all of the airfoil surface of the aircraft within said outline, the center of gravity of the aircraft being located along said axis in said lower half;

a plurality of lift-generating assemblies spaced around said fuselage, each of said assemblies including a respective rotor rotatable along the top of said fuselage, means for rotationally driving said rotor, a respective compressor in said fuselage below said rotor drawing in and compressing air from below said rotor, and a respective nozzle connected to said compressor to expel from below said fuselage the air compressed thereby, said nozzles projecting downwardly below said fuselage and exclusively forming rudder controls for said aircraft; and

control means for selectively directionally orienting each of said nozzles, each of said control means including a rotatable disk mounted on and substantially flush with the lower surface of said fuselage, said nozzle being formed at the lower end of a fixed-elbow tube rising through the disk to the compressor, and drive means connected to said disk for rotating same and thereby rotating said nozzle.

2. The aircraft defined in claim **1** wherein each of said control means further includes means for orienting the respective tube and nozzle in a vertical plane.

3. The aircraft defined in claim **1** wherein said rotor is an airscrew spaced above said fuselage.

4. The aircraft defined in claim **1** wherein said rotor is a fan substantially flush with the upper surface of the fuselage.

5. The aircraft defined in claim **1** wherein said nozzles are formed with longitudinal fins below said fuselage.

6. The aircraft defined in claim **1** further comprising a shaft, said rotor and said compressor being mounted on said common shaft and said means for rotationally driving said rotor thereby also driving said compressor.

7. The aircraft defined in claim **1** wherein said assemblies are angularly equispaced around said fuselage.

* * * * *

United States Patent

Di Martino

[15] 3,690,597

[45] Sept. 12, 1972

[54] **VERTICAL TAKE-OFF LANDING AIRCRAFT HAVING A PAIR OF COAXIAL COUNTER-ROTATING ROTORS, EACH FORMED BY A SET OF REVOLVABLE BLADES RADIALLY JUTTING FROM THE BODY OF THE CRAFT**

[72] Inventor: **Renato Di Martino,** Parco Margherita n.8, Naples, Italy

[22] Filed: **Aug. 19, 1970**

[21] Appl. No.: **65,115**

[30] **Foreign Application Priority Data**

Jan. 20, 1970 Italy.....................48200 A/70

[52] **U.S. Cl.**...**244/23 C**

[51] **Int. Cl.**...**B64c 29/00**

[58] **Field of Search**....................................244/23 C

[56] **References Cited**

UNITED STATES PATENTS

3,395,876 8/1968 Green.......................244/23 C

Primary Examiner—Trygve M. Blix

Attorney—Ernest G. Montague

[57] **ABSTRACT**

A vertical take-off landing aircraft, wherein at the periphery of a saucer-shaped body counter-rotate two similar and coaxial rotors. A rotor is composed of an annular caisson moved by gas-turbines and of a set of aerofoil-shaped blades jutting out of the caisson and revolvable around their own axis.

1 Claim, 8 Drawing Figures

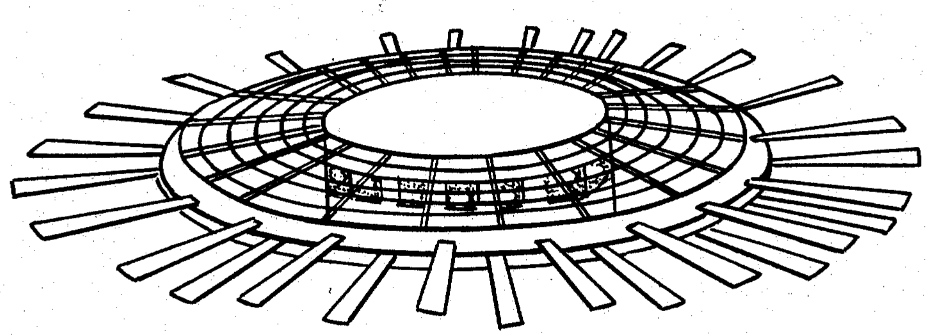


FIG. 1.

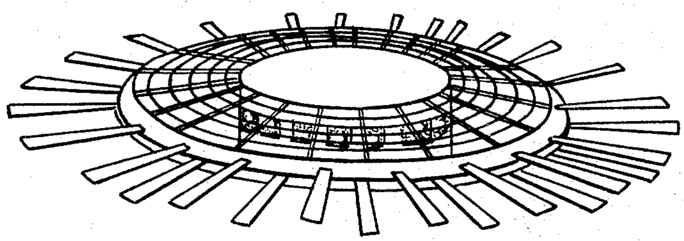


FIG. 2.

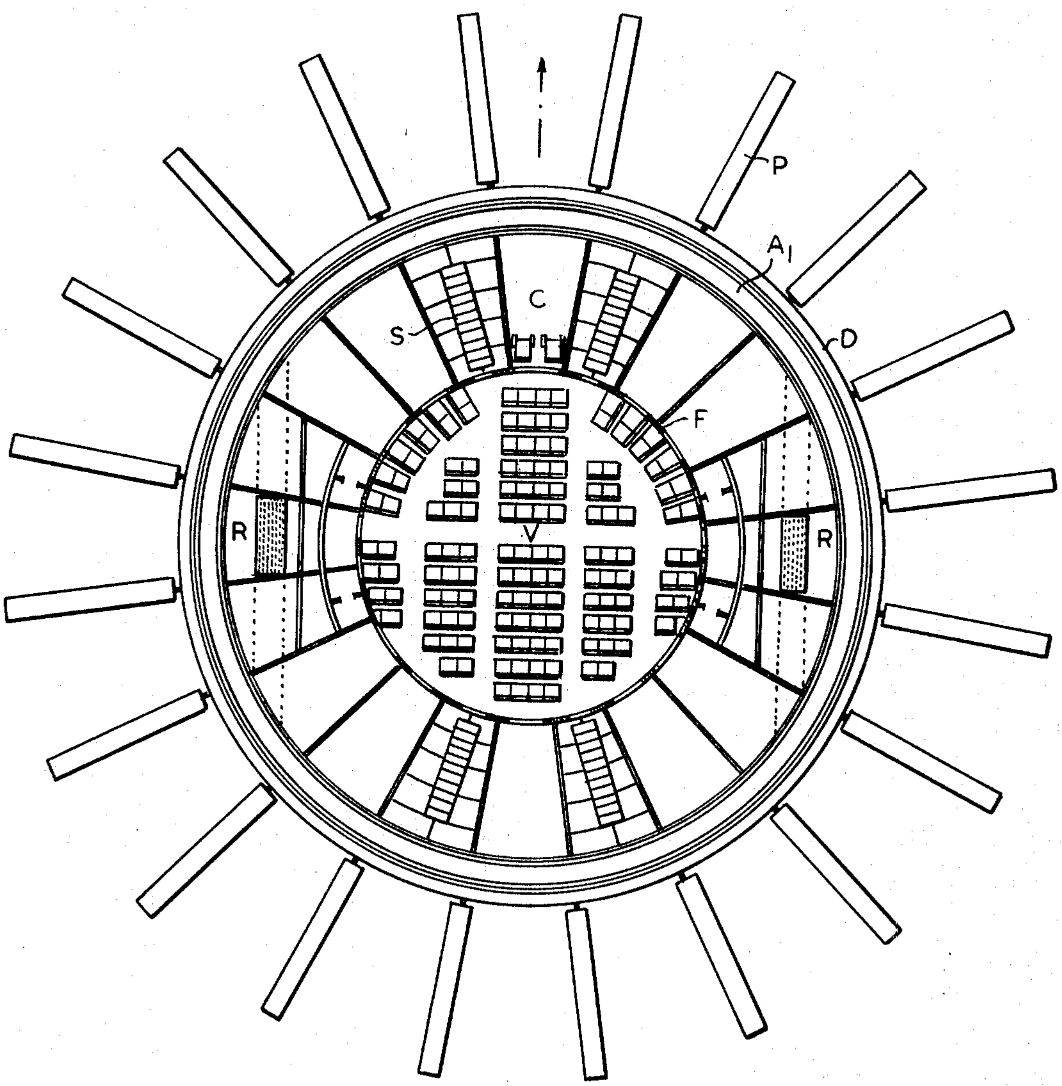


FIG. 3.

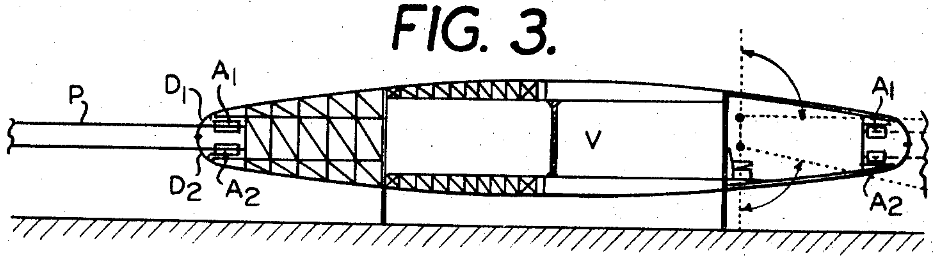


FIG. 4.

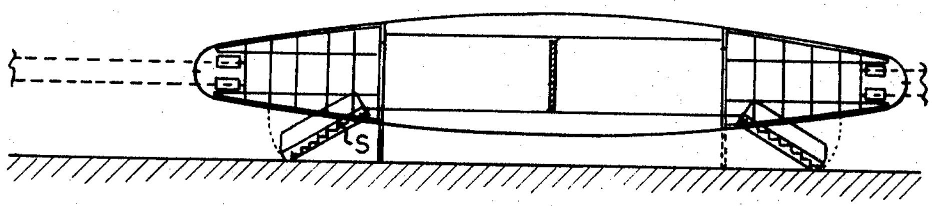


FIG. 5.

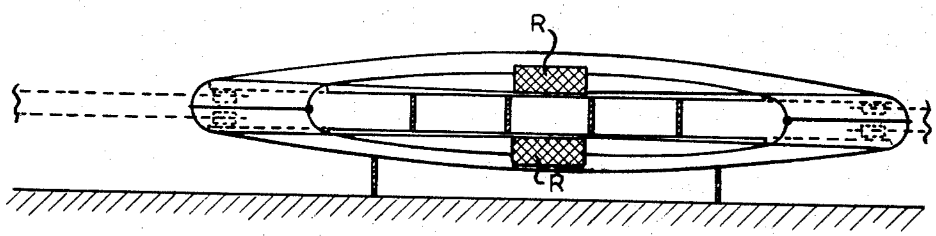
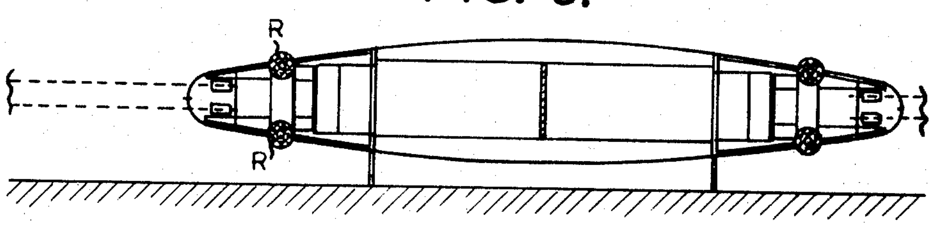


FIG. 6.



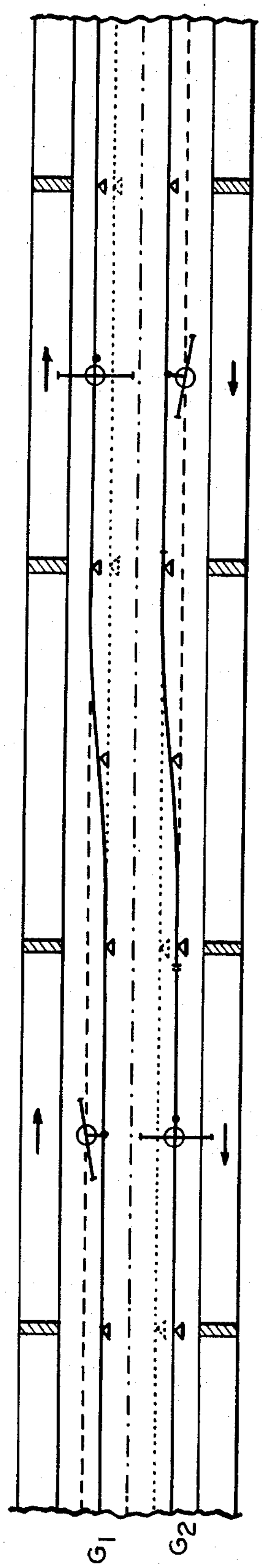


FIG. 7.

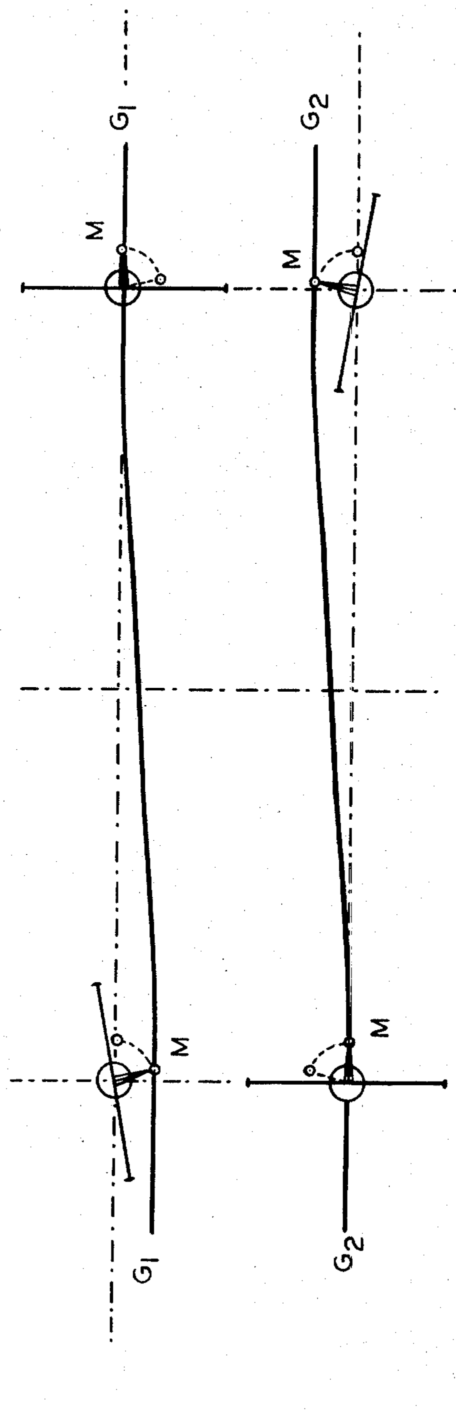


FIG. 8.

VERTICAL TAKE-OFF LANDING AIRCRAFT HAVING A PAIR OF COAXIAL COUNTER-ROTATING ROTORS, EACH FORMED BY A SET OF REVOLVABLE BLADES RADIALLY JUTTING FROM THE BODY OF THE CRAFT

The present invention relates to a saucer-shaped aircraft able to fly vertically as well as horizontally by means of the coaxial counterrotation around the body of two sets of radial blades having an aerofoil section and revolvable around their longitudinal axis.

It is one object of the present invention to provide a vertical take-off landing aircraft having a pair of coaxial counter-rotating rotors, each formed by a set of revolvable blades radially jutting from the body of the craft wherein for vertical flights, the pitch of all the blades must be the very same; when level flight is desired in a direction which coincides with the "axis of flight" of the craft, an initial slight increase of the pitch is to be given to the blades moving from the front to the rear of the craft; from this, a non-compensated slight push is created; the consequent slight decrease in lift is to be compensated by an increase of speed of the rotors.

It is another object of the present invention to provide a vertical take-off landing aircraft having a pair of coaxial counter-rotating rotors, each formed by a set of revolvable blade radially jutting from the body of the craft, wherein as soon as the speed begins to be noticeable, the former loss of lift of the "pushing" blades is going to be compensated by an increase of lift of the other blades—i.e., those moving from back to front—whose lifting action is improved from the increased absolute speed (the rotational speed plus the translation speed).

It is yet another object of the present invention to provide a vertical take-off landing aircraft having a pair of coaxial counter-rotating rotors, each formed by a set of revolvable blades radially jutting from the body of the craft, wherein for further increase the speed of the aircraft, the pitch of the blades is increased up to its maximum value, i.e., to the vertical position. Before this point, when the "pushing" blades lose all their lifting power, an increasing good share of the lift is transferred from the moving-forward blades to the body of the craft, whose aerofoil shape (biconvex wing) will work for that purpose.

When the speed is such that all the lift is provided by the body, the pitch of the "lifting" blades may be reduced to nothing in order to get the least drag from them.

It seems rather evident that a horizontal force can be produced in the very beginning of the flight, so that the start from the ground may be oblique, if desired, instead of merely vertical.

With these and other objects in view which will become apparent in the following detailed description, the present invention, which is shown by example only, will be clearly understood in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view of the aircraft, shown schematically;

FIG. 2 is a plan view of the same, with a possible arrangement of some components;

FIG. 3 is a vertical section of the aircraft along the axis of the flight;

FIG. 4 is a vertical section along a diameter crossing the stairs;

FIGS. 5 and 6 are vertical sections made, respectively, along the axis of the motors and along the diameter perpendicular to the axis of the flight; and

FIGS. 7 and 8 are schematic views indicating the system intended for giving to the blades, automatically, the periodical variation of pitch required for the level flight.

Referring now to the drawings, the body of the aircraft designed in accordance with the present invention, has the shape of a saucer with an aerofoil profile; its interior space may be divided into several sections depending upon the destination: a possible arrangement for passenger transport is shown in FIG. 2.

In this case, the passenger cabin V is located in the inner part of the body and is separated from the rest by a partition wall F with windows and doors; all around the passenger cabin are located: the pilot cabin C, the stairs S, the engine rooms R and the utility rooms.

The main feature of the aircraft is constituted from the ensemble of two blade-holder rings A_1 and A_2 FIGS. 2 and 3, identical to each other, coaxial and counter-rotating around the body.

These annular structures, each formed by a metallic caisson of rectangular section, have their internal diameter slightly larger than the external diameter of the body, in order to let the axles of the blades jut out of the inner wall of the ring in the space, where the apparatus for revolving the blades is located.

As a matter of fact, on the external wall of the body there are fixed two rails G_1 and G_2 FIG. 7, one for each ring, intended to guide the cranks M FIG. 8 attached to the axles of the blades; the rails can be moved vertically to some extent—upon command—along the wall of the body, so that the pitch of each blade depends upon the position of the rail, by means of the cranks.

In other words, the rotation of the rings A_1 and A_2 makes the blades rotate around the body, as well as revolve around their own axle in an amount which is regulated by the position of the rails G whose vertical displacement can be established by the pilot.

The energy for the rotation of the rings is given, throughout normal transmissions, from the motors, R adjacent to the rings.

The centrifugal force of the blades, created from their rotational movement, is borne by a polygonal chain—with as many angles as blades contained in the round caisson.

Each ring is careened on its outside part D in order to give an aerodynamic profile to the craft FIGS. 2 and 3.

When level flight is desired, it is necessary that for each rotor the blades of the right side have different pitch than those of the left side; it is necessary, in other words, that cyclically and automatically, the blades revolve around their own axis in correspondence, or in proximity, to the intersection with the vertical flame passing by the "axis of flight."

This is done by putting FIG. 7 each rail at different heights on each side of the aircraft; consequently, each rail shall have two transition segments, located respectively one in the front and another in the back of the aircraft.

Each of the above-said transition segments T FIG. 8 is made of a separate rail G, having a fulcrum at the center and movable at the end with adequate joints so that, when needed, a flex can be realized without interrupting the continuity of the supporting action of the rail itself.

When at full speed in level flight, the "pushing" blades are set vertically (like the oars of a row-boat) and the "lifting" ones are set almost horizontally, to reduce the drag, since the lifting action has been transferred to the body of the craft.

For the vertical flight as well as for "hovering," it is requested that the counter-rotating rotors have enough speed and that all the blades have the same pitch.

On level flight, the following three stages can be considered:

a. *Low speed:* the lift is only given by the blades;

b. *Average speed:* the lift is shared by both the blades and the body;

c. *High speed:* the lift is given only by the body, purposely having aerofoil section.

On this latest stage, the aircraft's stability is assured by the position of the center of gravity (below the center of vertical push), by the inertial resistance of the rotating masses and by the fact that the "pushing" action of the blades is much more effective in the front than in the rear so that the craft is actually "pulled" and not "pushed."

The change of direction in a horizontal plane as well as in a vertical plane can be obtained by using small jets, located in such a way as to produce couples acting respectively in the horizontal plane and in the vertical plane perpendicular to the axis of flight (because of the gyroscopic effect due to the rotating masses).

The new aircraft has been described without taking into account the devices related to the transmission and command of the movements, assuming that they can be realized in a conventional manner and are not part of the present invention.

While I have disclosed one embodiment of the present invention, it is to be understood that this embodiment is given by example only, and not in a limiting sense.

I claim:

1. A vertical take-off landing aircraft comprising

a body having the shape of a saucer with an aerofoil profile, and divided into a plurality of sections, including a center section, and including an outer wall,

a partition wall having windows and bars surrounding said center section,

a pilot cabin, engine rooms and utility rooms surrounding said inner section,

two blade-holder rings disposed coaxially and counter-rotating around said body; as well as including an inner wall,

said two blade-holder rings constituting a metallic caisson and having an inner diameter larger than the outer diameter of said partition wall of said body,

a plurality of blades mounted on axles jutting out from the inner wall of said rings,

power means for revolving said blades,

two rails fixed to said outer wall of said body, each of said rails coordinated to a corresponding of said rings,

a crank attached to each of said axles of said blades, and

means for moving the axles of said blades in vertical direction, in order to vary the pitch of said blades in response to the position of said rails.

* * * * *

United States Patent [15] 3,697,020

Thompson [45] **Oct. 10, 1972**

[54] **VERTICAL LIFT MACHINE**

[72] Inventor: **Raymond V. Thompson,** Simsbury, Conn.

[73] Assignee: **Chandler Evans Inc.,** West Hartford, Conn.

[22] Filed: **Sept. 14, 1970**

[21] Appl. No.: **72,091**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 836,393, June 25, 1969, Pat. No. 3,592,413.

[52] **U.S. Cl.** ....**244/12,** 244/12 C, 244/23 C, 244/42 CC

[51] **Int. Cl.** **B64c 29/00**

[58] **Field of Search** ....244/12 C, 23 C, 42 CC

[56] **References Cited**

UNITED STATES PATENTS

3,276,723	10/1966	Miller et al.	244/23 C
3,568,955	3/1971	McDevitt	244/23 C
3,072,368	1/1963	Seddon et al.	244/41
3,128,063	4/1964	Kaplan	244/42 CC
3,073,551	1/1963	Bowersox	244/23 C
3,261,576	7/1966	Valyi	244/42 CC
3,023,860	3/1962	Ellzey	244/42 CC

Primary Examiner—Milton Buchler
Assistant Examiner—Jesus D. Sotelo
Attorney—Fishman & Van Kirk

[57] **ABSTRACT**

A maneuverable lifting body wherein pressurized gas is discharged at supersonic velocity over the surface of at least three downwardly sloping lifting surfaces, the supersonically flowing gas separating and thereafter reattaching to the surface to provide a low pressure region intermediate the points of separation and reattachment. The low pressure region created on the upper surface, in cooperation with atmospheric pressure on the bottom of the body, results in vertical lifting forces which add to the vertical component of the momentum forces of the gas. Attitude control and maneuverability are accomplished by selectively venting ambient air into the low pressure regions whereby the low pressure region may be selectively destroyed with resultant force unbalance.

13 Claims, 7 Drawing Figures

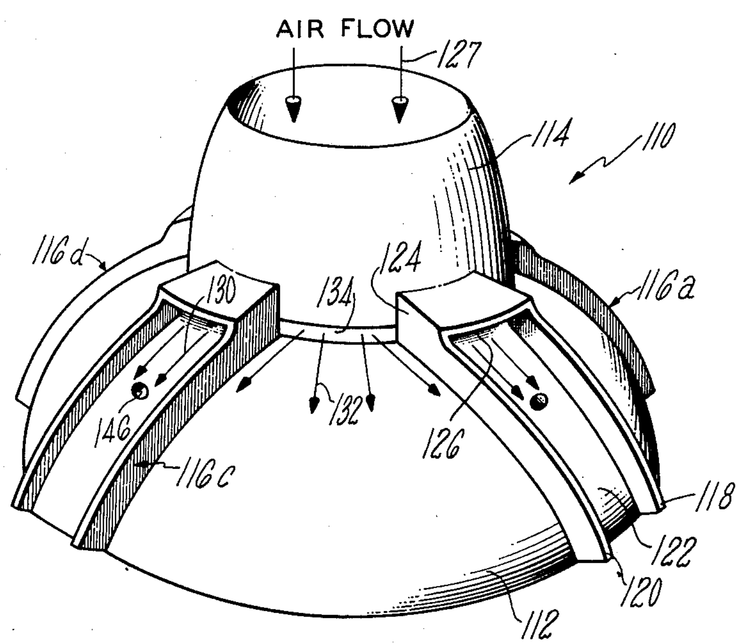


FIG. 1

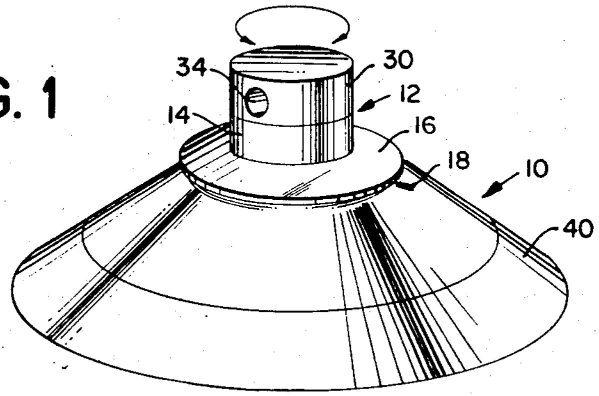


FIG. 2

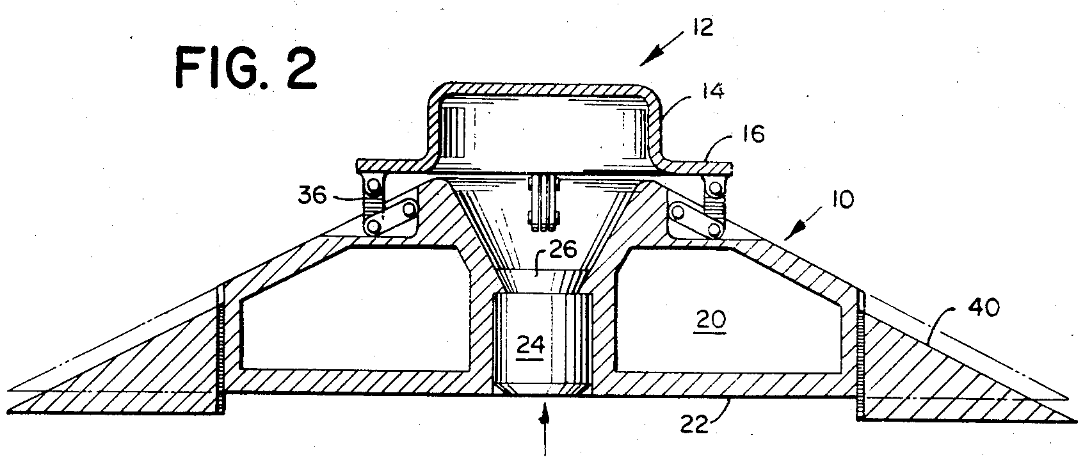
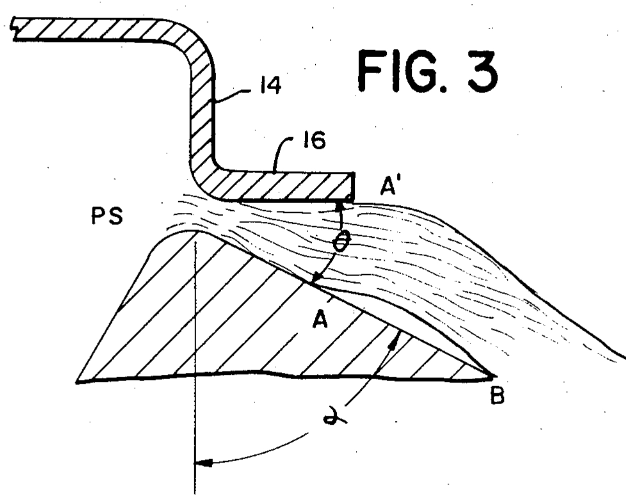


FIG. 3



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ATTORNEYS

FIG. 4

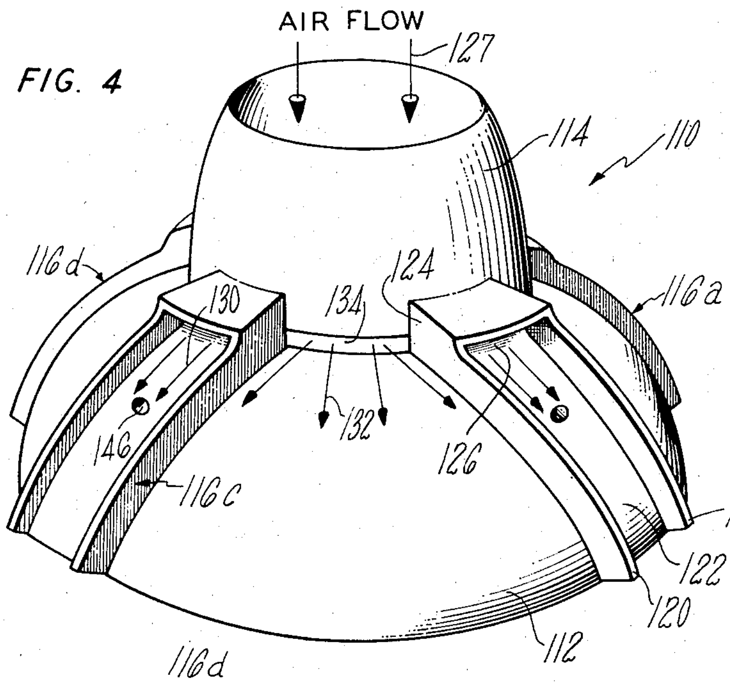
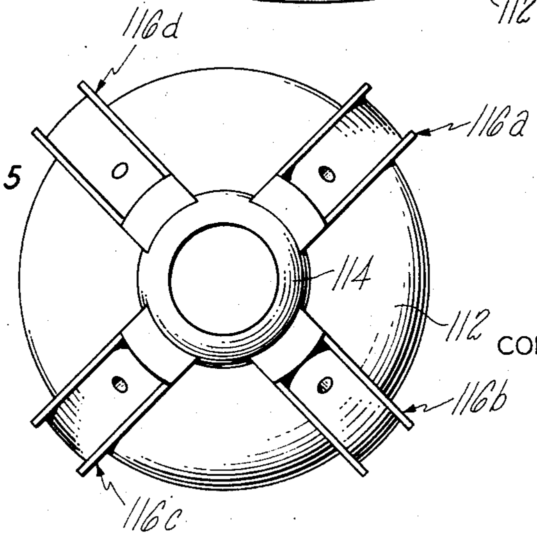


FIG. 5



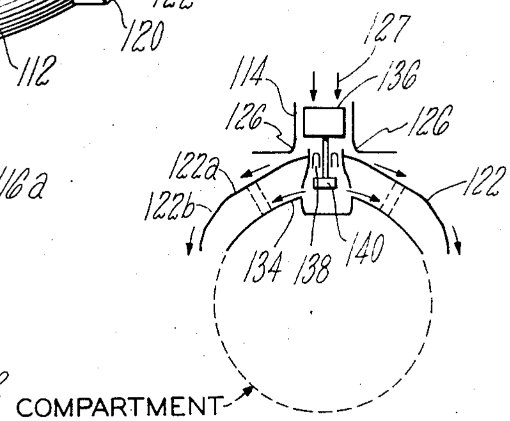


FIG. 6

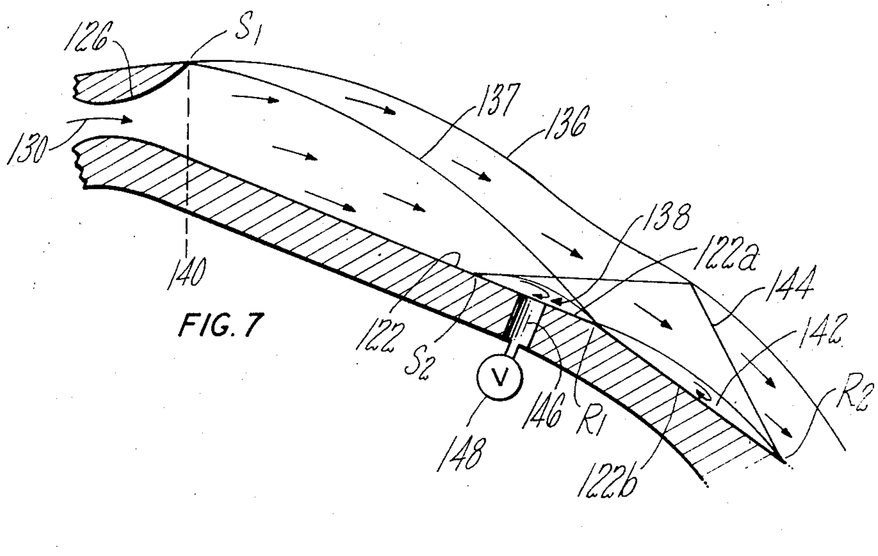


FIG. 7

VERTICAL LIFT MACHINE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of application Ser. No. 836,393 filed June 25, 1969, now U.S. Pat. No. 3,592,413 issued July 13, 1971.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the creation of lifting forces. More specifically, the present invention is directed to vertical lift machines involving boundary layer separation-reattachment control. Accordingly, the general objects of the present invention are to provide novel and improved methods and apparatus of such character.

2. Description of the Prior Art

While not limited thereto in its utility, the present invention is particularly well suited for application to self-lifting bodies, such bodies sometimes being referred to as "hovercraft." It is to be noted that the "-hovercraft" must be distinguished from the ground effect machine (GEM) or air cushion vehicle which creates and rides upon an air cushion established by drawing in atmospheric air and directing it downwardly beneath the vehicle. The "hovercraft," the most common example of which may be considered to be the helicopter, is not constrained to operation within a few feet of a surface as is the GEM but rather creates its own lift in somewhat the same manner as a conventional aircraft.

Prior art operational "hovercraft" have been characterized by a rotating airfoil or propeller which has generated the lifting forces in a conventional manner. The complexities of such rotating blade mechanisms, particularly in the helicopter environment where blade pitch must be constantly changing, are well known and will not be discussed herein. In addition to those vehicles which employ a rotating, generally horizontally mounted propeller mechanism, a number of self-lifting bodies have been proposed wherein air would be discharged outwardly in all directions from a region approximating the center of the vehicle over an immobile airfoil structure so as to generate vertical lift. In the latter type apparatus it was generally proposed to blow air over both upper and lower airfoil surfaces, lift being provided in the conventional aerodynamic manner.

The previously proposed lifting bodies of the immobile air-foil type have not been the subject of development due to the obvious inefficiencies in their design. That is, if reduced to practice, prior art designs would inherently provide exceedingly limited lift and thus little or no load carrying capacity. Perhaps more importantly, no practical manner of maneuvering such vehicles has been proposed. The lack of maneuverability, with the exception of relatively expensive helicopter type vehicles, has also characterized the rotating propeller type lifting bodies. Lack of maneuverability is, of course, a serious disadvantage in cases where the device is to be used as an observation platform during military activities or for manned transportation. Previous attempts at using comparatively inexpensive, camera bearing lifting bodies in the field have met with failure since the devices could only be positioned vertically above and connected to the launch site and would thereby reveal the position of the crew.

SUMMARY OF THE INVENTION

The present invention overcomes the above-discussed and other disadvantages of the prior art and, in so doing, provides a novel and improved maneuverable vertical lift machine. In accomplishing the foregoing, the present invention generates vertical lift by creating a pressure differential across a plurality of outwardly and downwardly flaring lift or expansion surfaces. Three or more equally spaced lift machines are used, and the lift surfaces would typically be four in number in a cruciform configuration. Subatmospheric pressure is created at the upper side of the lift surfaces through the use of supersonic flow streams discharging from convergent-divergent nozzles at the entrance to each lift surface. The supersonic flow separates and thereafter reattaches to the lift surfaces to provide low pressure regions on the upper side of each of the lift surfaces intermediate the points of separation and reattachment. Atmospheric pressure acts on the underside of the lift surfaces thereby providing the requisite pressure differential. The vertical lifting forces resulting from this pressure differential and the vertical component of the momentum forces of the supersonic gas stream combine to provide the vertical lift.

The invention presented in this application is further characterized by vent ports which control the introduction of ambient air into the low pressure regions on the lift surfaces to deflect the supersonic stream away from the upper side of the lift surfaces whereby the low pressure region is destroyed. A force unbalance then results whereby pitch and roll attitude control and directional maneuverability can be realized. A balancing of the horizontal components of the forces on the lift surfaces produces a hovering state whereas the force unbalance caused by the venting of a low pressure area on a lift surface to ambient results in selected attitude control or maneuverability. Maneuverability and/or attitude control may also be realized by varying the volume or pressure of the supersonic gas stream flowing over one or more of the lift surfaces.

The present invention is further characterized by contouring of the upper side of the lift surfaces to promote at least two separations and reattachments of the flow stream whereby two low pressure regions are established to substantially augment the total available lift force.

The present invention is further characterized by an upper cap assembly into which pressurized fluid is discharged by the propulsion source, the propulsion source typically comprising a gas turbine engine mounted vertically with its discharge nozzle facing into the cap. The cap may be mounted from the conical plate by means which permit tilting of the cap. In the preferred embodiment the cap and plate cooperate to define the nozzle which creates the supersonic flow. Maneuverability of the vehicle may be achieved by tilting the cap so as to choke the flow at one side of the body. Alternatively, maneuverability may be achieved by release of some of the gas from the cap into a stagnation chamber, the chamber having a horizontally oriented and steerable discharge nozzle.

BRIEF DESCRIPTION OF THE DRAWING

The present invention may be better understood and its numerous objects and advantages will become apparent to those skilled in the art by reference to the accompanying drawing wherein like reference numerals refer to like elements in the various figures and in which:

FIG. 1 comprises an isometric view of a first embodiment of a lifting body in accordance with U.S. Pat. application Ser. No. 836,393 of which the present application is a continuation in part.

FIG. 2 is a cross-sectional, side elevation view of a second embodiment of U.S. Pat. application Ser. No. 836,393 of which the present application is a continuation in part.

FIG. 3 is an enlarged, cross-sectional view of a portion of the embodiments of FIGS. 1 and 2.

FIG. 4 is an isometric view of the lifting body of the present invention.

FIG. 5 is a top plan view of the lifting body of FIG. 4.

FIG. 6 is a schematic representation of the lifting body of the present invention.

FIG. 7 is a schematic representation of an optimized lifting surface configuration.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the interest of presenting the background leading to the present invention, the description in U.S. Pat. application Ser. No. 836,393 is substantially repeated herein with respect to FIGS. 1-3.

With reference now to FIG. 1, a perspective view of a first embodiment of that earlier application may be seen. The embodiment of FIG. 1 is possessed of a generally conical shape and the upper surface of the load carrying portion of the vehicle is defined by a conical metal plate indicated generally at **10**. The vehicle body defined in part by plate **10** has an opening at its upper or smaller diameter end. Air under pressure is discharged vertically upwards about the axis of the vehicle through this opening.

Mounted from the vehicle and above the smaller diameter end of plate **10** is a cap assembly indicated generally at **12**. Cap assembly **12** is, as may best be seen from FIG. 3, hollow and has a riser portion **14** into which the pressurized fluid from the propulsion source is discharged. The cap assembly **12** also has, about the lower periphery of riser portion **14**, an outwardly extending flange **16**. The bottom surface of flange **16** and the upper or smaller diameter end of the conical plate **10** cooperate to define an annular convergent-divergent nozzle **18** through which pressurized gases discharged into cap **12** will escape. Fluid flowing through nozzle **18** will, as a result of the pressure within cap **14** and the nozzle design, be discharged down over the exterior of plate **10** at supersonic velocity.

As may be seen from a consideration of the embodiment of FIG. 2, the vehicle may be provided with a load space **20** which is defined in part by the inner surface of conical plate **10** and by a base plate **22**. In a typical operational configuration, where the lifting body would be employed as a remotely controlled and unmanned observation platform, electronics including maneuvering control servo systems, controllable television cameras and transreceivers would be mounted in load space **20**. Additional load space may be provided on top of cap **12** and cameras may be located in or on such additional space.

Also mounted within the lifting body and coaxial with conical plate **10** will, as can also be seen from FIG. 2, be a propulsion source **24**. Propulsion source **24** will comprise a gas turbine engine installed vertically with its discharge nozzle **26** facing the interior of cap assembly **12**. The combustion products discharged under pressure to nozzle **26** will be directed into cap **12** and will flow outwardly from the cap through the nozzle **18** as shown diagrammatically in FIG. 3.

In the embodiment of FIG. 1, in the interest of maneuverability, the cap **12** is provided with a rotatable upper section **30**. Cap section **30** defines, in its interior, a stagnation chamber which may be placed into communication with the interior of the lower cap section via suitable valving. The stagnation chamber has a discharge nozzle **34** which may be aimed by rotating cap section **30** by means not shown. Accordingly, horizontal maneuvering thrust may be generated by placing the stagnation chamber into communication with the interior of the lower cap section whereby engine exhaust gas will be discharged through nozzle **34** and the cap rotated so as to point the nozzle **34** in the desired direction.

Alternately, or in addition to the employment of a rotatable cap section and associated structure as above described, the maneuvering control of FIG. 2 may be utilized. In the FIG. 2 scheme the cap **12** is mounted from plate **10** by a plurality of linkage mechanisms, such as the double pivot linkage **36**. Accordingly, the cap **12** may be tilted to any desired angle relative to a vertical axis through the vehicle to thereby unbalance the horizontal momentum component of the gases exhausting through nozzle **18**. The means for moving linkages **36** have been omitted from the drawing in the interest of clarity.

Operation of the lifting body may be best understood by consideration of FIG. 3 which shows a cross section of the discharge nozzle **18**. In FIG. 3, P_s represents the supply pressure in cap assembly **12** of a gas being admitted to three-dimensional convergent-divergent nozzle **18**. The dimensions of the upper end of the conical plate **10** and the lower surface of flange **16**, the plate and flange cooperating to define nozzle **18**, are chosen so that assymetric separation of the supersonic gas jet discharging from nozzle **18** will occur along line A—A′ at the downstream end of the nozzle. The effect of the flat annular plate **10** attached to the convergent-divergent nozzle **18** is to promote a process of turbulent mixing between the separating jet boundary and the ambient gas trapped adjacent to the plate thereby resulting in a low pressure region. Restated, gas discharged from nozzle **18** flows at supersonic velocity over the surface of plate **10** and, in the manner known in the art, separates from the plate at point A and thereafter reattaches to the plate at point B a substantial distance downstream from point A. Ambient gas trapped between the points of separation and reattachment will be mixed with and entrained in the supersonic stream thereby creating a near vacuum on the surface of the plate between points A and B. Obviously, the combined effect of the low pressure region acting on the upper surface of plate **10** and atmospheric pressure acting on the bottom of the vehicle (plate **22**) will create a lifting force. This lifting force, when combined with the vertical component of the momentum of the gases being discharged from nozzle **18**, will create sufficient lift whereby the vehicle will rise vertically.

Referring again to FIG. **2** it is to be noted that conical plate **10** may be provided with a vertically movable, outboard section **40**. Downward movement of annular section **40** out of the usual plane of plate **10** will increase the length of the vortex between points A and B by moving the reattachment point of the supersonic gas stream downstream. Increasing vortex length will enhance lift by enlarging the area of the near vacuum region created above the surface of plate **10**.

Considering again FIG. **3**, tests have shown that angle θ defined by the divergent portion of nozzle **18** should be in the range of 30°–50°. This design parameter can, however, be satisfied by making angle α as great as 90°. When angle α is 90°, flange **16** obviously flares outwardly and upwardly and there will be no vertical momentum component to be added to the lift generated by the created pressure differential.

Referring now to FIGS. **4–7**, the embodiment of the present invention is shown. The lifting device, which is indicated generally at **110**, has a lower body component in the form of a skirt **112** and an upper body component in the form of a shroud **114**. Skirt **112** is a generally annular element and it may be approximately hemispherical as shown or frusto-conical. Of course, it might also be formed from a number of flat tapered segments joined together. Shroud **114** is generally cylindrical. Four lift elements **116*a***, **116*b***, **116*c***, and **116*d*** are mounted between cylindrical shroud **114** and skirt **112** and are spaced equi-distant about skirt **112** to take on a generally cruciform shape as best seen in FIG. **5**. Each of these lifting elements has a pair of side walls **118** and **120**, a lift surface **122** contained between the side walls, and an upper housing **124** which defines a nozzle **126** therein communicating with the interior of shroud **114**. The nozzles **126** are two-dimensional convergent-divergent nozzles (as indicated generally in FIG. **7**), and they extend between the respective side walls **118** and **120** of each lift element.

The lifting device of the present invention is powered by a turbofan type gas turbine engine which is located within shroud **114** and which delivers a supersonic gas stream to flow along the lift surfaces **122** of lift elements **116** whereby lift is created by separation and reattachment of the supersonic stream as will be more fully discussed hereinafter. The portions of skirt **112** between adjacent lift elements may also be employed to create additional lift by flowing either supersonic or subsonic gas streams along their upper surfaces. The air entering shroud **114** to flow through the gas turbine engine is indicated by the arrows **127**, and the supersonic air or gas streams flowing over lift surfaces **122** and skirt **112** are indicated by the arrows **130** and **132**, respectively. The gas flowing over skirt **112** is delivered from the interior of shroud **114** via a nozzle segment **134** which communicates with the interior of shroud **114** to deliver a stream of gas to the surface of skirt segment **112**. There would be a similar nozzle **134** communicating with each of the skirt segments between the adjacent lift elements.

Referring now to FIG. **6**, a schematic representation is shown of the device of the present invention. The turbofan gas turbine engine is of well known typical construction having a fan and compressor unit **136**, a burner section **138**, and a turbine **140**. Compressed air is bled from the fan and is delivered through the convergent-divergent nozzles **126** and flows along lift surfaces **122**. As will be described in more detail with respect to FIG. **7**, the supersonic gas streams separate and reattach to lift surfaces **122** thus generaling localized low pressure areas on the lifting surfaces **122** whereby a vertical lifting force results from the differential between those low pressure areas and the ambient pressure on corresponding areas on the bottom of the lifting device. The turbine discharge gases, or at least parts thereof, may also be passed through nozzles **134** to flow over the segments of skirt **112** in supersonic streams whereby lift is also generated. If the turbine discharge gas is to be passed over the skirts segments in a subsonic stream (which will create a slightly subambient pressure on the upper surface of skirt **112** with resultant lift) nozzle **134** will be convergent; if the turbine discharge gas is to be passed over the skirt segments at supersonic speed, the nozzles **134** will be convergent-divergent, a significantly subambient pressure will exist on the upper surface of skirt **112** resulting from separation and reattachment of the gas stream to generate lift as discussed in parent application Ser. No. 836,393.

Referring now to FIG. **7**, an enlarged cross-sectional profile of one nozzle **126** and lift surface **122** is shown. The gas stream **130** passing through nozzle **126** is at a super-critical pressure ratio; that is, the ratio P_0 / P_a (where P_0 is the compressive fan bleed pressure upstream of the throat of nozzle **126** and P_a is atmospheric pressure) is greater than **3**, and preferably about **10**. After passing through the two-dimensional convergent-divergent nozzle **126**, the gas expands freely and tends to separate from the walls of the duct. The upper divergent surface of nozzle **126** is physically restricted to a length equal to or slightly less than that corresponding to the point of free separation, S_1, of the immediate boundary layer. The pressure at this point is subambient, and consequently the local free boundary of the jet is acted upon by a transverse pressure gradient which deflects the fluid stream to flow along surface **122**, the upper boundary of the stream being indicated at **136**. The action of deflecting the fluid jet to flow along surface **122** produces a curved shock **137** extending from the free separation point S_1 to a point R_1 on surface **122**.

The same factors which caused the separation of the supersonic air stream from the upper surface of nozzle **126** are also experienced by the stream expanding along wall **122** thus resulting in separation at point S_2 to create a localized entrainment **138** of air at an extremely low pressure. The low pressure on lifting surface **122** in the projected area of entrainment **138** is very much lower than ambient. This low pressure area assists in maintaining alignment of the air stream with surface **122** and it also provides a substantial vertical pressure gradient with respect to the ambient pressure acting on the bottom of the lifting device whereby vertical lift is created. Thus, the supersonic gas stream flowing along surface **122** separates at point S_2 and reattaches at point R_1 creating between those two points an area of localized very low pressure, even approaching a vacuum, whereby a vertical force imbalance exists as a result of the pressure differential between the low pressure on surface **122** and ambient pressure acting on the rear of the surface **122** so that vertical lift is created. Of course, it will be understood that the profile depicted in FIG. **7** extends across the width of each of the lift elements **116** so that, for example, the separation point S_2 and the reattachment point R_1 are actually lines extending the full width of the lift elements, and the pressure differential exists across the width of the lift elements between walls **118** and **120**.

Lift surface **122** extends in a straight line or plane from the mouth **140** of nozzle **126** to reattachment point R_1. If this straight plane were continued at this point, the air stream would remain attached to the surface and no further lift would be generated. However, in accordance with the present invention, lift surface **122** is contoured to bend or incline downward at point R_1 so that the included angle between segment **122*a*** and segment **122*b*** is less than 180°. This contouring results in a further expansion and/or a second separation of the gas stream at point R_1 with reattachment at point R_2 thereby resulting in a second low pressure entrainment **142** and a reflected shock **144**. This second low pressure entrainment **142** results, similarly, in an extremely low pressure area at the projected upper surface of lift surface **122** and a resultant upward force from the pressure differential between this second low pressure area and ambient air on the bottom of the lift device thereby substantially augmenting the vertical lift.

Attitude control and maneuverability of the lift device of the present invention are readily accomplished by a pneumatic switching technique. Each of the lift devices is provided with an ambient vent port **146** which is in direct communication with entrainment area **138** at one end and is normally closed, such as via a valve **148**, at the other end. Valve **148** is connected to atmosphere, and when valve **148** is opened the ambient air, which is at a substantially higher pressure than the greatly reduced pressure in entrained volume **138**, flows into entrained volume **138** whereby the low pressure is destroyed and the stream separates from surface **122**. This destruction of the low pressure entrainment and separation of the stream from lift surface **122** terminates the lift force on that particular surface **122** and causes generation of a lateral steering thrust component. Accordingly, it can readily be seen that a force imbalance is then created with regard to the remaining three lift elements with a resultant change in attitude or direction of the lift device. Closing of the valve **148** cuts off the flow of ambient air and allows the supersonic stream to return to surface **122** for recreation of the low pressure volume **138**. As can be readily understood, the vent valves **148** can be opened or closed in any desired sequence or combination to produce desired attitude control and maneuverability of the lift device.

It is contemplated that a load compartment, either for cargo or passengers would be mounted under skirt **112** (as indicated in FIG. **6**), which compartment could be of any desired shape depending upon the intended use for the lift vehicle. The ease with which attitude control and maneuverability can be achieved in the present invention through the use of programmed vent valves results in an extremely compact vehicle which does not have any need for main rotor and tail systems traditionally present in vertical lift devices. The vehicle is, accordingly, readily concealed when not in use and easy to transport if it is desired to move it over ground. Furthermore, since most, if not all of the fan air and turbine exhaust gases are directed outwardly rather than straight down toward the ground, ground erosion effects and injection of dirt laden air into the engine, both of which are problems with traditional vertical lift devices, are substantially eliminated. Accordingly, the lift device of the present invention can be readily used from unprepared landing sites thereby further enhancing its utility.

It will also be readily understood by those skilled in the art that while four lift elements **116** in a generally cruciform array have been shown as the preferred arrangement, any number from three or more, preferably equally spaced around the vehicle, can be used with comparable results.

While a preferred embodiment has been shown and described, various modifications and substitutions may be made thereto without departing from the spirit and scope of the present invention. Accordingly, it is to be understood that the present invention has been described by way of illustration and not limitation.

What is claimed is:

1. A lifting device for generating vertical lift, the lifting device including:

a body component;

a plurality of lift elements extending generally radially from and being circumferentially spaced apart about said body component, each of said lift elements having a lift surface;

nozzle means associated with each of said lift elements for delivering a gas stream at supersonic velocity to each of said lift surfaces, each lift surface being positioned with respect to its associated nozzle means to create a subambient pressure region at each of said lift surfaces by separating and reattachment of said gas stream with respect to each lift surface; and

control means connected to each of said lift elements for selectively destroying the subambient pressure at the lift surface.

2. A lifting device as in claim **1** wherein:

said body component is a generally annular member; and wherein

said plurality of lift elements includes at least three lift elements equally spaced apart about said member.

3. A lifting device as in claim **1** wherein said nozzle means includes:

a convergent-divergent nozzle connected to one end of each of said lift elements.

4. A lifting device as in claim **1** wherein:

said body component is a generally annular member; and wherein

said plurality of lift elements includes four lift elements equally spaced about said member in a cruciform array.

5. A lifting device as in claim **1** wherein each of said lift surfaces includes:

a first portion extending from said nozzle means; and

a second portion extending from said first portion and inclined with respect to said first portion at an included angle of less than 180°.

6. A lifting device as in claim 1 wherein each of said lift elements includes:

a pair of side walls bounding said lift surface; and

a housing for said nozzle means.

7. A lifting device as in claim 1 wherein said control means includes:

valve means connected to deliver gas at higher than sub-ambient pressure to said subambient pressure region.

8. A lifting device as in claim 1 wherein said control means includes:

valve means connected to vent ambient air to said subambient pressure region.

9. A lifting device as in claim 8 including:

means for delivering a flow of pressurized gas to said nozzle means at a critical pressure ratio with respect to ambient pressure.

10. A lifting device as in claim 1 including:

gas turbine engine means for delivering a gas flow to said nozzle means at a critical pressure ratio.

11. A lifting device as in claim 10 wherein:

said gas turbine means is a fan engine; and including means for bleeding air from the fan of said engine to said nozzles.

12. A lifting device as in claim 10 including:

second nozzle means for delivering exhaust gas from said engine to flow along the upper surface of said body component between said lift elements to create lift.

13. A lifting device as in claim 1 wherein said body component includes:

a load compartment.

* * * * *

United States Patent [19]
Edwards
[11] 3,750,980
[45] Aug. 7, 1973

[54] **AIRCRAFT WITH VERTICAL TAKE OFF AND LANDING CAPABILITY**

[76] Inventor: **Samuel L. Edwards,** 212 Prince St., Newark, N.J. 07102

[22] Filed: **June 30, 1970**

[21] Appl. No.: **51,161**

[52] **U.S. Cl.** .... **244/12 C**
[51] **Int. Cl.** **B64c 17/02,** B64c 29/00
[58] **Field of Search** .... 244/12, 23, 93, 12 R, 244/12 C, 12 D, 36, 40, 1 R, 1 SS, 1 SA, 1 SB, 6, 7 R, 7 A, 73, 74

[56] **References Cited**

UNITED STATES PATENTS

3,632,065	1/1972	Rosta	244/12 C
3,335,976	8/1967	Kappus	244/23 B X
3,123,320	3/1964	Slaughter	244/12 C
3,067,967	12/1962	Barr	244/12 C
2,777,649	1/1957	Williams	244/23 C
3,507,461	4/1970	Rosta	244/12 C
3,437,290	4/1969	Norman	244/23 C
3,432,120	3/1969	Guerrero	244/93

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Assistant Examiner—Carl A. Rutledge
Attorney—Popper, Bain, Bobis and Gilfillan

[57] **ABSTRACT**

An aircraft with vertical landing and take off capability comprising a stator having a housing for control means as well as a cockpit for operational personnel and a turbine like rotor driven by reaction jets mounted on the stator, the turbine rotor having an air inlet on the upper surface of the stator and an air outlet on the bottom of the stator with means for directionally deflecting the air outlet for control purposes; the stator also including weight means mounted along the vertical axis of the stator and displaceable radially from the vertical axis.

6 Claims, 3 Drawing Figures

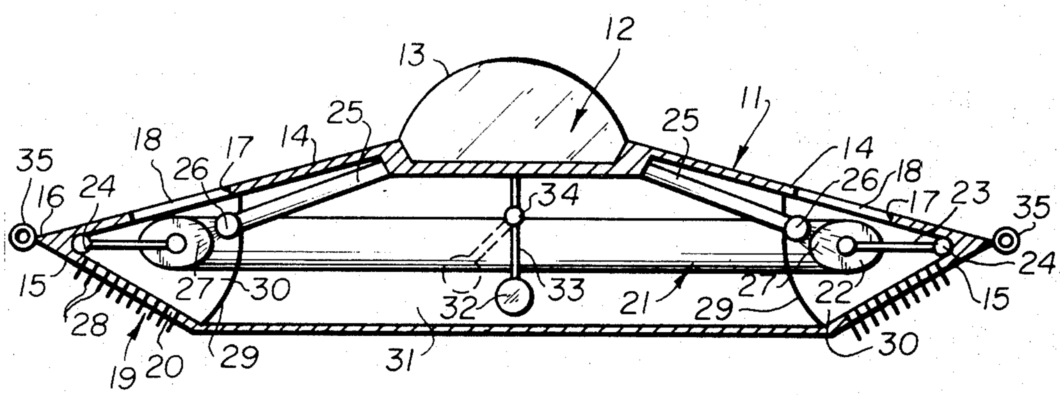


FIG. 1

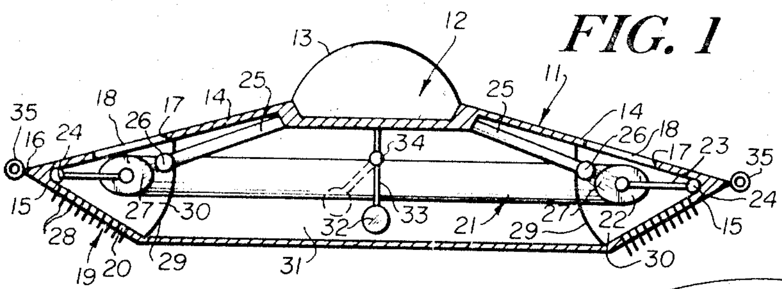


FIG. 2

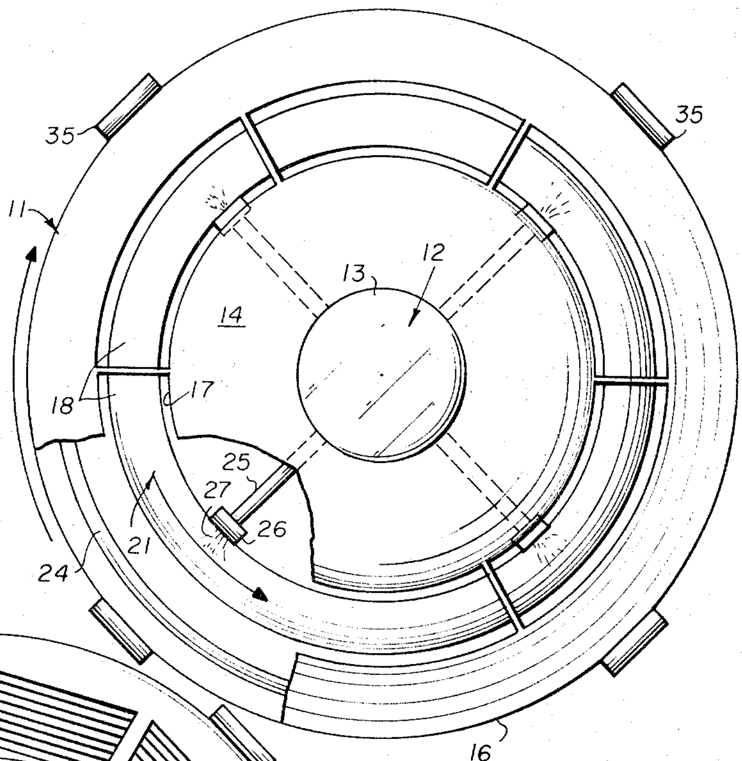
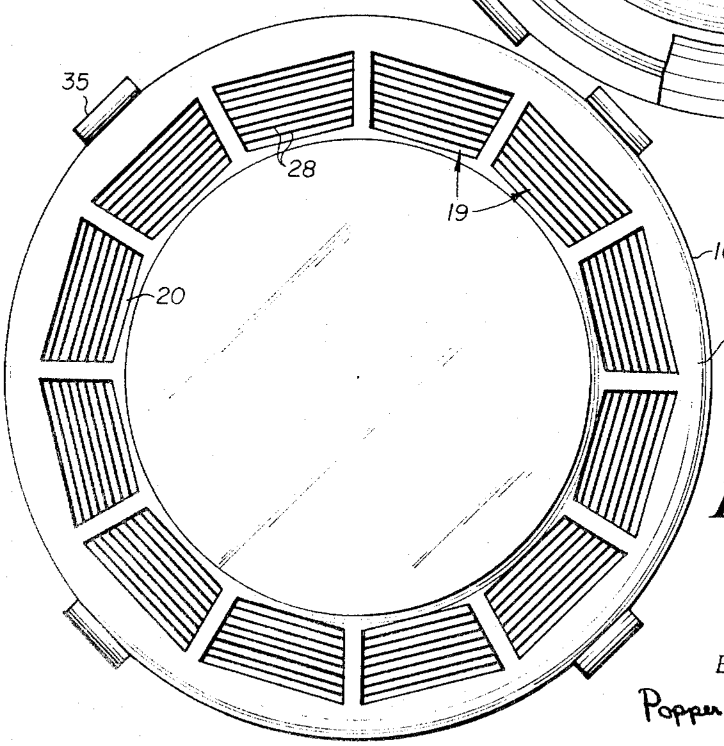


FIG. 3



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AIRCRAFT WITH VERTICAL TAKE OFF AND LANDING CAPABILITY

BACKGROUND OF INVENTION

Many vertical take off and landing aircrafts are known. Some are in the nature of helicopters characterized by at least one horizontally rotatable blade for the forcing of air downwardly to overcome the drag of gravity. Others are of the fixed wing variety having propulsion means, either propellers driven by conventional internal combustion engines or turbines or jet engines which engines are rotatable either independently of or simultaneously with the fixed wing. In still other fixed wing aircraft, the jet stream generated by a jet engine is deflectable downwardly to overcome the drag of gravity.

In all vertical take off and landing aircraft, control, particularly at sub-flight speeds for fixed wing aircraft is extremely critical and in many instances dangerously unstable. In addition, the aerodynamic structural characteristics of a vertical take off and landing aircraft are not consonant with high speed fixed wing aerodynamic demands.

It is among the objects and advantages of the present invention to provide a totally aerodynamically stable aircraft which has vertical take off and landing capabilities as well as high speed, aerodynamically stable straight flight capabilities.

Another object of the present invention is to provide an aircraft as aforesaid in which propulsion is generated by an annular, rotatable turbine capable of forcing very large quantities of air at relatively high velocities vertically downwardly with respect to the vertical axis of the aircraft.

A further object of the present invention is to provide an aircraft as aforesaid in which the turbine or rotor is driven by jet or rocket propulsion means.

Yet a further object of the present invention is to provide an aircraft as aforesaid in which control may be achieved by either deflecting the outlet air pass from the turbine or upsetting the vertical balance of the aircraft by weight displacement or a combination of the two.

SUMMARY OF INVENTION

An aircraft having vertical take off and landing capabilities comprising, a stator, an annular, rotatable turbine mounted within the stator generally coaxial therewith, reaction jet means mounted on the stator, the reaction jet from said means impinging upon the turbine to generate rotation, the stator having an air inlet opening above the turbine and an air outlet opening beneath the turbine, air deflection means in the air outlet opening, and rotational reaction-countering means on the stator positioned to balance the rotational reactive forces of the jet blast means and the turbine.

PREFERRED EMBODIMENT OF INVENTION

The objects and advantages aforesaid as well as other objects and advantages may be achieved by the aircraft claimed herein a preferred embodiment of which is illustrated in the drawings in which:

FIG. 1 is a side elevational cross sectional view of the aircraft;

FIG. 2 is a partially broken away top plan view of the aircraft; and

FIG. 3 is a bottom plan view of the aircraft.

Referring now to the drawings in detail, the aircraft comprises a stator **11** which is broadly disc-shaped having a circular peripheral configuration. The stator **11** includes a cockpit **12** covered by a transparent cowling **13.** The stator **11** which is analogous to the fuselage of a thick wing aircraft comprises a generally outwardly and downwardly incline annular top wall **14** and an annular inwardly and downwardly inclined bottom wall **15.** The top and bottom walls **14** and **15** are formed upon or engaged to each other at a periphery **16.**

The top wall **14** is provided with openings **17** spaced around the periphery of the aircraft and near the juncture between the top wall **14** and bottom wall **15.** Preferably, the opening **17** is continuous around the periphery of the wall **14** save for radial structural members **18** which extend across the annular opening **17.**

Similarly, the bottom wall **15** is provided with an opening **19.** The opening **19** is similar to the opening **17** in that it preferably extends annularly around the general periphery of the aircraft interrupted only by structural members **20.** An annular turbine **21** is mounted within the stator **11** with the turbine blades **22** positioned generally between openings **17** and **19.** The turbine **21** is provided with a mounting rib **23** which extends radially outwardly to the juncture between the top wall **14** and bottom wall **15** of the stator **11.** A bearing **24** at the radially outward end of the rib **23** provides a low friction mounting between the rotatable turbine **21** and the stator **11.**

The stator **11** is provided with a plurality of radial arms **25** extending outwardly from the cockpit **12** and terminating inwardly of the turbine **21.** Each of the arms **25** is provided with jet blast generating means **26** on its radially outward end. The jet blast **27** is directed at the upper portion of the turbine **21** in such a manner as to induce and generate rotation in the turbine.

Opening **18** in the top wall **14** of the stator **11** functions as an air inlet for the turbine **21.** Similarly, opening **19** in the bottom wall **15** of the stator **11** functions as an air outlet for the turbine **21.** Air is sucked inwardly through the air inlet opening **17** by means of rapid rotation of the turbine **21** generated by the jet blast means **26** and forced outwardly under high velocity through the air outlet opening **19.** The air outlet opening **19** is provided with air deflection vanes **28** which are movable in response to controls in the cockpit **12.**

The stator is also provided with an internal wall **29** isolating the turbine chamber **30** from the remainder of the stator **11.** The wall **29** also defines a second chamber **31** in the stator **11** which may be closed at the bottom or open as desired. The chamber **31** can provide additional carrying space for the aircraft.

In operation, the jet means **26** which may be rocket or conventional turbine jets are energized so that the jet blast **27** engages the turbine blades **22** of the turbine **21.** The turbine **21** rapidly rotates drawing air in through the air inlet **17** and forcing it out under high velocity through the air outlet **19.** In order to control the direction of air passing through the outlet **19,** the vanes **28** may be moved selectively at various positions on the stator **11.** Thus, most of the air can be forced downwardly to overcome gravity lifting the vehicle vertically upwardly. When translation of movement is desired, some of the vanes **28** may be oriented to deflect the air more radially outwardly thereby creating a horizontal vector. In addition, if all of the vanes **28** are positioned to deflect the air radially outwardly on a symmetrical basis the vertical vector of lift will be decreased without generating an unbalanced horizontal vector.

Another means of control is also illustrated in the drawings and comprises a weight **32** mounted on a shaft **33** on the vertical axis of the stator **11.** A universal joint **34** controlled from within cockpit **12** can displace the weight **32** from the vertical axis of the stator **11** as illustrated in broken lines in FIG. **1.** Displacement of the weight **32** causes the stator **11** to rotate around a horizontal axis of choice depending upon the radial position of weight. This in turn causes the stator **11** to tip generating force vector for translational flight.

The jet blast means **26** employed to generate rotation in the turbine **21** also generate rotational reaction forces in the stator **11.** These rotational reactive forces must be overcome otherwise the stator would tend to rotate in a direction opposite from that of the turbine **21.** In order to overcome these rotational reactive forces, a plurality of counterbalancing jets **35** are mounted on the periphery of the stator **11.** The jets **35** generate a counterbalancing force to the jets **26.** In addition, the vanes **28** could be rotationally deflected to provide some counter rotational forces to overcome the reactive rotational forces generated by the jets **26.**

The foregoing description is merely intended to illustrate an embodiment of the invention. The component parts have been shown and described. They each may have substitutes which may perform a substantially similar function; such substitutes may be known as proper substitutes for the said components and may have actually been known or invented before the present invention.

What is claimed is:

1. An aircraft having vertical takeoff and landing capabilities comprising,

a. a generally hollow housing,

b. an annular turbine mounted for rotation within the housing,

c. fixed reaction jet means mounted within the housing to impinge said jet upon the turbine,

d. the housing having upper air inlet opening means immediately above the turbine and lower air outlet opening means immediately beneath the turbine,

e. the jet means generating sufficient rotation of the turbine to induce a lift-producing flow of air downwardly through the upper air inlet opening means and outwardly through the lower air outlet opening means, exhaust from the jet means passing downwardly and outwardly through the lower air outlet opening means,

f. air deflection means in the lower air outlet opening means, and

g. rotational reaction-countering means on the housing positioned to balance the rotational reactive forces of the said fixed reaction jet means and the tubine.

2. An aircraft having vertical take-off and landing capabilities comprising,

a. the structure in accordance with claim **1** in which,

b. said air deflection means being adjustably movable to deflect the said stream of air eminating from the lower outlet opening means sufficient to counter rotatable reaction induced in the housing from said jet means and turbine.

3. An aircraft having vertical takeoff and landing capabilities comprising,

a. the structure in accordance with claim **1** and

b. means for moving the center of gravity of the aircraft radially with respect to the turbine including weight means mounted on a vertical shaft extending through the nominal center of gravity of the aircraft, said weight means being movable both in vertical and horizontal planes.

4. An aircraft having vertical take-off and landing capabilities comprising,

a. the structure in accordance with claim **1,** and

b. a conduit in the housing, the conduit extending between the said upper air inlet opening means and lower air outlet opening means,

c. the turbine lying within the conduit intermediate the opening means.

5. An aircraft having vertical takeoff and landing capabilities comprising,

a. the structure in accordance with claim **2** and

b. means for moving the center of gravity of the aircraft radially with respect to the turbine including weight means mounted on a vertical shaft extending through the nominal center of gravity of the aircraft, said weight means being movable both in vertical and horizontal planes.

6. An aircraft having vertical takeoff and landing capabilities comprising,

a. the structure in accordance with claim **5** in which

b. a control means including universal mounting means for the said shaft movable simultaneously in vertical and horizontal planes.

* * * * *

United States Patent [19]
Pinto

[11] **3,774,865**
[45] **Nov. 27, 1973**

[54] FLYING SAUCER

[76] Inventor: **Olympio F. Pinto,** Rua Visconde de Ouro Preto, 63, Rio De Janeiro, Brazil

[22] Filed: **Jan. 3, 1972**

[21] Appl. No.: **214,653**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 40,596, May 26, 1970, abandoned.

[52] **U.S. Cl.** .... **244/23 C,** 244/42 CG
[51] **Int. Cl.** **B64c 29/00**
[58] **Field of Search** .... 244/12 R, 12 C, 23 R, 244/23 C, 62 XR, 1 SS; 310/5, 6

[56] **References Cited**

UNITED STATES PATENTS

2,949,550	8/1960	Brown	244/62 XR
3,022,430	2/1962	Brown	310/5
3,022,963	2/1962	Frost et al.	244/15
3,339,863	9/1967	Nicklas et al.	244/1 SS
3,614,481	10/1971	Halliday	310/6
3,632,065	1/1972	Rosta	244/12 C

FOREIGN PATENTS OR APPLICATIONS

678,700	11/1959	Canada	244/23 C

OTHER PUBLICATIONS

Graff, R. F. Modern Dictionary of Electronics; 3rd Ed. p. 569.

Primary Examiner—Duane A. Reger
Assistant Examiner—Jesus D. Sotelo
Attorney—Keith D. Beecher

[57] ABSTRACT

A flying saucer type of aircraft or water vehicle is provided, which may take the form of a toy, or of an actual full-sized passenger and cargo carrying vehicle. The vehicle of the invention includes a cicular-shaped body comprising an outer rim portion and an inner hub portion, and upper and lower groups of rotor helicopter-like blades, each formed into a disc-shaped configuration, and rotatable about the central vertical axis of the hub in the annular space between the hub and rim. The helicopter blades are mounted on fluid bearings in the body, and are rotatably driven by turbine action. The two groups of helicopter blades define a pressurized chamber therebetween. Exhaust ports are provided on the rim which may be selectively opened to control the attitude of the vehicle, as well as to maneuver and control the direction of movement of the vehicle, once it is airborne. The pitch of the rotor helicopter blades is controllable, so that the pressurized fluid in the aforesaid chamber may be directed through the top or bottom of the assembly to control the lift or descent of the vehicle.

5 Claims, 12 Drawing Figures

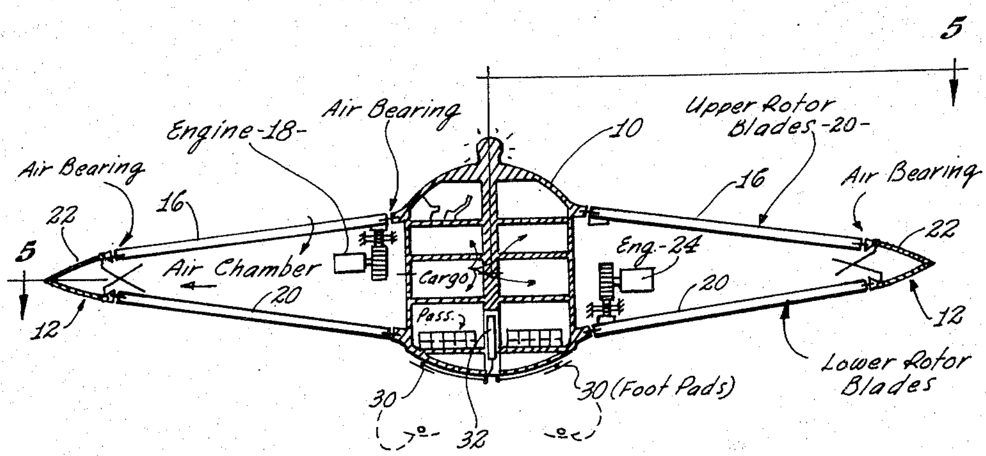

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Fig. 1

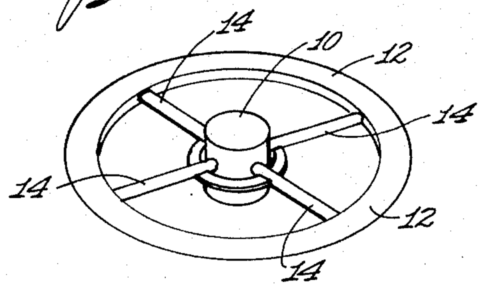


Fig. 2

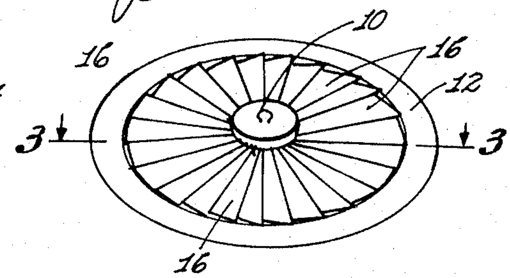


Fig. 3

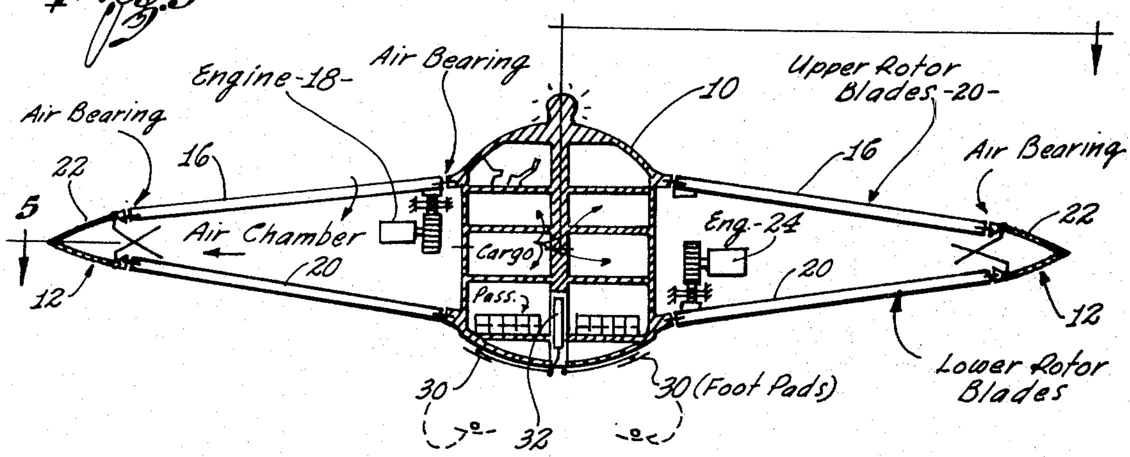


Fig. 4

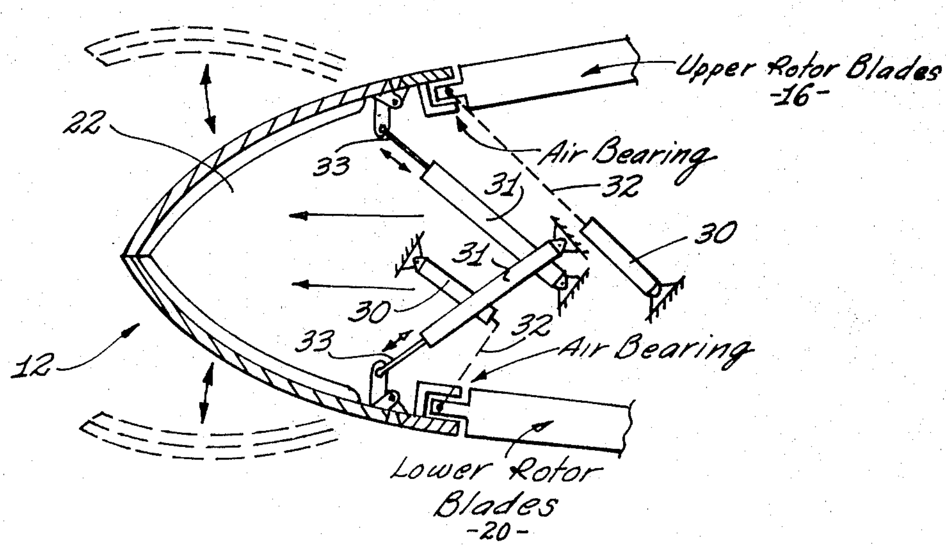


Fig. 5

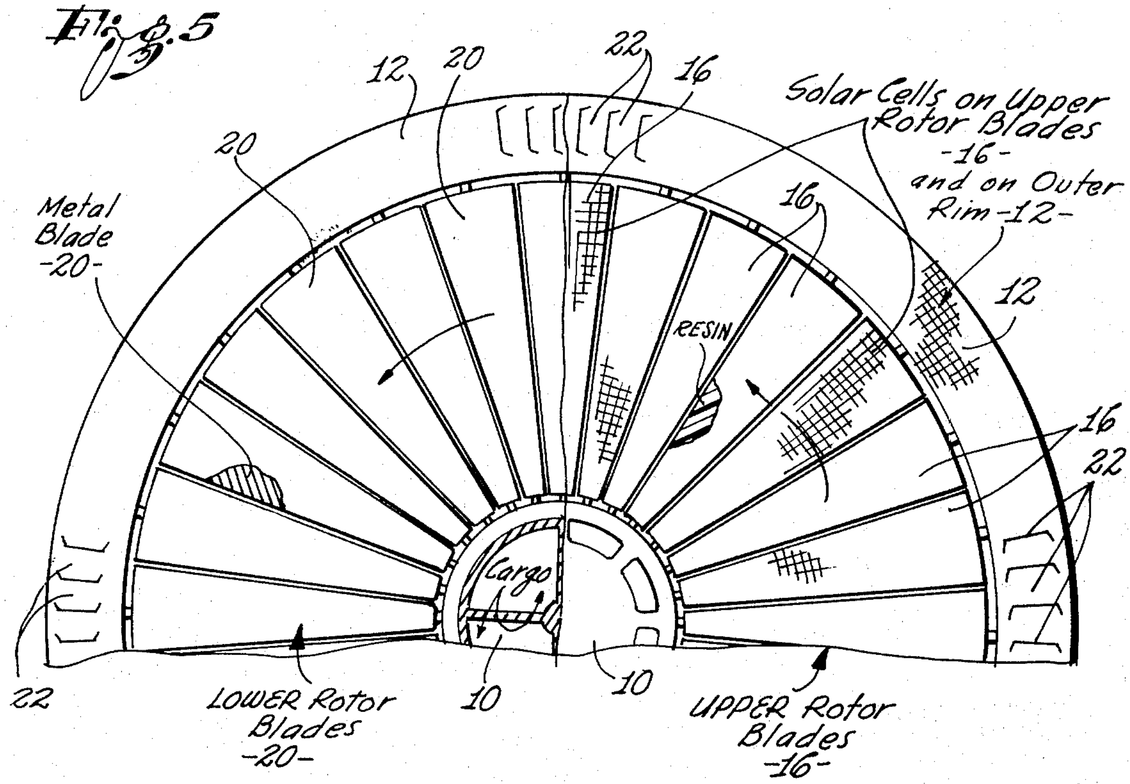


Fig. 6

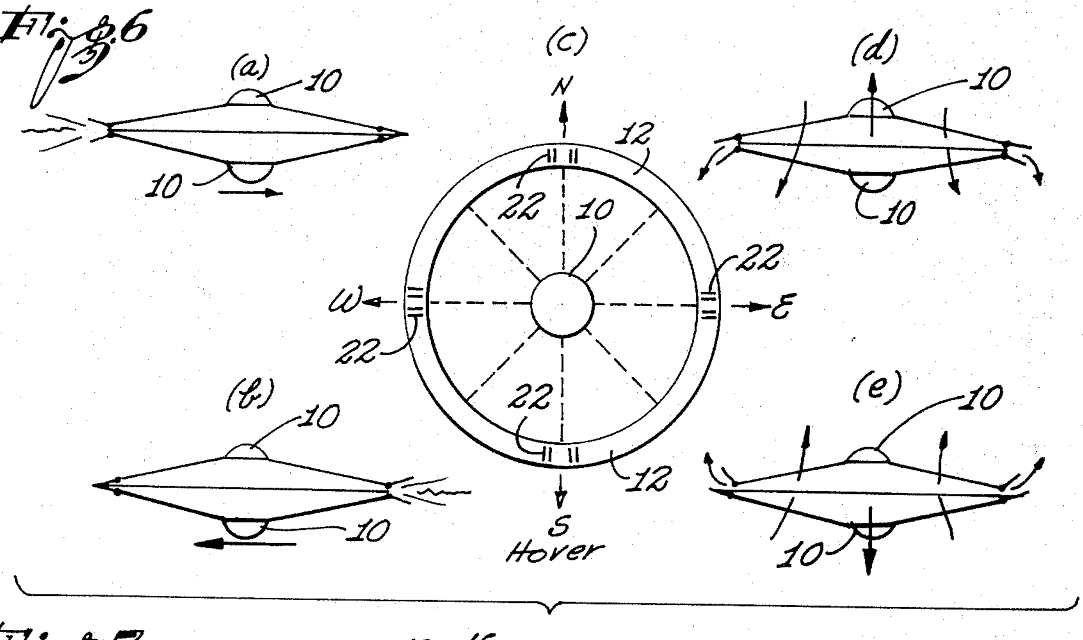


Fig. 7

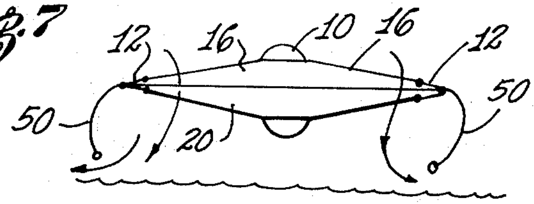


Fig. 4A

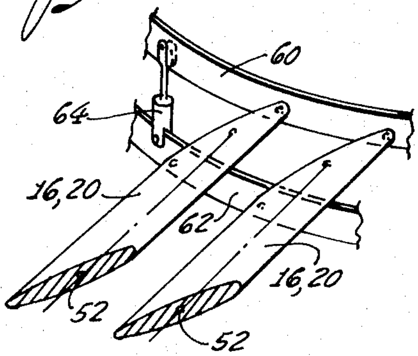
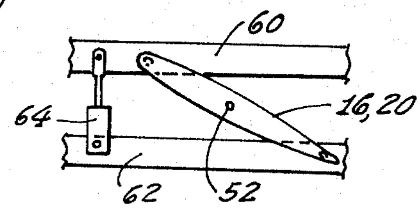


Fig. 4B



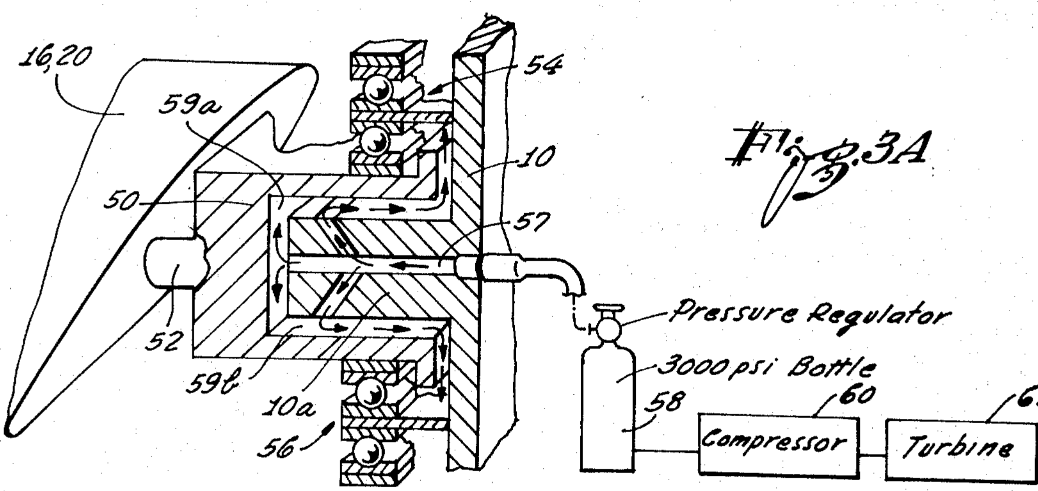


Fig. 3A

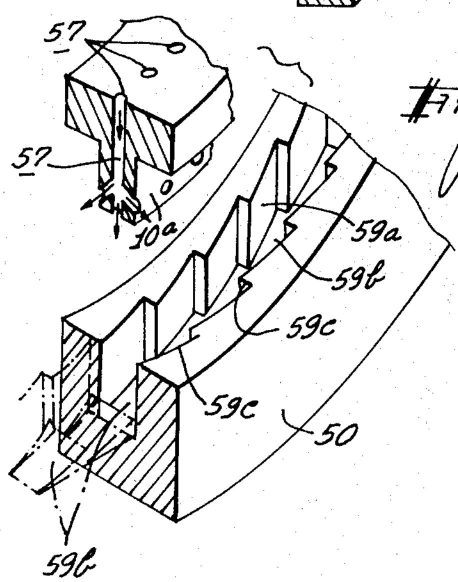


Fig. 3B

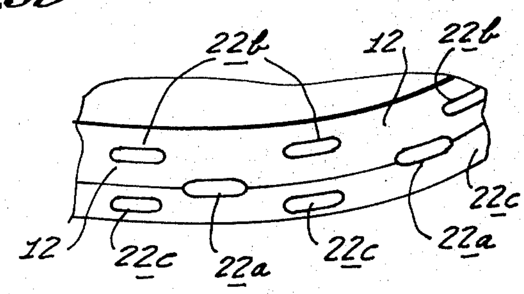


Fig. 4C

FLYING SAUCER

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of copending application Ser. No. 40,596, which was filed May 26, 1970, in the name of the present inventor and is now abandoned.

BACKGROUND OF THE INVENTION

The usual present day aircraft comprises a fuselage and a pair of wings, the wings being attached to the fuselage and extending outwardly on either side thereof. Such an aircraft is normally propelled through the air by means of a propeller or jet engines mounted on the wings, or elsewhere on the aircraft. The present day helicopter, on the other hand, comprises a central cabin, with rotating blades supported above the cabin, the blades having controllable pitch so as to provide lift and directional movement to the helicopter.

Disc-shaped vehicles are also known to the art, which incorporate some of the principles of the present day helicopter, and which are popularly designated as "flying saucers." Such vehicles are described, for example, in Canadian Patent No. 678,700 which issued Jan. 28, 1964; as well as in U.S. Pat. Nos. 3,395,876 and 3,437,290. However, difficulties have been encountered in the vehicles of the prior art, such as those described in the aforesaid patents, in providing appropriate means for driving the rotating helicopter blades in the vehicles without adding excessively to the weight of the vehicle or to the complexity of the drive mechanism. Difficulties also have been encountered in providing adequate attitude control for the vehicle, and adequate pitch control for its helicopter blades.

The vehicle of the present invention, like the prior art vehicles described in the aforesaid patents, incorporates some of the principles of the present day helicopter. The vehicle to be described has a disc-shaped "flying saucer" configuration, and it is capable of vertical ascents and descents, and of hovering over fixed locations. In addition, the vehicle of the invention exhibits excellent maneuverability characteristics and can readily be flown in any desired direction when it is airborne. The vehicle also incorporates simple and efficient attitude controls. Moreover, the vehicle of the invention may be constructed to exhibit amphibious characteristics, and to be propelled over the surface of water; or it may even be submersible, if so desired.

The embodiment of the invention to be descibed includes additional features in the form of solar cells and static electric generating means mounted directly on the helicopter blades, so as to constitute a source of electricity for the vehicle, as well as a means to facilitate movement of the vehicle through the air or water. This is an important feature, since weight is at a premium in vehicles of the type under consideration, and an appropriate source of power normally requires excessive weight. By the construction to be described, the vehicle itself operates as an electric generating source, so that adequate power is available with no significant addition in weight.

The saucer-like vehicle of the invention, as mentioned above, incorporates two groups of rotor helicopter-like blades. In the particular embodiment to be described herein, these blades are mounted in a simple and expeditious manner on appropriate air bearings in the body of the vehicle so as to provide a simple low friction rotational support therefor. As also mentioned, the rotor blades are driven in a simple and efficient manner by turbine means, which is combined with the air bearings. By such a drive, the overall weight of the vehicle is maintained at a minimum, as is the mechanical complexity thereof.

As also explained, the upper and lower groups of rotor helicopter blades of the vehicle define an enclosed chamber in the annular space between the central hub and the outer rim. This chamber is pressurized by varying the pitch of the rotor blades, so that the amount of air passing downwardly or upwardly through the chamber may be controlled so as to control the ascent or descent of the vehicle.

Also, vents are provided at the rim of the vehicle which may be selectively opened to create pressurized jets, as the pressurized fluid within the chamber passes through the opened vents, so as to control the attitude, maneuverability, and direction of travel of the vehicle, in a simple and uncomplicated method. The attitude control vents described above, which are supplied with pressurized fluid from the chamber between the upper and lower groups of helicopter blades, are useful for slight or delicate movements of the vehicle. Additional attitude and maneuverability control vents may be provided in the rim which are supplied with high pressure fluid from an appropriate compressor, for example, for quick movements of the vehicle.

SUMMARY OF THE INVENTION

A flying saucer, helicopter-type vehicle is provided which has no mechanical connection between the rotor blades and frame of the vehicle, and in which the rotor blades are suspended by air bearings, and rotated by an air turbine. Attitude control of the vehicle is effectuated by pressurized air jets which issue from the rim of the vehicle, and which may be selectively controlled to direct the vehicle in selected directions and to control the attitude of the vehicle. These features of the vehicle of the invention make it economically and industrially feasible.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top perspective view of the basic frame structure of the invention;

FIG. 2 is a top perspective view showing one embodiment of the saucer-like vehicle of the invention;

FIG. 3 is a cross-section of the embodiment of FIG. 2, taken along the lines 3—3 of FIG. 2, and on an increased scale with respect to FIG. 2;

FIGS. 3A and 3B are perspective fragmentary sections illustrating portions of an air turbine which is used to drive the rotor which supports the helicopter blades of the vehicle;

FIG. 4 is a fragmentary sectional view, on an enlarged scale, and showing an appropriate mechanism for controlling the pitch of the aforesaid helicopter rotor blades, and for selectively opening and closing vents in the rim of the vehicle for attitude and maneuverability control;

FIG. 4A is a fragmentary perspective representation showing an alternate mechanism for controlling the pitch of the aforesaid helicopter blades;

FIG. 4B is a fragmentary elevational view of the mechanism of FIG. 4A;

FIG. 4C is a fragmentary elevational representation of a part of the rim of the vehicle showing the displacement of the various vents from which the maneuverability and attitude control jets issue;

FIG. 5 is a fragmentary top plan view of a part of the vehicle, partly broken away to reveal the structure of the radial rotor helicopter blades of the vehicle of the invention;

FIGS. 6A–6D are schematic representations showing the maner in which the vehicle of the invention may be maneuvered; and

FIG. 7 shows the vehicle with a retractable flexible skirt which may be lowered from the rim to permit the vehicle to hover, for example, closely over the surface of a body of water.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

The saucer-like vehicle illustrated in FIGS. 1–3, for example, includes a central hub **10** and an outer rim **12**, which, together, constitute the body of the aircraft. The hub **10** and rim **12** both have circular configurations, and they are mounted in concentric relationship by means, for example, of a plurality of radial struts **14**, as shown in FIG. **1**. The rim and struts may be hollow and filled with light gas to aid in the buoyancy of the vehicle.

The annular space between the hub and rim of the vehicle is enclosed by an upper group of helicopter-like rotor blades **16**, and by a lower group of helicopter rotor blades **20**. The two groups of blades form a pressurized chamber therebetween, as shown in FIG. **3**. The outer rim of the said chamber is hermetically sealed, so that the chamber may be pressurized, for reasons to be explained.

The upper disc-shaped group of rotor helicopter-like blades **16** (FIG. **2**) extend radially outwardly from the hub **10** toward the rim **12**, the blades **16** being rotatable in one direction about the central vertical axis of the hub **10**. The rotor blades **16** are driven, for example, by an air turbine, as will be described. The lower group of rotor helicopter blades **20** extend radially out from the lower end of the hub **10** to the rim **12**, and the lower blades are rotatable in the opposite direction from the blades **16** about the vertical axis of the hub **10**. The lower group of helicopter blades **20** is also driven by an air turbine, as will be described.

As best shown in FIGS. 3A and 3B, for example, the helicopter blades **16** are actually mounted at their inner ends on a rotor ring **50** which is rotatably supported in air bearings for rotation about a radial peripheral stub **10a** on the hub **10**; the stub being concentric with the central vertical axis of the hub. The lower blades **20** are supported on a similar ring which rotates about a similar stub at the lower end of the hub **10**. Each of the blades **16** and **20** in the upper and lower groups is supported on the ring **50** by means, for example, of a shaft **52**, so that the individual blades may be rotated about its longitudinal axis to control its pitch. The blades **16** and **20** are also supported in respective rotor rings, similar to the ring **50**, at their outer ends for rotation in similar air bearings at the rim **12**. Ball bearings **54, 56** are also mounted on the hub **10** to support the rotor rings, such as the ring **50**, when the vehicle is at rest.

High pressure compressed air derived, for example, from a pressurized source **58**, is driven through vents **57** in the peripheral stub **10*a*** and into the space between the stub and rotor ring **50** to serve, not only as an air bearing for the rotor, but also as a turbine. The turbine serves to drive the rotors **16** and **20** about the vertical axis of the hub **10**. The pressurized air jets issuing from the vents in the stub **10a** coact with three different sets of turbine blades **59*a*, 59*b*** and **59*c***, formed on the base and side walls of a peripheral groove in the rotor ring **50**. In this manner, a three-way air bearing turbine is provided which supports the rotor ring **50** on an air film, and which also drives the rotor ring **50** and the attached rotor blades **16** about the vertical axis of the hub **10**. Duplicate air bearing turbines may be provided at the upper and lower ends of the hub **10** for respectively driving the rotor blades **16** and **20**, and duplicate air bearing/turbine combinations may be provided at the outer rim for the same purpose.

As illustrated schematically in FIG. **3A**, the pressure source **58** may be in the form of an air bottle which is established at 3000 psi pressure by means of a compressor **58** which, in turn, may be driven by an appropriate turbine **62**.

The pitch of the helicopter blades **16** and **20** may be controlled by appropriate control mechanisms, such as cylinders **30** shown in FIG. **4**, which are coupled by means of appropriate linkages **32** to the various blades. The cylinders **30** may be actuated in any appropriate manner, so as to provide any desired pitch to the blades **16** of the upper group, or to the blades **20** of the lower group, and thereby control the ascent or descent of the vehicle.

As an alternate pitch control, and as shown in FIG. 4A and 4B, the blades **16** and **20** may be individually supported between rings **60** and **62** at each end of each blade in the respective groups. The spacing between the rings **60** and **62** may be controlled by an appropriate hydraulic air cylinder **64** which, like the air cylinders **30** and **31**, may be controlled by any appropriate means so as to control the spacing between the rings **60** and **62**, and the resulting rotation of the blades **16** and **20** about their individual shafts **52**.

Groups of exhaust vents designated **22** are provided in the rim **12**, and these vents may be positioned in the manner shown in FIG. 4C. Specifically, certain vents **22*a*** are positioned at the extremity of the rim, so that when such vents are opened, the resulting air jets extend radially in the general plane of the vehicle. Other vents **22*b*** are provided in the upper face of the rim **12**, so that when the vents **22*b*** are selectively opened, air jets extending up from the plane of the vehicle issue therefrom. Still further vents **22*c*** are provided in the lower surface of the rim, and when the latter vents are selectively opened, the resulting air jets extend down from the plane of the vehicle. As will be described, the selective opening of the jets **22*a*, 22*b*** and **22*c*** provides an effective means for controlling the attitude of the vehicle, as well as to maneuver the aircraft and to control its direction of flight.

The exhaust vents **22*a*, 22*b*** and **22*c*** may be selectively opened and closed by air cylinders, such as the air cylinders **31**, and by appropriate linkages **33**, for example, as shown in FIG. **4**. Certain of the air vents **22** may be connected to the interior of the chamber between the hub **10** and the rim **12**, so that when such vents are opened, pressurized fluid in the chamber is caused to be discharged through the open vents as jets. For example, when jets **22*a*** at selected annular positions on the periphery of the rim **12** are opened, the aircraft is caused to move in a desired direction. In addition, the attitude of the craft may be controlled, or the vehicle may be maneuvered, when selected vents **22*b*** and **22*c*** are opened on the upper or lower surface of the rim. Others of the vents may be connected directly to a high pressure compressed source, for rapid speed or maneuverability of the vehicle. The chamber between the rotor blades **16** and **20** may be pressurized from any appropriate source.

The various movements of the vehicle under the control of the vents **22** are illustrated in the schematic representation of FIG. **6**. For example, in FIG. **6**A, the left hand group of upper and lower vents **22*b*** and **22*c*** are opened (or vents **22*a*** are opened) to cause the vehicle to move to the right; in FIG. **6**B, the right hand group of the upper and lower vents **22*b*** and **22*c*** (or vents **22*a***) are opened to cause the vehicle to move to the left. In FIG. **6**C, all the lower vents **22*c*** are opened to cause the vehicle to hover over a particular location. In FIG. **6**D, all the upper vents **22*b*** are closed, and all the lower vents **22*c*** are opened, and the pitch of the upper and lower helicopter blades **16** and **20** is adjusted to a position so that air is drawn in through the top of the annular chamber between the hub **10** and rim **12** and discharged out through the bottom of the chamber and through the lower vents **22*c***, as shown by the arrows, so as to cause the vehicle to move directly upwardly. In FIG. **6**E, the pitch of the helicopter blades is adjusted and the upper vents **22*b*** are opened, so that the opposite situation occurs, and the vehicle is moved directly down. As mentioned above, the attitude of the aircraft, for example the pitch and roll thereof, may be controlled by selectively opening the upper and lower vents of the different groups.

In the vehicle of the invention and as described, the drive and support of the helicopter blades is relatively simple and economically feasible. Likewise, the pitch control of the blades is achieved by relatively simple mechanical means, which can be remotely controlled in a variety of ways known to the art. In the construction described above, the upper rotor blades **16** have a synchronous pitch for all blades, and the lower blades have a synchronous pitch, when the control is achieved through the rings **60** and **62**, as described in conjunction with FIGS. **4**A and **4**B. Because of the resulting perfectly symmetrical pitch between all the blades, they have a gyroscopic effect which is useful to stabilize and navigate the vehicle.

Another feature of the structure described above is that the upper blades **16** and the lower blades **20** may rotate at different relative rates, and their drives are independent of one another. This enhances the safety of the vehicle, since either the upper blades **16** may be driven alone, the lower blades **20** may be driven alone, or both groups of blades may be driven. Also, the vehicle may operate with the blades stationary, and by the selective control of the air vents described above.

As shown in FIG. **5**, solar cells may be provided in the upper helicopter blades **16** and on the outer rim **12**, and on any other available space on the top surface of the vehicle, so that the sun's energy may be converted into electrical energy for use in the vehicle, and appropriately stored. The electrical energy may be stored in capacitors in known manner, and used either directly to drive electric motors for the air compressors, or to supply other electrical energy for the vehicle.

Likewise, the under-surfaces of the upper blades **16** may be metalized, and the upper surfaces of the lower blades **20**, may be formed of a resin material, as shown in FIG. **5**, and appropriately placed grounding means and brushes provided for the metalized blades, so as to constitute a Wimhurst electrostatic generator. Then, as the blades rotate, the brushes are caused to generate a high voltage static electricity. The resulting electricity from the brushes may be stored in high voltage condensers and used, for example, to charge batteries incorporated into the electrical system of the vehicle. The condensers may be positioned in compartments in the rim **12** of the vehicle.

It is also possible to insulate the rim **12** from the remainder of the vehicle, and to provide an electric charge on the rim from the static electricity generator formed by the blades **16** and **20**, and thereby facilitate the movement of the vehicle through the atmosphere. It has been found that a high voltage electrically charged body passes more easily through the atmosphere than one without such a charge, due to the ionization of air flowing around the attack edge of the aircraft.

As mentioned above, all empty spaces within the vehicle may be filled with light gas, such as helium, to reduce the effective weight of the vehicle as much as possible. Moreover, by selectively accumulating positive or negative static charges on one side of the vehicle, it will be attracted or repelled from other bodies having opposite or like charges. This latter effect can be used for docking purposes with an orbital space station.

As shown in FIG. **7**, a flexible skirt **50** may be lowered from the periphery of the rim **12** for hovering purposes. The skirt may be retracted by any suitable mechanism when not in use.

As mentioned above, the pressurized air for the air bearings and turbine drive, as well as for the air cylinders **30** and **31**, and **64**, and for maneuvering the vehicle by direct supply to selected ones of the air vents **20**, may be supplied by appropriate air compressors, such as by the compressor **60** of FIG. **3**A. The turbine drive of the rotor blades **16** and **20** is advantageous in that it obviates the need for complicated mechanical coupling mechanisms between the drive motor and the rotor blades, as mentioned above. The central hull and all controlling equipment and accessories of the vehicle may be made air tight and water tight, for use of the vehicle, on or under the surface of water. When used underwater, water pumps will be used in place of air compressors to provide water bearings, rather than air bearings, and to cause water jets to issue through the vents **22**, rather than air jets.

The invention provides, therefore, a saucer-like vehicle which is constructed in a relatively simple manner to enable the vehicle to exhibit all the characteristics of present day helicopters, insofar as vertical ascent and descent and hovering capabilities are concerned, and also to exhibit excellent maneuverability characteristics. The vehicle of the invention is relatively inexpensive to build, and it is simple to operate. As mentioned above, the vehicle of the invention may be designed as a toy, or as an actual full-sized vehicle for transporting passengers and cargo.

An important feature of the present invention is the drive of the rotor through the combined air bearings and air turbine concept, as described above. In the construction described herein, the rotor blades **16** and **20** are mounted on rotor rings which foat in air bearings, with high pressure air being directed against turbine blades in the rings, so as to drive the rotor. The relatively large diameter of the air bearings, together with the combined effect of the two inner and two outer air bearing/turbine mechanisms, provides enormous torque, and sufficient to drive the vehicle in a highly efficient manner.

The structure of the present invention also has a feature of a sealed annular chamber between the inner hub and outer rim, with selectively operated vents on the upper rim for controlling the direction of flight and the attitude of the aircraft, as described. As also described, electrical energy for the aircraft may be provided by causing the aircraft itself to operate as a generator, in the described manner, so that additional heavy electrical generating equipment is not required.

The invention provides, therefore, an improved saucer-like helicopter-type vehicle which has a minimum of moving parts, and which has a high safety factor. Moreover, the vehicle of the invention is relatively inexpensive to construct, so as to be commercially feasible. Moreover, it is light, and may be easily maneuvered.

While particular embodiments of the invention have been shown and described, modifications may be made, and it is intended in the following claims to cover all modifications which come within the spirit and scope of the invention.

What is claimed is:

1. A vehicle comprising: a disc-shaped body having a hub portion and a rim portion; means supporting said hub portion and said rim portion in spaced concentric relationship; upper and lower groups of helicopter blades; fluid bearing means supporting said helicopter blades on said hub portion and on said rim portion of said body for rotation in opposite directions about said hub portion and around the central vertical axis thereof, so as to create a gyroscopic effect and maintain the vehicle in a stable position, said fluid bearing means including a ring member supporting said helicopter blades and rotatable about said central vertical axis, said ring member having turbine blades therein; means for introducing pressurized fluid into said ring member and against said turbine blades to cause said ring member to be supported on films of the fluid and to produce rotation of said ring member about said central vertical axis; said upper and lower groups of helicopter blades being spaced axially from one another along the axis of rotation thereof to define a pressurized annular chamber between said hub portion and said rim portion, said rim portion having a series of vents disposed around the periphery thereof in communication with said pressurized annular chamber; means for selectively opening said vents to cause fluid from said pressurized chamber to issue therefrom as jets to control the vehicle; and means coupled to the blades of said upper group and of said lower group to vary the pitch thereof, so as to control the flow of pressurized fluid through said chamber and thereby to control the lift of the vehicle.

2. The vehicle defined in claim **1**, and which includes solar cells mounted on the top side of the blades of said upper group to provide electrical energy for the aircraft.

3. The vehicle defined in claim **1**, in which the blades of said groups are formed of electrically insulated material and of electrically conductive material, respectively, to constitute a static electricity generator for generating electricity for the aircraft.

4. The vehicle defined in claim **2**, and which includes means for introducing electricity from said static electricity generator to said rim to create static electricity charges on said rim.

5. The vehicle defined in claim **1**, and which includes a retractable skirt mounted on said rim to extend down from the periphery thereof to permit the vehicle to hover over a particular location.

* * * * *

United States Patent [19]

Kissinger

[11] **3,871,602**

[45] **Mar. 18, 1975**

[54] **CIRCULAR WING AIRCRAFT**

[75] Inventor: **Curtis D. Kissinger,** Gloversville, N.Y.

[73] Assignee: **Panaflight Corporation,** Albany, N.Y.

[22] Filed: **Sept. 4, 1973**

[21] Appl. No.: **394,195**

Related U.S. Application Data

[63] Continuation of Ser. No. 198,704, Nov. 15, 1971, abandoned.

[52] **U.S. Cl.**........................ **244/13,** D12/78, 46/78, 244/34 A, 244/45 R

[51] **Int. Cl.**.. **B64c 3/12**

[58] **Field of Search**........ 244/12 R, 12 C, 13, 23 R, 244/23 C, 34 R, 34 A, 35 R, 45 R; D12/71, 78; 46/74 R, 76 R, 78

[56] **References Cited**

UNITED STATES PATENTS

1,523,994	1/1925	Myers	244/35 R
1,726,558	9/1929	Hall	244/13
2,063,456	12/1936	Nemeth	244/35 R
2,713,465	7/1955	Novinger	244/45 R X
2,864,567	12/1958	Kissinger	244/13
2,957,647	10/1960	Shew	244/45 R X
3,078,062	2/1963	Fischer	244/12 C X
3,081,965	3/1963	Shew	244/12 CW
3,138,347	6/1964	Rodriguez	244/12 R
D177,547	4/1956	Wen	D12/78
D198,249	5/1964	Sleeman et al.	D12/71

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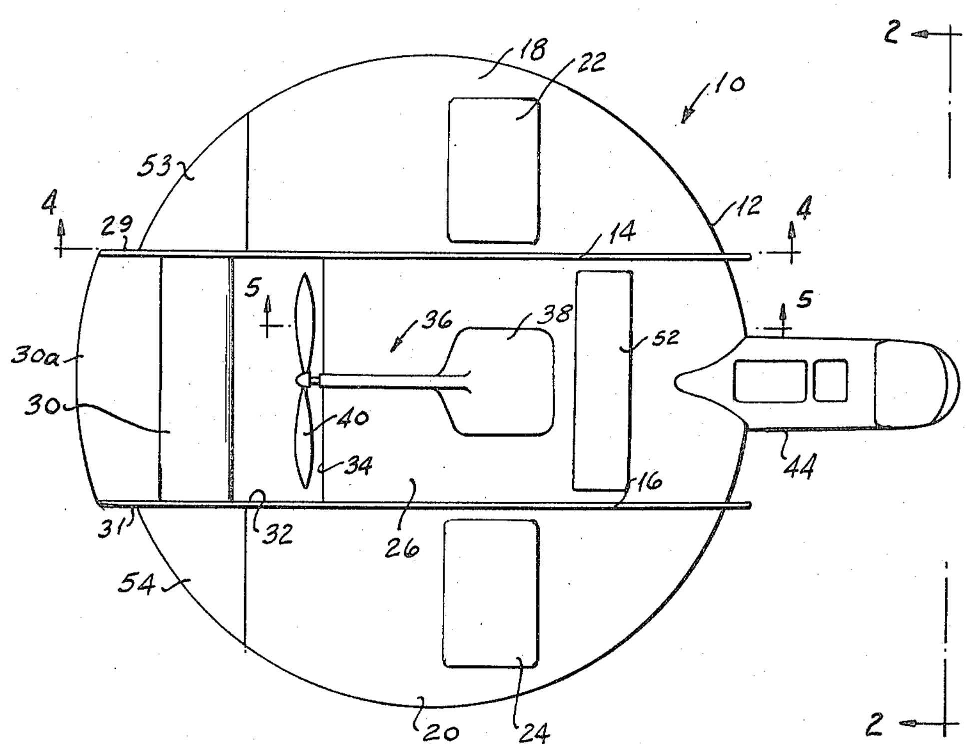
Attorney, Agent, or Firm—Shenier & O'Connor

[57] **ABSTRACT**

An improved circular wing aircraft in which the main airfoil is of generally circular shape having a pair of vertical stabilizers running along chords of the circle and equally spaced from the longitudinal axis of the craft from points just ahead of the leading edge of the craft to points behind the trailing edge thereof in which a cut-out portion of the airfoil is displaced rearwardly and held in an elevated position by the vertical stabilizers so as to form a space in which a pushed prime mover is located. The central portion of the wing between the vertical stabilizers is provided with an undercamber.

6 Claims, 5 Drawing Figures



PATENTED MAR 18 1975

3,871,602

SHEET 1 OF 2

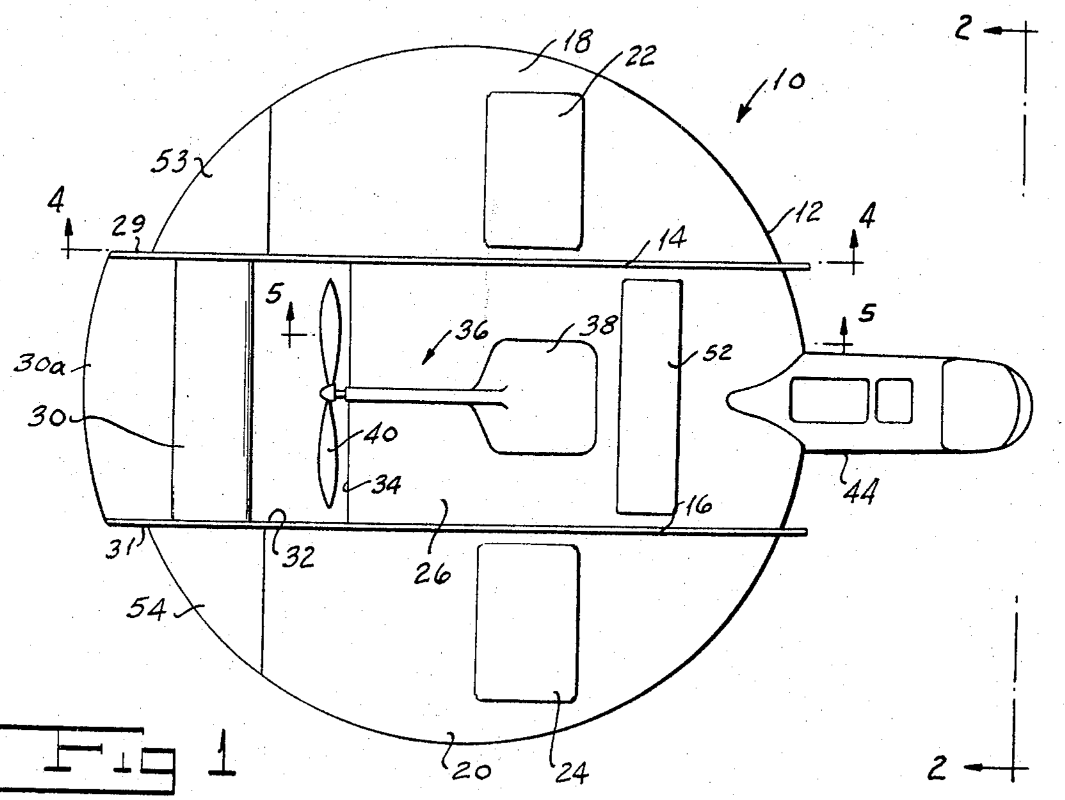


Fig 1

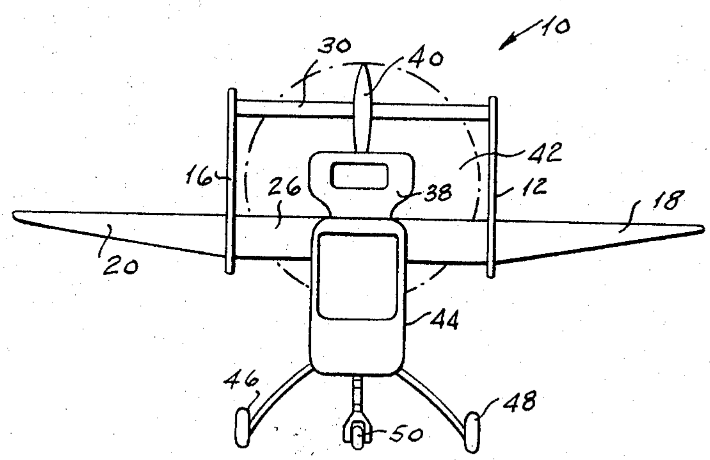


Fig 2

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Shoemaker & Mattare
ATTORNEYS

Fig 3

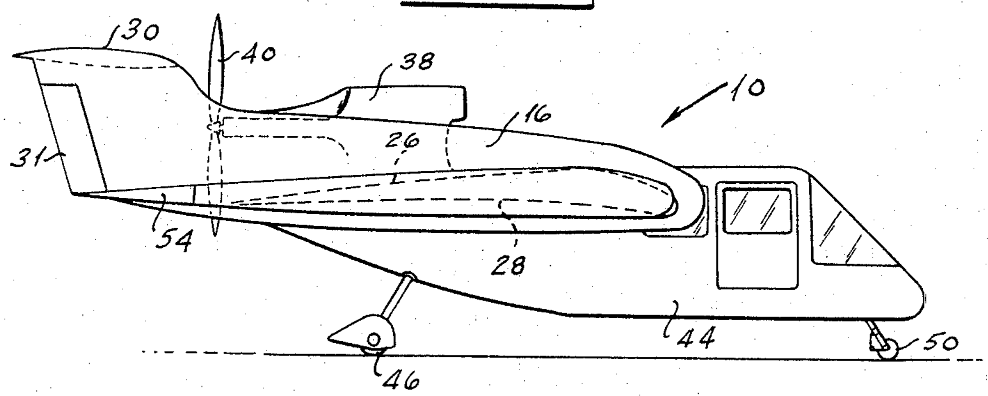
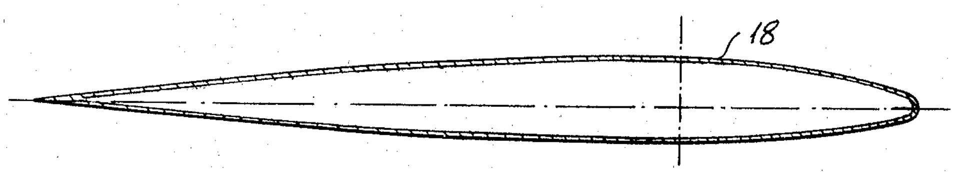


Fig 4



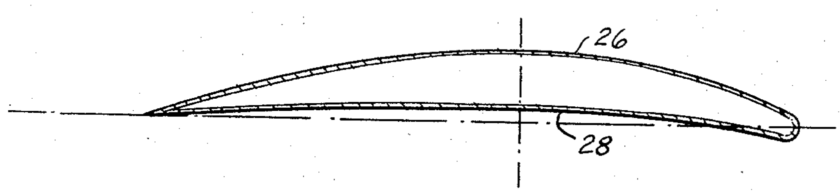


Fig 5

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ATTORNEYS

CIRCULAR WING AIRCRAFT

This is a continuation of application Ser. No. 198,704, filed Nov. 15, 1971, now abandoned.

BACKGROUND OF THE INVENTION

Various efforts have been made in the prior art to provide an aircraft having good maneuverability at relatively low speeds. Such an aircraft should be stable in flight and should permit take-off and landings at relatively low speeds. A particular example of an aircraft capable of such operation is shown in my prior U.S. Pat. No. 2,864,567 issued Dec. 16, 1958 for "Aircraft."

While the aircraft shown in my prior patent referred to hereinabove successfully achieves the objects of providing low landing and take-off speeds, and good maneuverability at low speed its operation is not as ideal as is desirable. I have provided an improved form of the aircraft shown in my prior patent which enhances its desirable characteristics. The slow speed and landing characteristics of my improved aircraft are superior to those of aircraft of the prior art. My aircraft has improved lateral and directional stability and control. It provides a more positive pitch control.

SUMMARY OF THE INVENTION

One object of my invention is to provide an improved circular wing aircraft having superior low-speed handling characteristics over aircraft of the prior art.

Another object of my invention is to provide an improved circular wing aircraft which is capable of low speed take-off and landing.

A further object of my invention is to provide an improved circular wing aircraft which can be flown at high angles of attack without loss of lateral or directional stability and control.

Another object of my invention is to provide an improved circular wing aircraft which is relatively simple in construction for the result achieved thereby.

A further object of my invention is to provide an improved circular wing aircraft having greater safety and reduced noise level.

Other and further objects of my invention will appear from the following description:

In general my invention contemplates the provision of an improved aircraft the main airfoil of which is generally circular in shape and which is provided with a pair of spaced vertical stabilizers extending along chords of the circle and equally spaced from the aircraft center line from points ahead of the leading edge to points behind the trailing edge with a cut-out portion of the airfoil bounded at its lateral edges by the chords displaced upwardly and rearwardly and supported by the vertical stabilizers so as to provide a space for a pusher type engine. The outer wing sections which have a normal camber may be provided with spoilers in addition to ailerons while the center section of the airfoil between the vertical stabilizers has a higher degree of camber to enhance its lifting effect.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings which form part of the instant specification and which are to be read in conjunction therewith and in which like reference numerals are used to indicate like parts in the various views:

FIG. **1** is a top plan view of my improved circular wing aircraft.

FIG. **2** is a front elevation of my improved circular wing aircraft.

FIG. **3** is a side elevation of my improved circular wing aircraft.

FIG. **4** is a sectional view of my improved circular wing aircraft taken along the line **4—4** of FIG. **1.**

FIG. **5** is a sectional view of my improved circular wing aircraft taken along the line **5—5** of FIG. **1.**

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now more particularly to the drawings, my improved circular wing aircraft, indicated generally by the reference character **10** includes a generally circular wing **12.** Respective vertical stabilizers **14** and **16** extend entirely through the wing **12** along spaced chords generally parallel to and equally spaced from the longitudinal axis of the aircraft. These stabilizers extend from points slightly ahead of the leading edge of the circular section to points behind the trailing edge. They are, moreover, as can be seen by reference to FIG. **3** provided with upwardly extending portions adjacent to the tail of the aircraft.

The vertical stabilizers **14** and **16** divide the wing **12** into outer wing sections **18** and **20,** each of which has a conventional camber forming a convex bottom airfoil such, for example, as NACA 2409. The stabilizers **14** and **16** further form a central section **26** which I form with a concave botton such, for example, as NACA No. 6409, as shown in FIG. **5.** I have indicated this by the reference character **28.**

I provide a horizontal stabilizer by cutting a portion **30** out of the rear of the central section of the wing **12** and mounting it at the upper edges of the vertically extending air portions of the stabilizers **14** and **16.** The lower portions of vertical stabilizers **14** and **16** form a boundry between the concave bottom of the center section **26** and convex bottom of the outer portions **18** and **20.** In addition I space the leading edge of the horizontal stabilizer **30** rearwardly from the trailing edge **34** of the forward center wing section **26** to provide an opening **32.** This may be achieved either by moving section **30** rearwardly with respect to the section **26** or by displacing the trailing edge **34** forwardly of the edge of the cutout section. Preferably I move the elevator section rearwardly for increased leverage.

I mount the power plant, indicated generally by the reference character **36,** of my aircraft on or in the central wing section **26.** Power plant **36** may include an engine **38** adapted to drive a pusher propeller **40** located in the opening **32** adjacent to the trailing edge **34** of the forward wing section **26.** It will readily be appreciated that the horizontal stabilizer may be provided with a moveable "elevator" portion **30A**, or may be fully moveable. It will also be readily appreciated that alternatively to providing an engine **38** and the propeller **40** I might use a jet engine. The aircraft includes a fuselage providing a cabin section **44** having landing wheels **46** and **48** and a nose wheel **50.** A larger version of this aircraft may have the cabin section enclosed entirely within the wing structure.

From the structure described thus far, it will be seen that the vertical stabilizers **14** and **16** provide a tunnel-like space **42** for the flow of air in a fore-and-aft direction over and under the central wing section **26.** Owing to the fact that a pusher-like power plant **36** is employed, the air flow over the wing is relatively undisturbed. Moreover, propeller **40** moves air to the stabilizer and rudders **29** and **31** with more force than do conventional drive systems which results in greatly improved elevator and rudder control at slow forward speeds. Location of the wing section just ahead of the propeller permits the wing to act as a turning vane for the air flow entering the propeller. This results in improved propeller performance and reduction of asymmetrical thrust at high angles of attack.

The construction of my improved aircraft has features resulting in improved operation over the aircraft shown in my U.S. Pat. No. 2,864,567. First, I provide the space for opening **32** and the resultant tunnel space **42** which provides a space in which the propeller **40** may operate. As a result propeller inflow acts on the center section of the wing to create some static lift and also acts to delay stalling at high angles of attack. The increased force of the outflow from the propeller **40** which is directed onto the stabilizer **30** and rudders **29** and **31** provide more positive pitch control and directional at lower speed.

In my aircraft, moreover, I may employ spoilers **22** and **24** in the outer wing sections **18** and **20.** These control spoilers are located at or slightly ahead of the high point of each wing tip. They may be used in addition to, or in conjunction with ailerons **53** and **54** to provide improved roll control for the aircraft.

Further as is pointed out hereinabove while the outer wing sections **18** and **20** have a conventional camber providing a convex bottom airfoil, the central wing section **26** is formed with a concave bottom airfoil. This arrangement achieves a more even lift distribution across the wing **12.** As a consequence, the central portion of the wing contributes its proper share of the overall lift. Since the concave bottom center section develops a comparatively higher lift for a given angle of attack than does a conventional airfoil, my arrangement provides a more even spanwise lift distribution and performance of the wing **12** is improved.

I may, if desired, provide a lift-destroying spoiler **52** across the center portion of the wing. This could be used during landing of the aircraft to lessen lift just prior to touchdown. As a consequence, more effective braking action is provided and the tendency of the aircraft to float just above the runway owing to the large ground cushion effect is reduced.

In operation of my improved circular wing aircraft propeller **40** is driven by motor **38** to draw air rearwardly over the central wing section **26.** The vertical stabilizers **14** and **16,** which extend the full length of the main airfoil, act as wing "fences" to control the flow of air and to minimize "spanwise" flow. With the trailing edge of stabilizer **30** behind the circular wing surface more leverage and more effective control are provided. The spoilers **22** and **24** and ailerons **53** and **54** in the outer wing sections may be operated by any suitable mechanism known to the art. Rudders **29** and **31** also provided at the rear of vertical stabilizers **14** and **16** are used for directional control. Their effectiveness at low forward speeds is enhanced by the air flow from propeller **40.**

It is to be noted, as can be seen from FIG. **2** that the high points of the outer wing sections and of the central wing section are located on a straight line extending in a transversly skewed direction. Location of the pusher propeller **40** in the space **32** not only provides improved performance by enhancing the lifting action of the center wing section, by increasing the effectiveness of the elevator and rudders, by improving the operation of the propeller at high angles of attack, but it is safer in that the propeller is not located outside the periphery of the aircraft. Moreover, noise in the cabin is reduced. Spoiler **52** may be operated on landing to reduce the cushion effect of the wing.

It will be seen that I have accomplished the objects of my invention. I have invented an improved circular wing aircraft which has improved performance and safety over circular wing aircraft of the prior art. My improved aircraft has improved lateral, directional and pitch stability and control. It is capable of taking off and of landing at relatively slow speeds and possesses a greater speed ratio. My aircraft incorporates an airfoil providing a higher lift than do circular aircraft with conventional airfoils.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of my claims. It is further obvious that various changes may be made in details within the scope of my claims without departing from the spirit of my invention. It is, therefore, to be understood that my invention is not to be limited to the specific details shown and described.

Having thus described my invention, what I claim is:

1. An improved aircraft including in combinataion, a main airfoil having a first certain outline configuration when viewed from the top thereof, respective elongated vertical members on opposite sides of and equally spaced from the fore-and-aft centerline of said main airfoil, said vertical members extending generally parallel to said fore-and-aft axis throughout said airfoil from the leading edge thereof to the trailing edge thereof and positioned inboard of the outboard edges of said airfoil to divide said main airfoil into a relatively independent central section between said members, and respective outer sections outboard of said members, said members projecting above the upper surface of said main airfoil and projecting below the under surface of the main airfoil to form tunnel-like spaces for the flow of air from the leading edge to the trailing edge of the airfoil over and under the central section thereof, said outer sections extending rearwardly of said central section to provide outer section inboard edges extending rearwardly from the trailing edge of said central section to the trailing edges of said outer sections, said inboard edges and said central section trailing edge forming a second certain outline configuration, a horizontal stabilizer formed with a leading edge and outer edges in said second outline configuration, and means including upwardly extending portions of said vertical members adjacent to the trailing edges of said outer sections to provide vertical stabilizers for mounting said horizontal stabilizer above said main airfoil and with the leading edge of said horizontal stabilizer spaced rearwardly from said central section trailing edge, said central section being formed with a concave bottom surface and said outer sections being formed with convex bottom surfaces.

2. An improved aircraft as in claim **1** in which the trailing edge of said horizontal stabilizer extends to a location rearward of said outer airfoil sections.

3. An improved aircraft as in claim 1 in which said vertical members extend from points ahead of the leading edges of said outer wing section to points beyond the trailing edges of the outer wing sections.

4. An improved aircraft as in claim 1 including spoilers and ailerons located in said outer wing sections.

5. An improved aircraft as in claim 1 including a spoiler in said central section.

6. An improved aircraft as in claim 1 including a pusher engine mounted adjacent to the trailing edge of said center section with the propeller thereof in the space between the center section trailing edge and the leading edge of the horizontal stabilizer.

* * * * *

United States Patent [19]

Kaelin

[11] **3,933,325**

[45] **Jan. 20, 1976**

[54] **DISC-SHAPED AEROSPACECRAFT**

[76] Inventor: **Joseph Richard Kaelin,** Villa Seeburg, Buochs, Switzerland

[22] Filed: **Sept. 24, 1974**

[21] Appl. No.: **508,895**

[30] **Foreign Application Priority Data**

Sept. 25, 1973 Switzerland........................ 13750/73

[52] **U.S. Cl.**.. **244/23 C**

[51] **Int. Cl.²**.. **B64C 29/00**

[58] **Field of Search**..... 244/12 B, 12 C, 23 B, 23 C, 244/52, 54, 55

[56] **References Cited**

UNITED STATES PATENTS

2,677,931	5/1954	Prieto	244/52 X
2,743,885	5/1956	Peterson	244/12 C X
2,930,546	3/1960	Wibault	244/23 B
2,935,275	5/1960	Grayson	244/23 C
3,072,366	1/1963	Freeland	244/23 C
3,193,214	7/1965	Hollingsworth	244/52 X
3,335,976	8/1967	Kappus	244/23 B X
3,514,053	5/1970	McGuinness	244/12 C

FOREIGN PATENTS OR APPLICATIONS

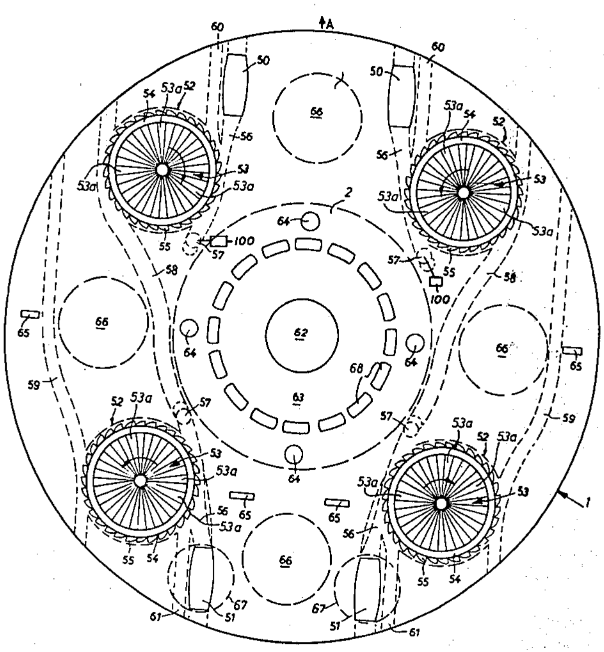
2,030,603	12/1971	Germany	244/23 C
230,204	3/1963	Austria	244/23 C

Primary Examiner—Trygve M. Blix
Assistant Examiner—Barry L. Kelmachter
Attorney, Agent, or Firm—Werner W. Kleeman

[57] **ABSTRACT**

An aerospacecraft possessing a discus shaped body equipped with at least one disc type air screw driven by a turbine by the exhaust gases of a jet engine. The disc type air screw is equipped with variable pitch blades and works in the manner of a helicopter rotor for the generation of lift.

2 Claims, 6 Drawing Figures



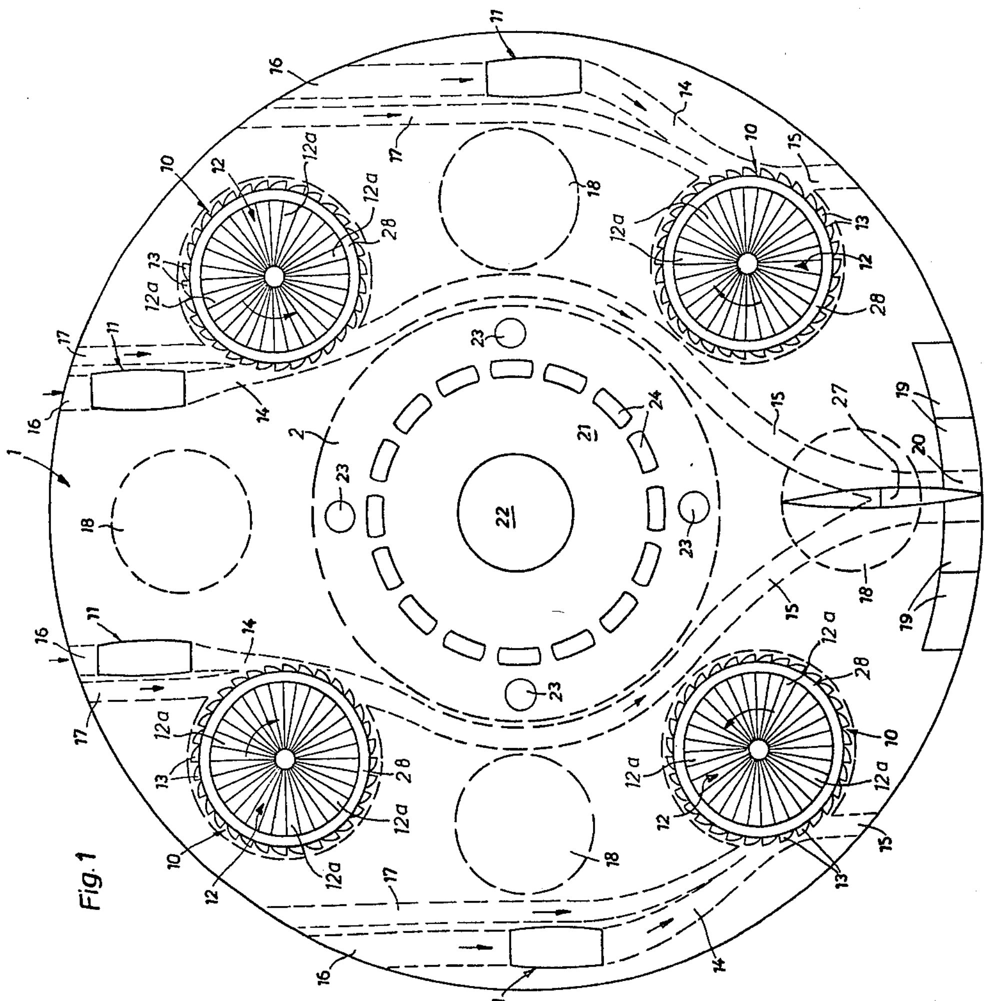


Fig. 1

Fig. 2

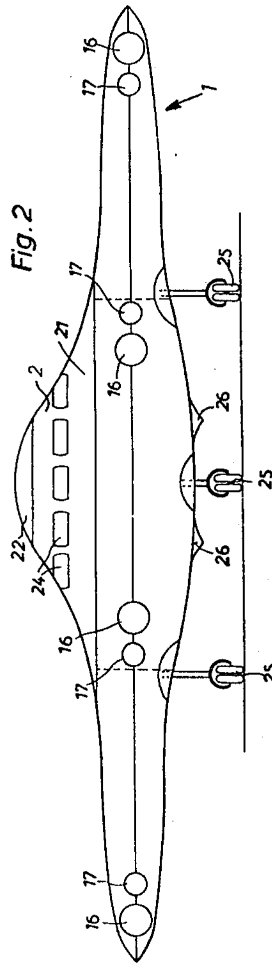


Fig. 4

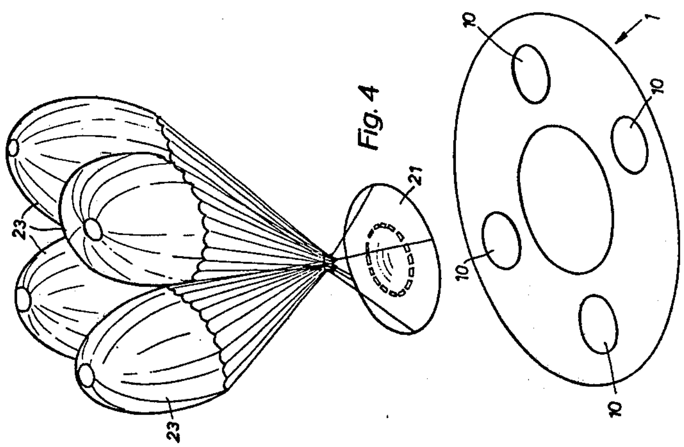
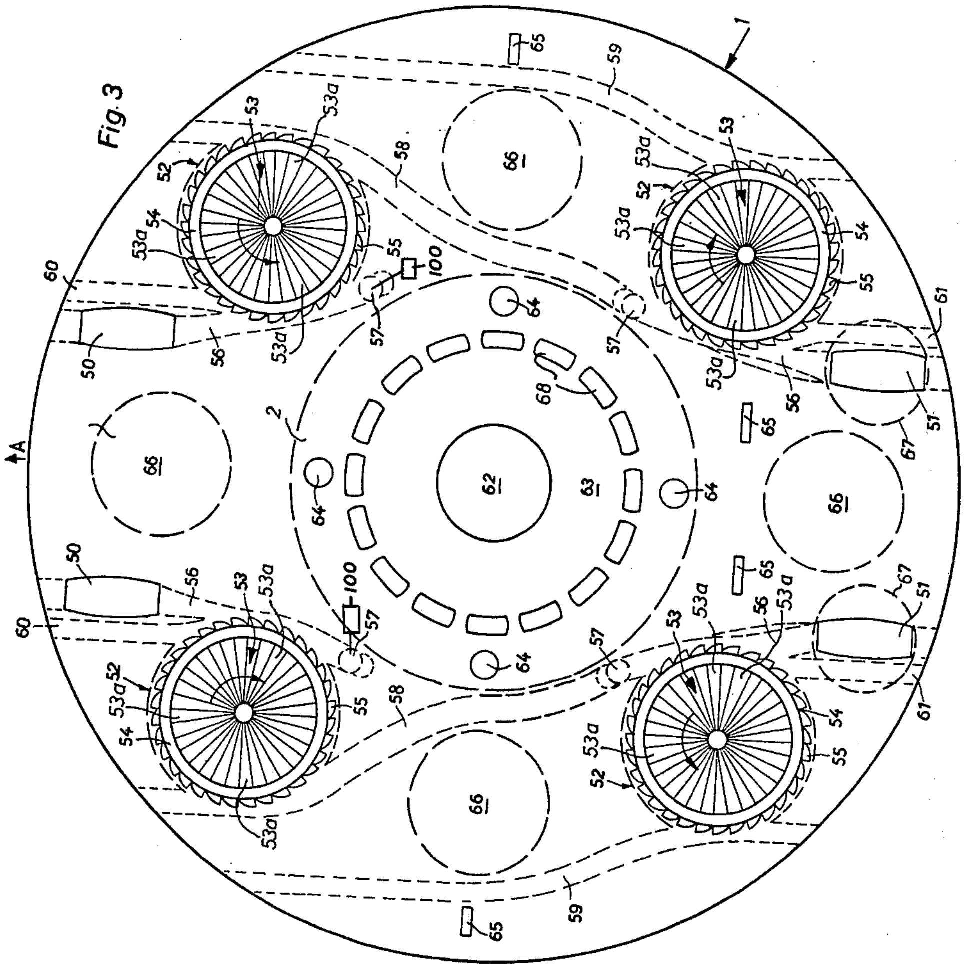


Fig. 3



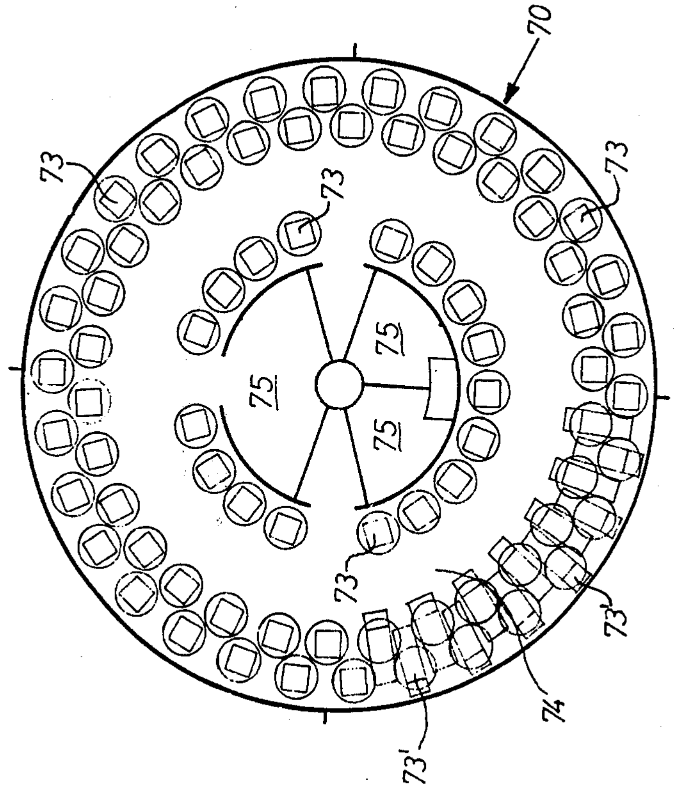


Fig. 5

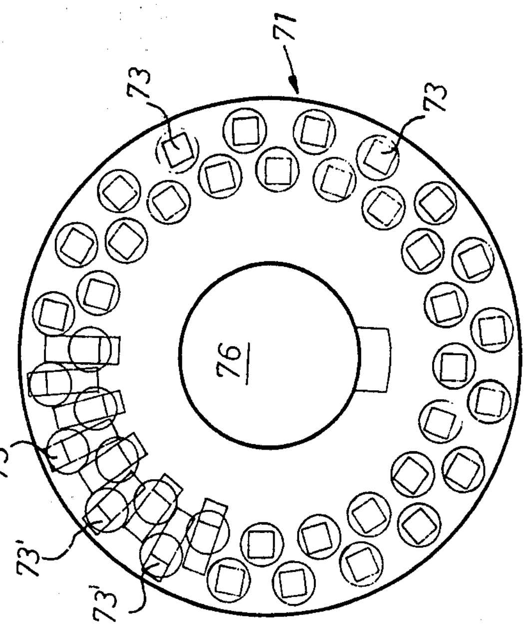


Fig. 6

DISC-SHAPED AEROSPACECRAFT

The present invention concerns a new and improved construction of aerospacecraft. The aerospacecraft of this development is distinguished by its discus shaped formation. Also, that it possesses at least one disc type air screw which is driven by the off-gases or exhaust gases from a jet engine via a turbine. The disc type air screw is equipped with adjustable pitch blades and used like helicopter rotors for lift.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be better understood and objects other than those set forth above, will become apparent when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawings wherein:

FIG. 1 is a plan view of a first example of an aerospacecraft,

FIG. 2 is a frontal view of the craft shown in FIG. 1,

FIG. 3 is a plan view of a second example of an aerospacecraft

FIG. 4 is a general illustration of the craft with opened parachute and the cabin detached from the craft,

FIG. 5 is a plan view of the lower passenger space, and

FIG. 6 is a plan view of the upper passenger room inside the cabin of the aerospacecraft.

DETAILED DESCRIPTION OF THE INVENTION

As shown in FIG. 1 and 2, the craft is constituted by a round discus or disc type of body **1**, which is centrally more convex on the upper side than on the under side in order to create lift during flight. Four gyroscopes **10** are installed in this body **1** and which are equally spaced along an imaginary circle. The body **1** is further equipped with four jet engines **11**, two of which are diametrically opposed to each other along a diagonal near the periphery of body **1**, whereas the other two engines are placed side by side and symmetrically to a diagonal which lies at 90° to the first mentioned diagonal. Conventional types of jet engines can be used for these four jet engines **11**. The four gyroscopes **10** are fitted with disc type air screws **12** with several adjustable pitch blades **12***a* and also fitted with vanes **13**, which are impinged by the off-gases or exhaust gases from the jet engines **11**. To guide the exhaust gases onto the vanes **13** on the disc type air screws **12**, ducts **14** are provided, through which the exhaust gases from the jet engines **11** are guided straight onto the vanes **13** of the disc air screws **12**. Further ducts **15** are provided, which lead the exhaust gases after contact with the vanes **13** of the disc air screws **12** to the outside of the craft. For the intake of fresh air to the jet engines **11** the ducts **16** are provided. Furthermore, ducts **17** can direct fresh air immediately onto the vanes **13** of the disc type air screw **12**. The fuel for the jet engines **11** is stored in four fuel tanks or storages **18** which are also placed on an imaginary circle between the gyroscopes **10**. The fuel tanks **18** are emptied simultaneously, so that the trim of the craft is maintained. Four elevators **19** are provided for the steering of the craft, a trim foil **20** and a rudder with stabiliser **27**.

In the centre of the craft there is provided a ring shaped cabin **21** which is intended for the passengers as well as a pilot cabin **22**. The latter is placed centrally and above the passenger cabin **21**. Both of these cabins **21** and **22** can be detached from the outer part of the aerospacecraft and are fitted with four parachutes **23** which are capable of carrying the detached cabins **21** and **22**, as can be seen from FIG. **4**. The passenger cabin **21** is provided with a number of windows **24**.

An undercarriage **25** is installed for the landing of the craft. Steps (not shown) aid entry and exit from the cabins **21** and **22**. There are further provided special hydraulically adjustable stabilisers **26** for landing on water and also for the stabilising of the craft during flight.

The four jet engines **11** can be rotated (not shown) so that the jet force of the engines **11** can work in two directions which are at 90° to each other. This makes it possible to use them for lift as well as for forward movement of the craft.

The four disc type air screws **12** are constructed in such a way that the individual air screw blades **12***a* can be adjusted by means of a planetary drive in conventional manner, for example by means of EDV controlled number of revolutions.

At the end of the blades **12***a* of the disc type air screw **12** there is provided a fly mass **28** which rotates with the disc type propeller. It serves to lend the necessary stability to the craft during flight as well as during take-off and landing.

The effectiveness of the described aerospacecraft is as follows:

Reacting onto the body **1** of the craft are firstly the thrust forces of the four jet engines **11**, which by means of their rotatability can react in two directions at right angles to each other. Secondly, the more complex shape of the upper part of the body in contrast to the lower side creates a lifting force for the craft. Thirdly, the four gyroscopes **10** create a force which stabilises the craft in space, and fourthly the disc type air screws **12** lend further lift to the craft.

The combination of the four forces make it possible to take off with the craft in three different ways. Firstly, the four jet engines **11** can be positioned horizontally prior to take-off, so that the craft can take off similar to a conventional aircraft on a virtually horizontal plane. During this take-off the blades of the circular air screw **12***a* are positioned in such a way, that they give virtually no lift. Secondly, the craft can take off at an angle of 45°, in which for instance two jet engines **11** are positioned vertically, whereas the other two remain in a horizontal position. Together with this the two disc air screws **12** react with their blades **12***a* as lifting rotors. Take-off at an angle below 45° can also take place if all four jet engines **11** are positioned horizontally and if the pitch for the air screw blades **12***a* is adjusted accordingly. Thirdly, the craft can take off vertically, in which case all four jet engines are directed in such a way that they react vertically.

For vertical take-off, the exhaust gases of the jet engines **11** do not drive the blades **12***a* of the rotary air screw, so that these are operated purely by the air flowing through ducts **17**. This drive, however, is sufficient to create the stabilising force of the rotors **12**. Touch-down on land respectively air takes place in a similar manner.

As the arrows indicate in FIG. **1**, two of the four gyroscopes **10** are revolving in a clock-wise direction, whereas the other gyroscopes **10** are revolving anti-clockwise. This effect is obtained firstly by the positioning of exhaust gas ducts **14** and otherwise by the shape of the turbo blades **13** on the disc type screw **12**. For a stable position of the craft it is necessary that two of the four gyroscopes **10** work in opposite directions to the remaining two.

FIG. **3** shows a plan view of a second example of an aerospacecraft. Its outer shape is the same as that shown in FIG. **2.**

In this second embodiment, each two jet engines **50** and **51** are symmetrically positioned on a diagonal across the craft and near the periphery of the body **1.** Four gyroscopes **52** are provided which are equidistantly spaced along an imaginary circle, similar to the first embodiment. These gyroscopes **52** can either be combined, as in the first embodiment with disc-type air screw **53** with adjustable pitch blades, or they can be installed separately as a fly wheel gyroscope **54** next to the disc type air screws **53.** The disc type air screw **53** is fitted on the periphery with turbine vanes **55,** onto which the exhaust gases from jet engines **50** and **51** are ducted. Should the gyroscope **52** be installed as a separate entity next to the air screws **53,** then they are driven by suitable gears (not shown on the drawing) from the air screws **53.** FIG. **3** shows the manner in which the ring shaped fly wheel mass **54** is attached to the blade ends of air screw blades **53*a*.** This fly wheel mass **54** offers the craft the necessary space stability, similar to the example of FIG. **1.**

Behind the jet engines **50** and **51** there are installed the exhaust gas ducts **56** which direct the exhaust gases from jet engines **50** and **51** directly onto the turbo vanes **55.** The exhaust gas ducts **56** merge with the exhaust pipes **57** behind the turbo vanes **55,** which are inclined from the centre plane of the disc by 45°, so that the emerging gas stream is directed against the ground at approx. 45° and results in lift during take-off of the aircraft. The two rear jet engines **51** are each mounted on a turntable **67** and can be rotated through 180°, so that the thrust of all four jet engines **50** and **51** can work in parallel directions. Should the two rear jet engines **51** be positioned in such a way that their thrust reacts in the same direction as the thrust from the forward jet engines **50,** then three-way valves, schematically indicated by reference character **100** in FIG. **3,** close the exhaust pipes **57,** belonging to jet engines **51,** and instead the exhaust gas ducts **56** of the jet engines **51** are connected with the ducts **58,** so that fresh air can flow through ducts **58** and the channels **56** to the jet engines **51.** Pipes **59, 60** and **61** are provided for the cooling and the drive of the turbo vanes **55.** By means of the pipes **59,** additional cooling air flows into the aerospacecraft when moving, the quantity being dependent upon the speed of the craft, whereas fresh air is sucked and led to the turbo vanes **55** through the pipes **60** by means of the flow of exhaust gases of the forward engines. Fresh air is sucked and led to the turbo vanes **55** on the rear jet engine **51** by means of pipe **61.**

In the centre of the body, and analogous to the first embodiment a cabin **63** for passengers and a second cabin **62** for the pilot are provided. The passenger cabin is fitted with a number of windows **68.** Fitted to these cabins are four parachutes **64,** which in case of danger can be separated from the outer part of the disc body and are capable of carrying the detached cabin. This can be seen in FIG. **4.**

Steering of the aircraft is controlled by four withdrawable steering vanes. The fuel for the jet engines **50** and **51** is stored in four symmetrically arranged tanks **66** which are equally emptied during operation.

The effective working of the described aerospacecraft, similar to that described in example **1,** is as follows:

For take-off the thrust of the two rear jet engines **51** is adjusted in an opposite direction to that of the forward jet engines **50.** This drives the four disc type air screws **53** in the directions indicated by the arrows. The pitch of the air screw blades in the disc type air screw **53** is adjusted for take-off in such a way that the highest possible lift is created. By means of the four exhaust pipes **57,** the exhaust gases of the jet engines **50** and **51** are directed against the ground, so that the thrust of the engines **50** and **51** is used for the lifting of the craft during vertical take-off.

As soon as the craft has obtained a certain height, the two rear jet engines **51** are revolved through 180° so that the thrust of all four jet engines **50** and **51** reacts in the same direction. Lift is then only being exerted by the two forward jet engines **50** by means of the exhaust pipes **57** and the resulting exhaust jet and the disc type air screws **53,** which are driven by the exhaust gases from jet engines **50.** During this time the rear jet engines **51** produce pure forward thrust, as their exhaust gases do not emerge via the exhaust pipes **57** nor the disc type rotors **53.**

Touch-down on land or water of the craft takes place in a similar manner.

Alteration of the pitch of the air screw blades **12*a*** respectively **53*a*** alters the lift created by the rotary screws **12** or **53.** The amount of this lift can therefore be adjusted by regulation of the number of revolutions of the air screw disc **12** and **53.**

During any break-down, which could become dangerous for passengers and crew, as for instance fire, failure of control or engines, the cabins **21, 22** and **62** and **63** can be detached from the outer ring shaped part of the craft. This separation can be carried out by mechanical, hydraulic or electrical installations. The separated centre **2** of the craft with its cabins is lowered by means of the parachutes **24** respectively **64** in a manner which is not dangerous for either the passengers or crew. Near the ground, the cabins are braked by means of braking rockets, so that the touch-down on either land or water is as soft as possible.

FIG. **5** and **6** show a plan view of the lower respectively upper passenger area **70** respectively **71.** In both passenger cabins **70** and **71** revolving seats **73** are arranged around the periphery of the circular room in two rows. In this arrangement one row is offset with respect to the other, so that the seats **73** in both rows can be transformed into couches.

In the lower passenger room **70** a further row of seats **73** is installed, which is separated by a passage **74.** In the centre of the room **70** are rooms **75** which can be used for various purposes.

In the case of the upper passenger area **71,** which is smaller than the lower passenger area **70,** a pilot cabin **76** is provided in the centre, which can be adjusted vertically by means of a lift.

The described aerospacecraft can take off vertically from ground as well as from water and the same applies for touch-down.

Gyroscopes **10** respectively **52** maintain the craft in its various flight attitudes.

The discus shaped body exhibits a form which is aerodynamically of advantage, as the air resistance can be kept low even at high speeds. While there is shown and described present preferred embodiments of the invention, it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practiced within the scope of the following claims.

Accordingly, I claim:

1. An aerospacecraft comprising a substantially discus-shaped body, a number of disc-type air screws provided for said body, a number of turbines and a number of jet engines provided for said body, one respective turbine and jet engine being operatively associated with a respective disc-type air screw, each of said disc-type air screws being driven by the associated turbine by means of exhaust gases emanating from the associated jet engine, each of said disc-type air screws being equipped with variable pitch blades and functioning in the manner of a helicopter rotor for the generation of lift, each turbine having vanes driven by the exhaust gases generated by the associated jet engine, and said number of jet engines being symmetrically arranged along diagonals extending across the craft, two of said number of jet engines defining rear engines, means for rotating said two rear jet engines through 180° in a plane extending through the center of the body, and each jet engine driving the associated disc-type air screw.

2. An aerospacecraft comprising a substantially discus-shaped body, a number of disc-type air screws provided for said body, a number of turbines and a number of jet engines provided for said body, one respective turbine and jet engine being operatively associated with a respective disc-type air screw, each of said disc-type air screws being driven by the associated turbine by means of exhaust gases emanating from the associated jet engine, each of said disc-type air screws being equipped with variable pitch blades and functioning in the manner of a helicopter rotor for the generation of lift, each turbine having vanes driven by the exhaust gases generated by the associated jet engine, duct means for said disc-shaped body for directing the exhaust gases of each jet engine against the vanes of the associated disc-type air screw, said duct means merging with exhaust pipe means inclined through an angle of about 45° with respect to the central plane of the body to permit downward deflection of the exhaust gases from each jet engine, said number of jet engines comprising four jet engines substantially symmetrically arranged along diagonals extending across the craft, two of said jet engines defining rear engines, means for rotating said two rear jet engines through approximately 180° in a plane extending through the center of the body, each jet engine driving an associated disc-type air screw, and means for interrupting the connection of the duct means of the jet engines with the exhaust pipe means in order to be reconnected with air ducts when both rear jet engines are positioned such that the thrust of all four jet engines is in the same direction.

* * * * *

United States Patent [19]

MacNeill

[11] **4,014,483**

[45] **Mar. 29, 1977**

[54] **LIGHTER-THAN-AIR CRAFT**

[76] Inventor: **Roderick M. MacNeill,** 23 Woodbury Road, Southborough, Mass. 01772

[22] Filed: **Sept. 15, 1975**

[21] Appl. No.: **613,221**

[52] **U.S. Cl.** .... **244/5;** 244/23 C; 244/137 P

[51] **Int. Cl.²** **B64C 39/00;** B64B 1/04

[58] **Field of Search** .... 244/5, 12 C, 23 C, 29, 244/90 R, 137 P

[56] **References Cited**

UNITED STATES PATENTS

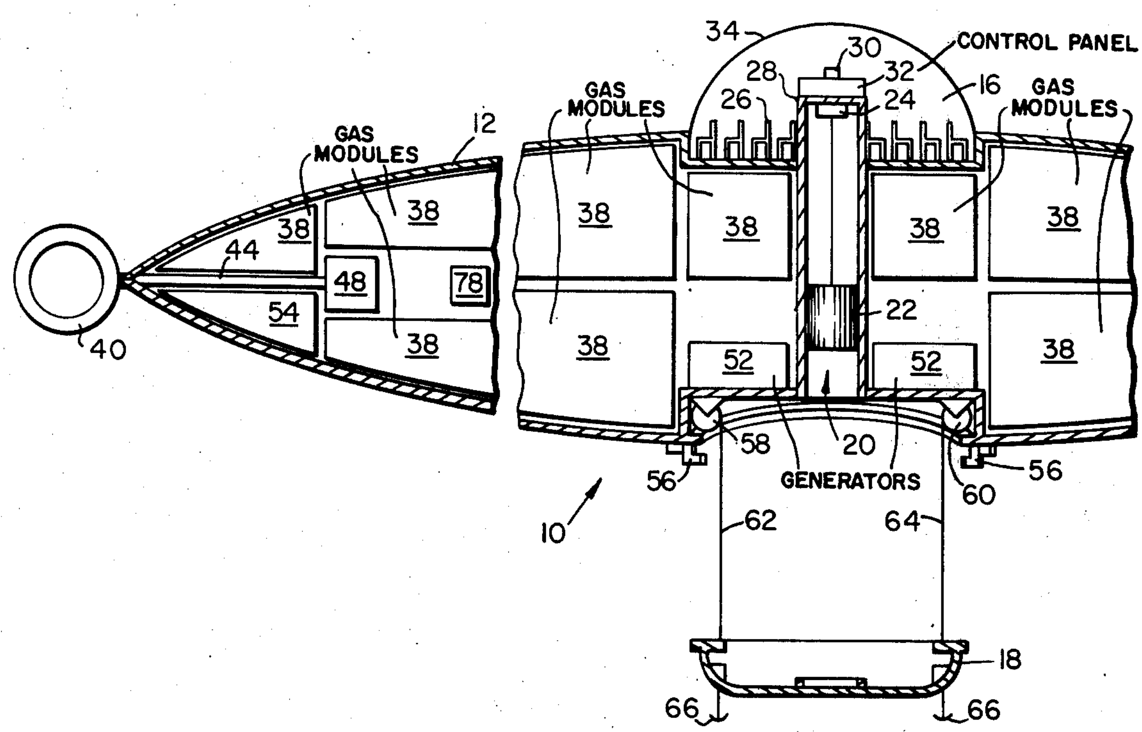
3,469,804	9/1969	Rowan	244/12 C
3,514,053	5/1970	McGuinness	244/23 C X
3,752,417	8/1973	Lagace	244/12 C
3,820,744	6/1974	Denton	244/5
3,934,847	1/1976	Bentivegna	244/137 P

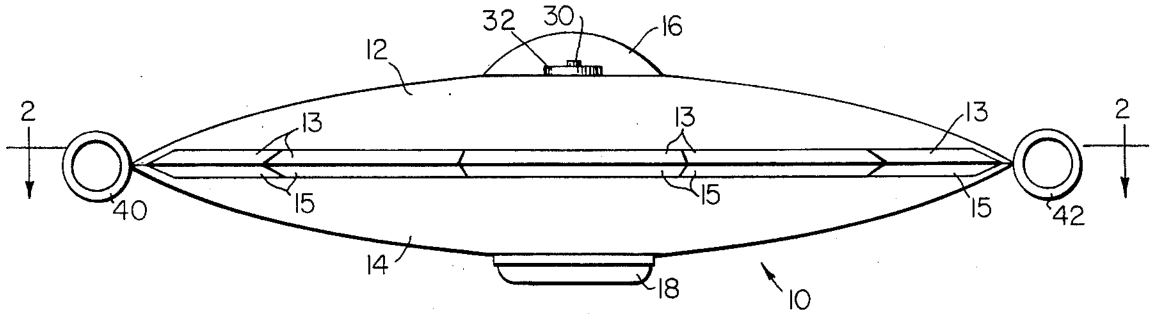
Primary Examiner—Stephen G. Kunin
Assistant Examiner—Barry L. Kelmachter
Attorney, Agent, or Firm—Cesari and McKenna

[57] **ABSTRACT**

A lighter-than-air craft having a discus shape. A passenger compartment is located at the top center of the craft and a payload pod at the bottom center beneath the passenger compartment. The pod connects to the passenger compartment by a passageway which extends up through the center of the craft. Moreover, the pod is detachable from the craft, and can be raised or lowered to the ground, thus eliminating the need to land the craft in picking up or discharging passengers and cargo. The discus shape, together with a plurality of automatically controllable ailerons distributed about the circumference of the craft, improve the stability and control of the craft in flight.

12 Claims, 8 Drawing Figures

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16
12
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2
40
15
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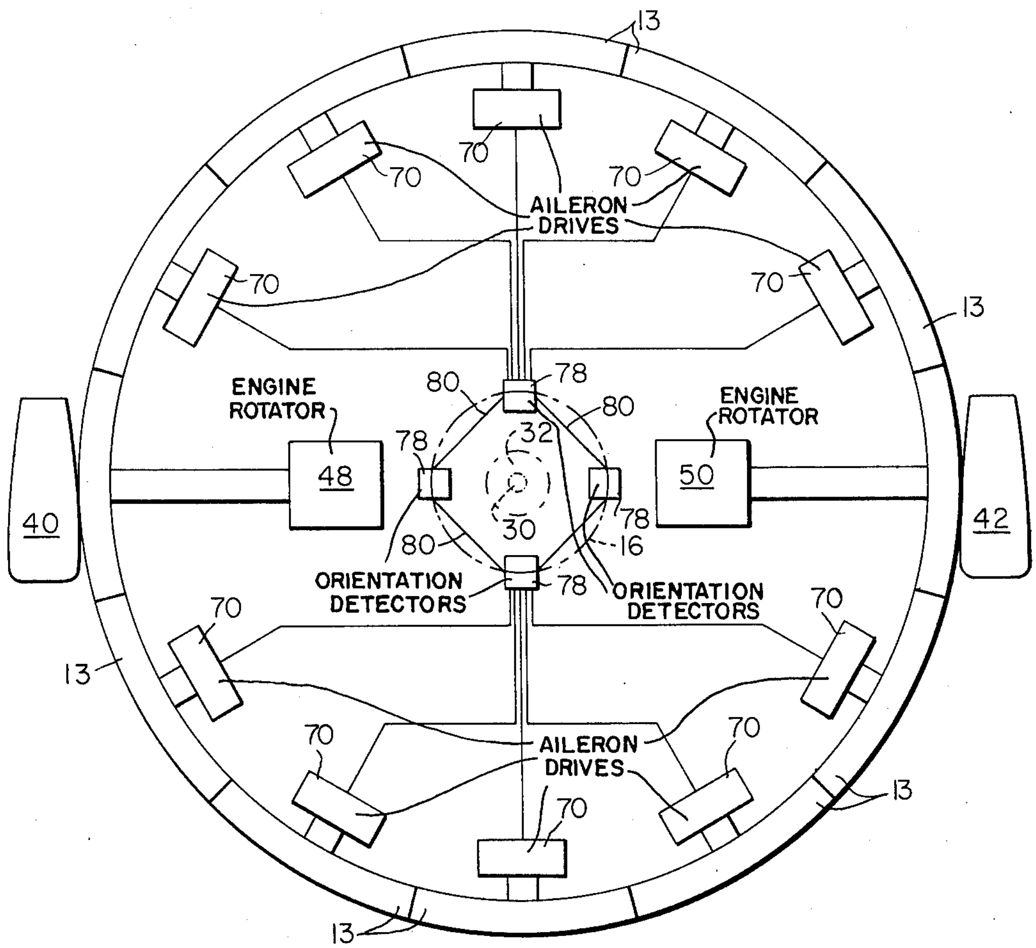
42
14
18
10

FIG. 1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70
70
70
AILERON
DRIVES
70
70
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80
78
ENGINE
ROTATOR
80
ENGINE
ROTATOR
78
32
48
50
40
42
30
78
80
16
78
ORIENTATION
DETECTORS
ORIENTATION
DETECTORS
70
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13
70
AILERON
DRIVES
70
70
13
13

FIG. 2

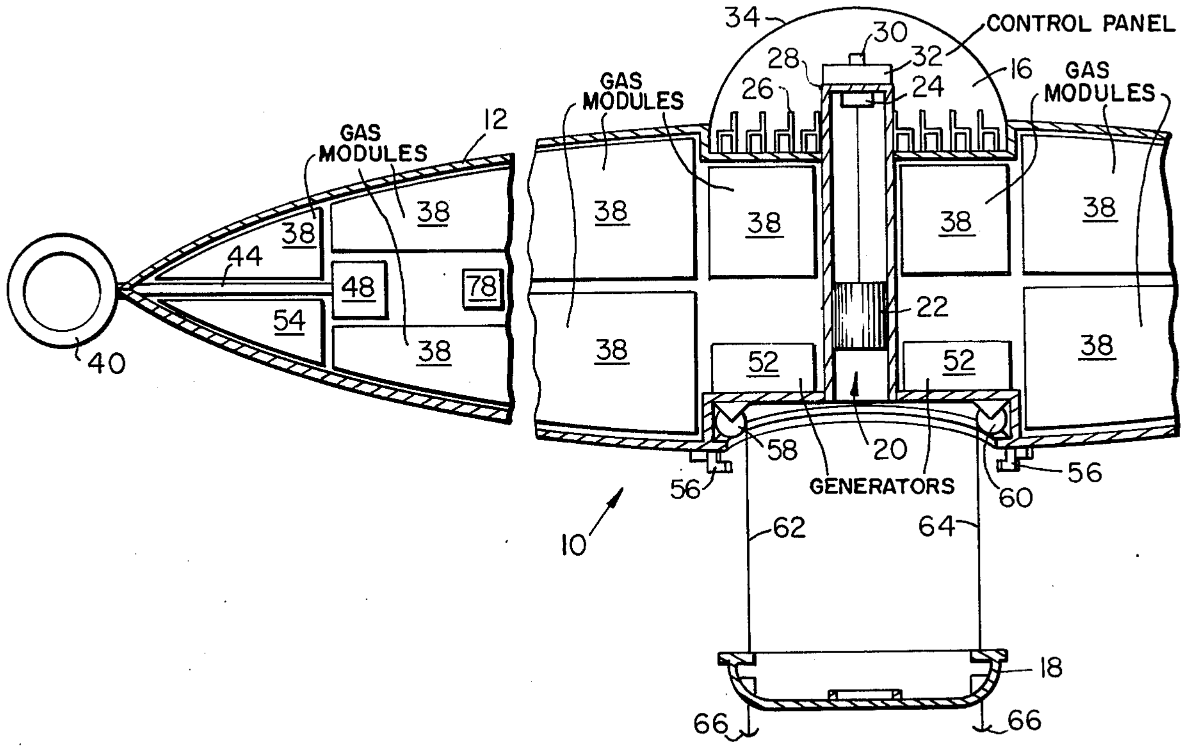

34
30
CONTROL PANEL
28
32
16
GAS MODULES
26
24
GAS MODULES
12
GAS MODULES
38
44
48
78
54
22
52
40
58
20
56
GENERATORS
60
10
62
64
18
66
66

FIG. 3

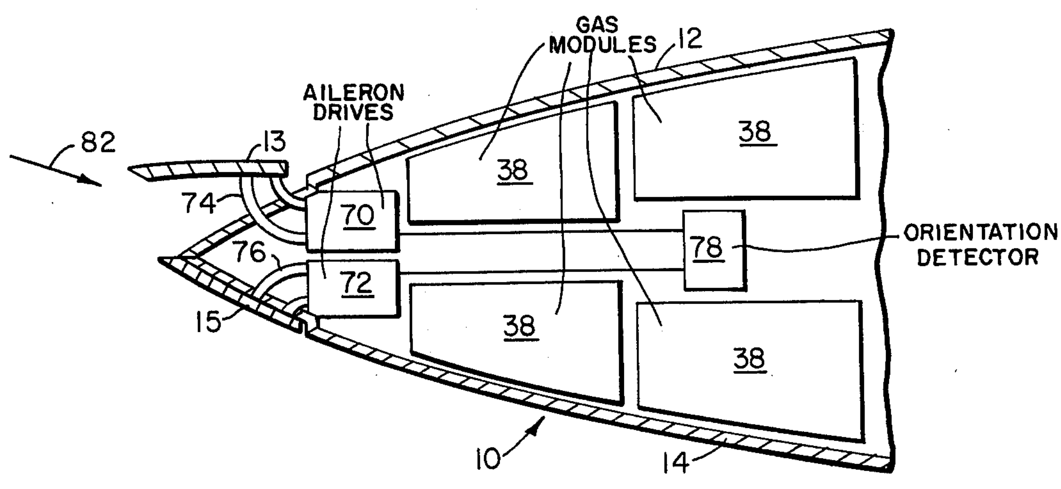
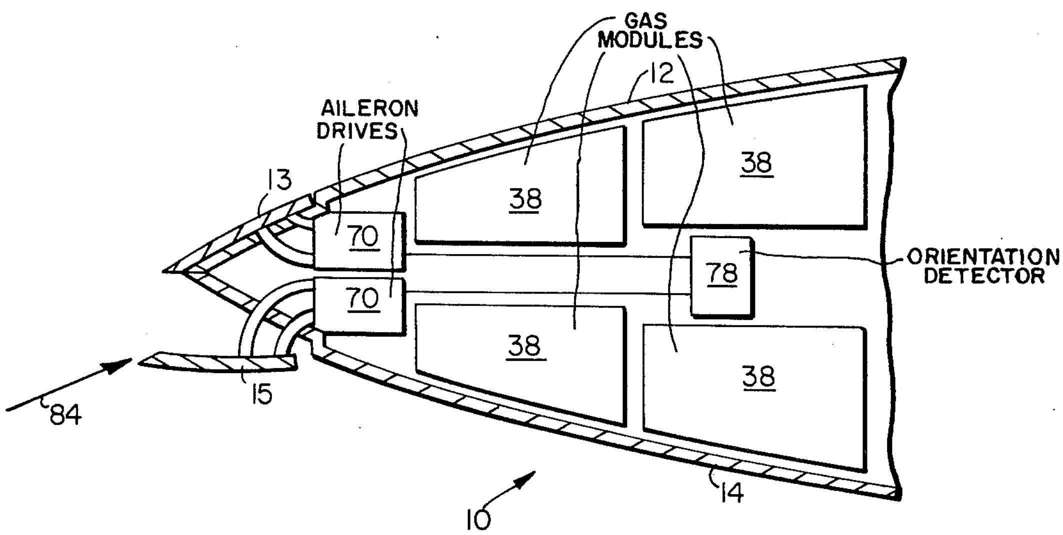

GAS MODULES
12
AILERON DRIVES
82
13
38
74
70
76
78
ORIENTATION DETECTOR
72
15
10
14

FIG. 4A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AILERON
DRIVES
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ORIENTATION
DETECTOR
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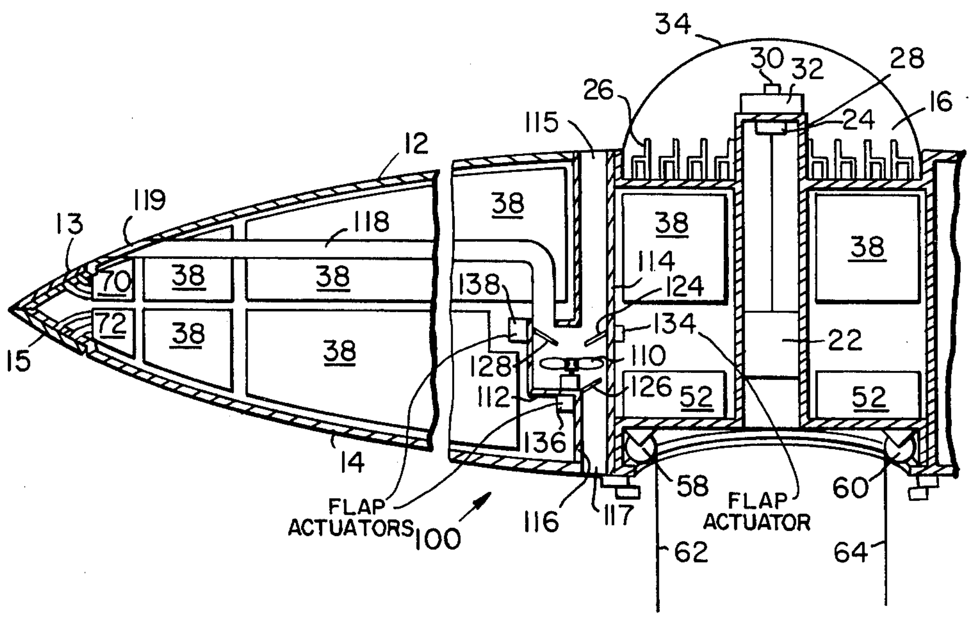
10

FIG. 4B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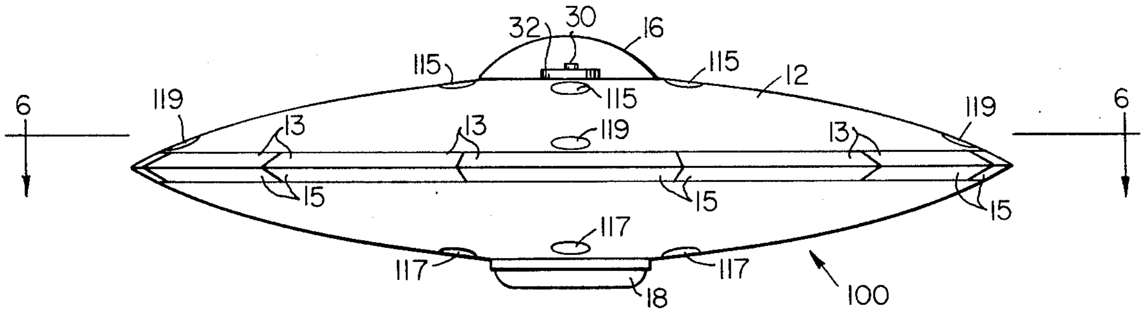
70
138
134
22
72
38
38
110
128
126
52
52
112
15
136
14
58
60
FLAP
ACTUATORS
100
116
117
FLAP
ACTUATOR
62
64

FIG. 7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6
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13
119
13
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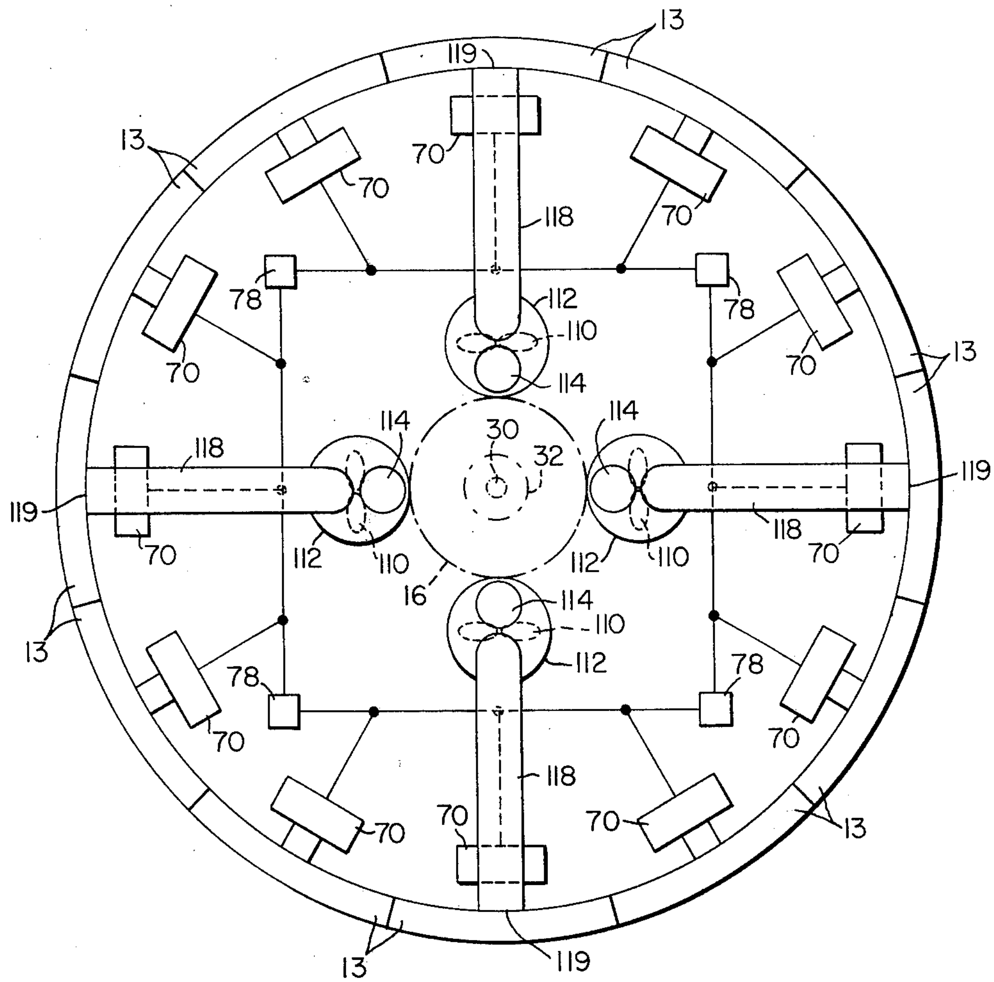
15
15
117
117
117
18
100

FIG. 5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119
119
70
112
110
112
110
70
16
114
13
110
78
112
78
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70
118
70
70
70
70
13
13
119

FIG. 6

LIGHTER-THAN-AIR CRAFT

BACKGROUND OF THE INVENTION

This invention relates to aircraft, and more particularly, to a multi-purpose lighter-than-air craft.

Interest has increased recently in lighter-than-air craft as a means of transporting passengers and cargo by air. Unlike the conventional airplane, which requires maintained motion of its wings relative to the air for lift, the lighter-than-air craft is lifted by a contained volume of lighter-than-air gas. Lighter-than-air craft have many desirable features. For example, they land and take off on runways which are shorter than those conventional aircraft of comparable payloads require. They can carry large numbers of passengers and large amounts of cargo. Since they typically consume substantially less fuel during takeoff and landing than conventional aircraft, they can be relatively economical to operate. Additionally, they can be considerably more quiet and less polluting during takeoff and landing than conventional aircraft.

Notwithstanding these features, lighter-than-air craft have experienced little practical use to date. Several reasons account for this limited use.

For example, the lighter-than-air craft presently known in the art are generally difficult to control and manuever during flight. Relatively large, unobstructed ground areas have been required to allow for uncontrolled drift of the craft upon leaving or approaching the ground. These problems are aggravated by high winds and turbulent air currents. Such conditions frequently force the grounding of lighter-than-air craft, thereby reducing productive flight time.

Additionally, in conventional lighter-than-air craft, the pilot is generally required to vent substantial quantities of the lighter-than-air gas to lower the craft to the ground. Special facilities and time must be made available for securely anchoring the craft to the ground during the loading and unloading of passengers and cargo, and for replenishing the supply of lighter-than-air gas for subsequent takeoff.

It is, therefore, an object of this invention to provide a more stable and controllable lighter-than-air craft.

Another object of this invention is to provide an lighter-than-air craft in which the effects of winds and turbulent air currents on the craft's stability are minimized.

Still another object of the invention is to provide a lighter-than-air craft which facilitates loading and unloading of passengers and cargo.

Still another object of the invention is to provide a lighter-than-air craft which minimizes the time and ground space required for loading and unloading passengers and cargo.

SUMMARY

In accordance with this invention, a lighter-than-air craft has a substantially discus shape so as to minimize drag and wind resistance about the craft's circumference. A plurality of ailerons distributed about the circumference of the craft compensate the craft as wind direction and velocity change. Pilot effort in stabilizing the craft therefore is minimized.

In an illustrative embodiment of the craft of this invention, a passenger and crew compartment is located at the top center of the craft, while a payload pod is located at the bottom center beneath the passenger and crew compartment. The pod connects to the passenger and crew compartment by a passageway which extends up through the craft's center. Moreover, the pod is detachable from the craft and can be lowered to the ground with the craft maintained at a considerable altitude above the ground. The craft can thus hover safely above a relatively small ground area to load and unload passengers and cargo, and need land only for periodic maintenance checks and repair.

The invention is pointed out with particularity in the appended claim. The foregoing and other features and advantages of the invention will be better understood by reference to the following detailed description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevation of an illustrative embodiment of the aircraft of the invention;

FIG. **2** is a top view of the aircraft of FIG. **1** with the upper hull portion removed for showing control elements internal to the craft;

FIG. **3** is an enlarged cross-sectional view of one end of the craft of FIG. **1**;

FIGS. **4A** and **4B** are enlarged cross-sectional views of one end of the craft illustrating the operation of the ailerons;

FIG. **5** is a side elevation of another illustrative embodiment of the aircraft of the invention;

FIG. **6** is a top view of the craft of FIG. **5** with the upper hull portion removed for showing control elements internal to the craft; and

FIG. **7** is an enlarged cross-sectional view of one end of the craft of FIG. **5**.

DETAILED DESCRIPTION

In FIGS. **1, 2,** and **3**, a lighter-than-air craft **10** comprises upper and lower hull portions **12** and **14**, respectively. The hull portions **12** and **14** combine to provide craft **10** with a substantially discus shape. Thus, craft **10** has a maximum height or thickness near its center and a gradually decreasing thickness in a radial direction to the circumference of the craft. Preferably, this craft **10** is symmetrically shaped about a vertical axis which extends through the upper and lower hull portions **12** and **14** at the craft center. Thus, as viewed from the top or bottom, craft **10** is circular in outline, as indicated in FIG. **2**. Also, the maximum center height or thickness of the craft is preferably no larger than about one-fifth of its overall diameter. The thickness of the craft at its circumference is preferably as small as possible.

The discus shape of craft **10** minimizes drag and wind resistance about the craft circumference. This reduces the effect of wind on the craft and improves the stability of the craft in flight. A plurality of upper and lower ailerons **13** and **15**, respectively, also improve flight stability. As seen in FIG. **1**, ailerons **13** and **15** are attached about the circumference of hull portions **12** and **14**. When manually or automatically activated, ailerons **13** and **15** move radially outwardly from hull portions **12** and **14**, respectively, to provide control surfaces which react with the wind to tilt the craft either upwardly or downwardly as viewed in FIG. **1**. They can be automatically controlled to compensate for changes in the craft's orientation due to winds or turbulent air currents. The operation of ailerons **13** and **15** is described in more detail below in connection with FIGS. **4A** and **4B** of the drawing.

A passenger and crew compartment **16** is located at the top center of hull portion **12;** and a payload pod **18** is located at the bottom center of hull portion **14** under compartment **16.** As seen in FIG. **3,** a vertical, centrally disposed passageway **20** connects the pod **18** and compartment **16.** An elevator **22** located in the passageway **20** and an elevator motor **24** transport passengers and crew between the pod **18** and the compartment **16.** Obviously, other transport means, such as stairs or ladders, could be substituted.

As seen in FIG. **3,** the compartment **16** has a plurality of passenger seats **26.** A pilot's chair **30** is situated on a platform **28** at the center of the compartment **16.** A control panel **32** surrounds the pilot's chair **30** and includes all of the necessary means for activating the various steering, propulsion and control mechanisms of the craft. This control panel **32** and chair **30** arrangement permit the pilot to operate the craft **10** while facing in any direction. Moreover, if a dome **34,** formed of a transparent material, encloses the compartment **16,** both the pilot and passengers have visibility in all directions.

The illustrated configuration of craft **10** has a number of inherent advantages. Since payload is typically a significant fraction of the total weight of the craft, the location of payload pod **18** at the bottom center of the craft provides the craft with a low center of gravity. Additional stability is thus provided in maintaining the craft in level, upright orientation. Passenger and crew compartment **16** is safely positioned at the top center of craft **10.** If the craft is forced to the ground in an emergency, the passengers and crew are maintained in relative safety. The hull portions **12** and **14** would absorb a significant portion of any impact. Although not shown, compartment **16** could include one or more emergency exits, or dome **34** could be made ejectable, in the event that passage through pod **18** is not possible.

A plurality of lighter-than-air, self-contained gas modules **38** (FIG. **3**) are distributed internally of hull portions **12** and **14** to provide lift. A lighter-than-air gas, such as helium, can be used. The use of these modules also has several advantages. For example, if one module is damaged, the total lift capacity of the aircraft is only reduced by a small amount. Thus, even if one module vents all its gas, the pilot can compensate for this loss of lift capacity. Moreover, replacement of damaged modules is less expensive than the repair or replacement of a large gas container. Furthermore, the lift capacity can be tailored to meet the load requirements during a flight either by varying the number of modules that are aboard or by varying the amount of gas that each module contains.

Still referring to FIG. **2,** a pair of jet engines **40** and **42** attached at diametrically opposite positions at the circumference of the craft **10** provide the thrust for propelling the craft in flight. These engines **40** and **42** are rigidly mounted on the ends of shafts, such as shaft **44** extending from rotators **48** and **50,** respectively. As the pilot activates the rotators **48** and **50** to turn the shafts about their longitudinal axes, the jet engines **40** and **42** rotate in a vertical plane. Thus, by controlling the relative thrusts from and orientation of the engines **40** and **42,** the pilot can direct the craft **10** to any orientation. That is, he can cause the craft **10** to move in a forward or reverse direction, to roll, to yaw or to pitch. If the jet engines **40** and **42** are vertically oriented, the pilot can maintain altitude (e.g. in the event of loss of lighter-than-air gas), hasten ascent, or force descent. The ability to force descent leads to yet another advantage: there is no need for venting gas from modules **38** during normal landing operations.

Rotators **48** and **50** and their respective shafts represent means for rotating the jet engines **40** and **42** in response to pilot or automatic command control. For example, they may comprise electric motors which operate in response to electrical control signals from control panel **32.** Power to these motors, the control panel **32,** and to other mechanisms in craft **10,** such as elevator motor **24,** can be provided by generators **52** or any other suitable power source (e.g. batteries). Alternatively, rotators **48** and **50** may be components in a hydraulic system.

Fuel for jet engine **40** is contained in a fuel tank **54** (FIG. **3**) located within hull portion **14** at the bottom of the craft. A similar fuel tank, not shown in FIG. **3,** is provided at the other end of the craft for jet engine **42.** Although not shown, suitable safety barriers, such as vertical explosion and fire retardant walls extending between hull portions **12** and **14,** would be located in the craft to shield compartment **16** and pod **18** from the various fuel tanks.

Control panel **32** includes means accessible to the pilot for starting and stopping the jet engines **40** and **42.** The pilot can thus shut the engines down when not needed, for example, when parking craft **10** in the air, and turn the engines back on, for example, when departure from the air space is desired, all while sitting at control panel **32.**

As indicated in FIG. **1** and best seen in FIG. **3,** payload pod **18** can be detached from hull portion **14** and lowered to the ground. Retractable clamps **56** attached to hull portion **14** hold pod **18** in position at the bottom of craft **10.** When they are released, hydraulic or electric motors **58** and **60** can lower the pod **18** by means of cables **62** and **64.** Preferably, the cables **62** and **64** are long enough to lower the pod **18** to the ground with craft **10** hovering safely at a considerable altitude (e.g., 100 feet or more) above the ground. Anchors **66** secure the pod **18** to the ground while passengers and cargo are loaded and unloaded. Although not shown in FIG. **3,** the pod **18** includes one or more access doors.

Thus, cargo and passengers can be loaded in or unloaded from payload pod **18** on the ground without ever landing craft **10.** Only a relatively small ground space, sufficient in size to accommodate pod **18,** is required for the exchange. The area can be otherwise obstructed with tall trees or buildings which can be safely avoided by maintaining sufficient altitude of craft **10.** The equilibrium of craft **10** in the air above pod **18** is maintained automatically by ailerons **13** and **15,** or, if necessary, manually by the pilot using jet engines **40** and **42.**

In accordance with another aspect of this configuration, the anchors **66** can be set with the pod **18** on the ground and the motors **58** and **60** can be energized to winch the craft **10** to the ground. Additionally, the cables **62** and **64** may be releasably connected to the pod **18,** thereby to facilitate the exchange of pods.

Referring to FIGS. **4A** and **4B,** aileron drives **70** and **72** connect to ailerons **13** and **15** by way of arms **74** and **76,** respectively. The drives **70** and **72,** which are typically electric motors, form part of a servomechanism including a craft orientation detector **78.** As shown in FIG. **2,** there are illustratively four of such detectors **78** in craft **10** and each one of the four is electrically interconnected by leads **80.** Detectors **78** sense changes in the orientation of craft **10** from a reference plane, e.g., horizontal. Each detector may comprise a gyroscope or mercury switch which develops an error signal indicative of a change in craft orientation. These error signals are in turn sent to selected ones of drives **70** and **72** to activate their associated ailerons and to compensate for the change.

For example, in FIG. **4A**, an upper aileron **13** is shown in an activated position away from hull portion **12.** It is assumed that a wind blowing essentially in the direction indicated by arrow **82** has caused the end of craft **10** shown in FIG. **4A** to move downwardly out of the desired orientation, and has caused one of detectors **78** to sense this and to move aileron **13** into the position shown. The wind will react with aileron **13** in the illustrated position, generating a upward force on the inner surface thereof, which causes the end of craft **10** to move upwardly, thus compensating for the change initially caused by the wind.

In FIG. **4B**, a lower aileron **15** is shown in an activated position away from hull portion **14.** It is assumed in this case that a wind blowing essentially in the direction indicated by arrow **84** has moved the end of craft **10** shown in FIG. **4B** upwardly, causing one of detectors **7B** to sense this and to activate aileron **15.** The wind now exerts a downward force on the inner surface of aileron **15,** causing the end of craft **10** to move downwardly, again compensating for the change initially caused by the wind.

Ailerons **13** and **15** in this way assist in maintaining the equilibrium of craft **10,** even in face of changing winds, and turbulent air currents. The servomechanism comprised of the detectors **78,** drives **70** and **72,** and ailerons **13** and **15** is preferably designed with a speed of response considerably shorter than a pilot could provide in manually adjusting the ailerons. Also, to compensate for particular changes in the attitude of craft **10,** it is preferable that more than one aileron be activated at a given time. For example, at one end of craft **10,** two or more adjacent upper ailerons **13** may be activated, while at the opposite end of craft **10,** two or more lower ailerons are activated. Moreover, adjacent ailerons may be activated to differing levels and angles of inclination, thus imparting a warping effect about the circumference of the craft.

The pilot is also provided with control means such as a joy stick control at panel **32** for disabling the servomechanism and for manually operating ailerons **13** and **15** to assist the steering of craft **10** during maintained flight through the air. For example, the ailerons can be used by the pilot to initiate a departure from level flight.

The craft embodiment **100** shown in FIGS. **5, 6,** and **7** contains an internal propulsion mechanism. Otherwise, the craft **100** is similar in construction to craft **10** of FIGS. **1** through **4** and like reference numerals indicate like components in the Figures.

As seen in FIGS. **6** and **7,** the craft **100** includes four fans mounted near the center of gravity of the craft. As best seen in FIG. **7,** each fan **110** is separately enclosed in a housing **112,** and three air ducts extend from each housing **112.** A first air duct **114** extends upwardly in the craft to an opening **115** at the top of hull portion **12.** A second air duct **116** extends downwardly in the craft to an opening **117** at the bottom of hull portion. A third air duct **118** extends laterally in the craft to an opening **119** (FIG. **5**) near the craft circumference.

At the juncture of the air ducts **114, 116,** and **118** and housing **112,** adjustable pivoted flaps **124, 126,** and **128,** movable by flap actuators **134, 136,** and **138,** respectively, vary the relative air flow through each duct. Flap actuators **134, 136,** and **138,** which are typically electric motors, are controllable by the pilot through suitable control means located at control panel **32.** Also, the pitch of each fan **110** is variable by the pilot through suitable control means at control panel **32** to vary the rate and direction of the air flow through ducts **114, 116** and **118.** Fans **110** can thus move air upwardly, downwardly or laterally through the craft depending upon the flap and fan pitch selections made by the pilot.

The pilot can use this propulsion mechanism to propel craft **100** in a forward, reverse or lateral direction, or to hasten ascent or force descent of the craft. For example, to force descent of craft **100,** the pilot activates flap **128** to close lateral air duct **118.** Flaps **124** and **126** are left open. The pitch of a fan **110** is selected to draw air from opening **117** at the bottom of the craft and to exhaust it at opening **115** at the top of the craft. A similar control selection for each of the four fan **110** causes craft **100** to move downwardly in the air.

To propel craft **100** in a particular lateral direction, two diametrically opposed fans **110** aligned along that direction. may be used. In each of these two fans, flap **124** is activated to close duct **114,** while flaps **128** and **126** are left open. The pitch of one of these two fans is selected to draw air from opening **117** at the bottom of the craft and to exhaust it at opening **119** at one end of the craft. The pitch of the other of the two fans **110** selected to move air in the opposite direction, namely to draw air from opening **119** at the other end of the craft and to exhaust it at opening **117** at the bottom of the craft. The combined action of the two fan **110** causes craft **100** to move laterally through the air along a line of flight passing through the two fans **110** being utilized. As will be apparent, numerous other combinations of flap positions and fan pitch selections make various other craft manuevers possible.

Variable pitch fans **110** and flap actuators **134, 136,** and **138** can each be electrically operated and powered by generators **52.** Alternatively, fans **110** may be powered by internal combustion engines.

Thus, lighter-than-air craft constructed in accordance with the various embodiments of the invention have several advantages. The discus shape, combined with the automatically controllable ailerons distributed about the circumference of the craft, increase stability and facilitate control. The adverse effects of changing winds and turbulent air currents on the craft, even while hovering, are reduced. Cargo and passengers can be loaded into or unloaded from the craft without the need of bringing the craft to the ground. The time and ground space required for loading and unloading procedures are minimized.

As will be apparent, the above-described craft are illustrative only of two specific embodiments of this invention, and can be modified in many ways by those skilled in the art. For example, deviations from a circular outline shown in FIGS. **2** and **6** can be made in each craft while still maintaining the discus-like shape. The size of the craft can be selected in terms of the payload to be carried. The propulsion mechanism described in connection with craft **100** can be varied in many ways. Instead of four variable pitch fans, one or more jet engines mounted internally of the craft could be used to move air through the propulsion control air ducts. Instead of, or in addition to, the air flow control flaps mounted internally of the craft **100**, air control means, such as pivoted flaps or vanes, could be mounted at each air duct opening at the craft's outer surface. More or fewer air ducts. than are shown in craft **100** could be included. Also, in both of the embodiments, I described specific placements for various items such as passenger chairs, pilot chair and control panel, engines, power supplies and other items. These locations could change from craft to craft. Hence, I believe that these and other modifications are clearly within the true spirit and scope of the invention, and it is the object of the appended claims to cover all such modifications.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A lighter-than-air craft comprising:

A. a discus-shaped hull including upper and lower hull portions;

B. means for containing internally of said hull a volume of a lighter-than-air gas to provide lift to said craft;

C. propulsion means mounted to said hull for moving said craft in flight;

D. means for controlling said propulsion means; and

E. stabilizing means comprising a plurality of ailerons distributed about the periphery of said upper hull portion and a plurality of ailerons distributed about the periphery of said lower hull portion, said ailerons being selectively movable relative to said hull portions to provide variable control surfaces for changing the orientation of said craft in flight.

2. A lighter-than-air craft as recited in claim **1** in which said hull is substantially symmetrically shaped about a vertical axis through the center of the craft, whereby the periphery of said hull is essentially circular in shape.

3. A lighter-than-air craft as recited in claim **2** in which the maximum thickness of said hull is no larger than about one-fifth of the overall diameter of said hull.

4. A lighter-than-air craft as recited in claim **2** in which said stabilizing means further includes

i. means for sensing a change in the orientation of said craft, and

ii. means coupled to said craft orientation sensing means for automatically actuating at least one of said ailerons to compensate for the sensed change.

5. A lighter-than-air craft as recited in claim **1** further including a passenger and crew compartment located at the top center of said hull.

6. A lighter-than-air craft as recited in claim **1** further including a payload pod located at the bottom center of said hull.

7. A lighter-than-air craft as recited in claim **6** in which said pod is detachable from said hull and said craft further includes means for raising and lowering said pod to the ground while said craft maintains altitude above the ground, whereby passengers and cargo can be loaded into and unloaded from said pod without bringing said craft to the ground.

8. A lighter-than-air craft as recited in claim **1** wherein

A. said propulsion means includes first and second jet engines mounted at diametrically opposite positions at the periphery of said hull, said jet engines being rotatable in a vertical plane; and

B. said propulsion means includes means for rotating said jet engines in the vertical plane to vary the direction of thrust therefrom.

9. A lighter-than-air craft as recited in claim **1** wherein:

A. said propulsion means includes a plurality of air ducts communicating between an internal portion of said hull and opening at the exterior surface of said hull, and at least one fan mounted internally of said hull for moving air through said air ducts; and

B. said propulsion control means includes means for varying the direction and volume of air moving through said air duct.

10. A lighter-than-air craft as recited in claim **1** in which said lighter-than-air gas containing means comprises a plurality of discrete lighter-than-air gas containing modules distributed internally of said hull.

11. A lighter-than-air craft comprising:

A. a hull including upper and lower hull portions, said hull being discus shaped with a maximum thickness at the center of the hull and a gradually decreasing thickness in a radial direction to the periphery of the hull;

B. means for containing internally of said hull a volume of a lighter-than-air gas to provide lift to said craft;

C. propulsion means mounted to said hull moving said craft in flight;

D. means for controlling said propulsion means;

E. stabilizing means comprising

i. a plurality of ailerons distributed about the periphery of said upper hull portion;

ii. a plurality of ailerons distributed about the periphery of said lower hull portion;

iii. said ailerons being selectively movable relative to said hull portions to provide variable control surfaces for changing the orientation of said craft in flight;

F. a passenger and crew compartment located at the top center of said upper hull portion;

G. a payload pod located at the bottom center of said lower hull portion beneath said passenger and crew compartment;

H. a passageway connecting said payload pod to said passenger and crew compartment and extending through the center of said hull;

I. means for detaching said payload pod from said hull; and

I. means for detaching said payload pod from said hull; and

J. means for raising and lowering said payload pod to the ground while said craft maintains altitude above the ground whereby passengers and cargo can be loaded into and unloaded from said pod without bringing said craft to the ground.

12. A lighter-than-air craft as recited in claim **11** in which said stabilizing means is automatically controllable and further includes means for sensing a change in the orientation of said craft and means coupled to said craft orientation sensing means for automatically actuating at least one of said ailerons to compensate for the sensed changed.

* * * * *

United States Patent [19]

Richard

[11] **4,023,751**

[45] **May 17, 1977**

[54] **FLYING SHIP**

[76] Inventor: **Walter A. Richard,** 1501 Sabine Ave., Port Arthur, Tex. 77640

[22] Filed: **July 28, 1976**

[21] Appl. No.: **709,270**

[52] **U.S. Cl.** .... **244/23 C**

[51] **Int. Cl.²** **B64C 29/00;** B64C 15/02

[58] **Field of Search** .... 244/23 C, 23 B, 23 R, 244/12.1, 12.2, 12.3, 15, 165, 164, 23 A, 52, 12.4, 12.5; 60/39.34, 39.35

[56] **References Cited**

UNITED STATES PATENTS

2,705,867	4/1955	Lewis	60/39.34
2,989,271	6/1961	Bohr	244/23A
3,148,848	9/1964	Price	244/23 D
3,200,588	8/1965	Math	60/39.34
3,614,030	10/1971	Moller	244/23 C
3,750,980	8/1973	Edwards	244/12.2
3,862,732	1/1975	Wyatt et al.	244/165
3,915,416	10/1975	Anderson et al.	244/165

Primary Examiner—Trygve M. Blix
Assistant Examiner—Galen L. Barefoot

[57] **ABSTRACT**

A flying ship is disclosed which comprises a hollow, saucer-shaped body having a convex upper surface surmounted at its center portion by a dome-shaped transparent canopy covering a passenger compartment, and a bottom including a generally concave major bottom portion, and an annular outer bottom portion which is inclined upwardly at its outer edge and is joined to the concave major bottom portion by a smooth upwardly open curve. Plural jet engines are adjustably mounted beneath the ship in a circular pattern inward of the outer edge and beneath the annular outer bottom portion to provide lift for take-off and landing, and horizontal thrust, as well as lift, for flight. An annular fluid motor is provided in the ship above the jet engines which includes an annular tube in which, an endless train of pistons is slidably mounted. Fuel from an annular fuel tank is pumped through a distributor and plural injectors into the annular fluid motor tube at an angle whereby the kinetic impact of the injected fuel propels the train of pistons in one direction at sufficient speed to give gyroscopic stability to the ship. A fuel outlet port is provided in the annular fluid motor tube above each engine to supply fuel from the annular fluid motor to the jet engines. Each jet engine includes a combustion chamber formed inside of a ball and socket joint, a fuel inlet on one side of the ball and socket joint which provides communication between the fuel outlet from the annular fluid motor tube and the interior of the combustion chamber, and a jet discharge nozzle provided on the side of the ball and socket joint opposite the fuel inlet.

12 Claims, 17 Drawing Figures

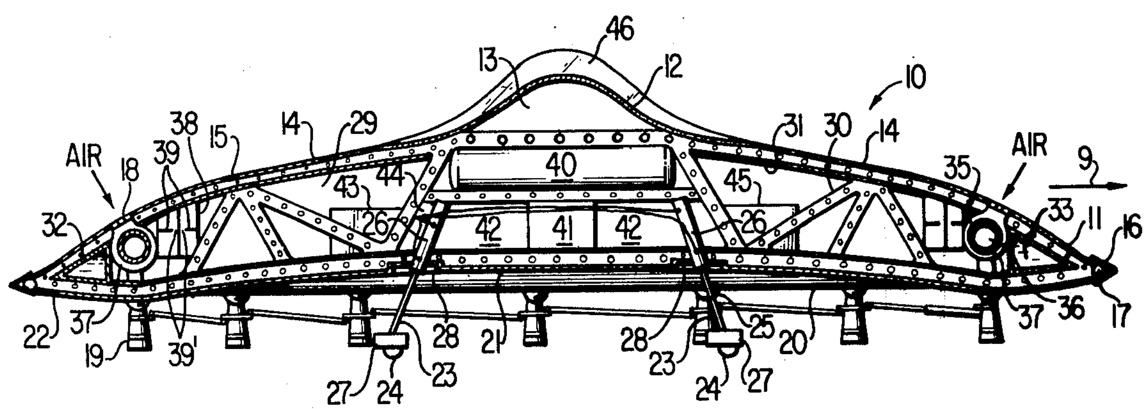


FIG. 1

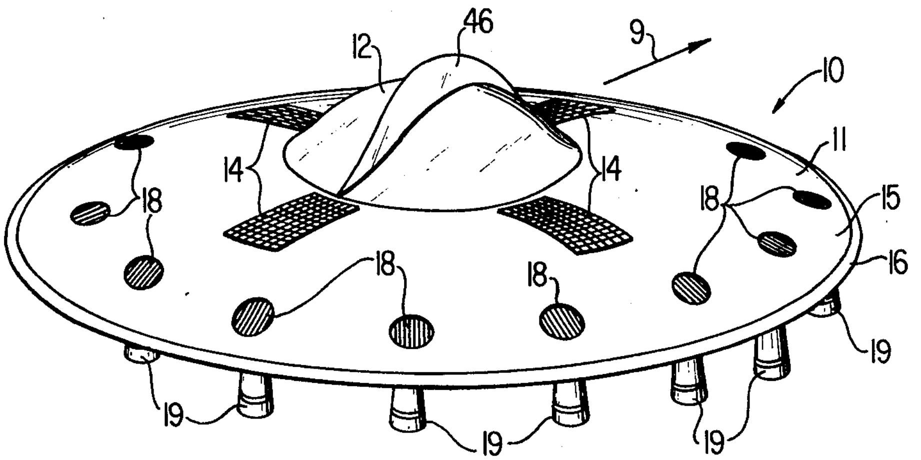


FIG. 2

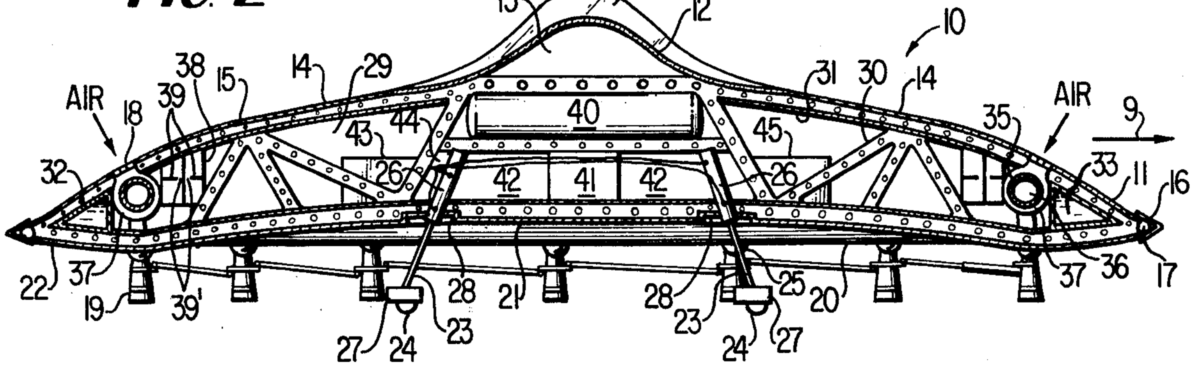
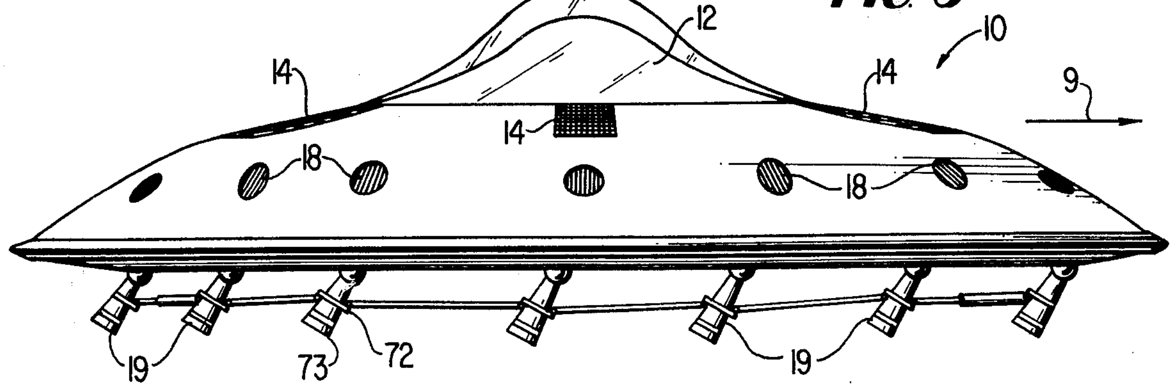


FIG. 3



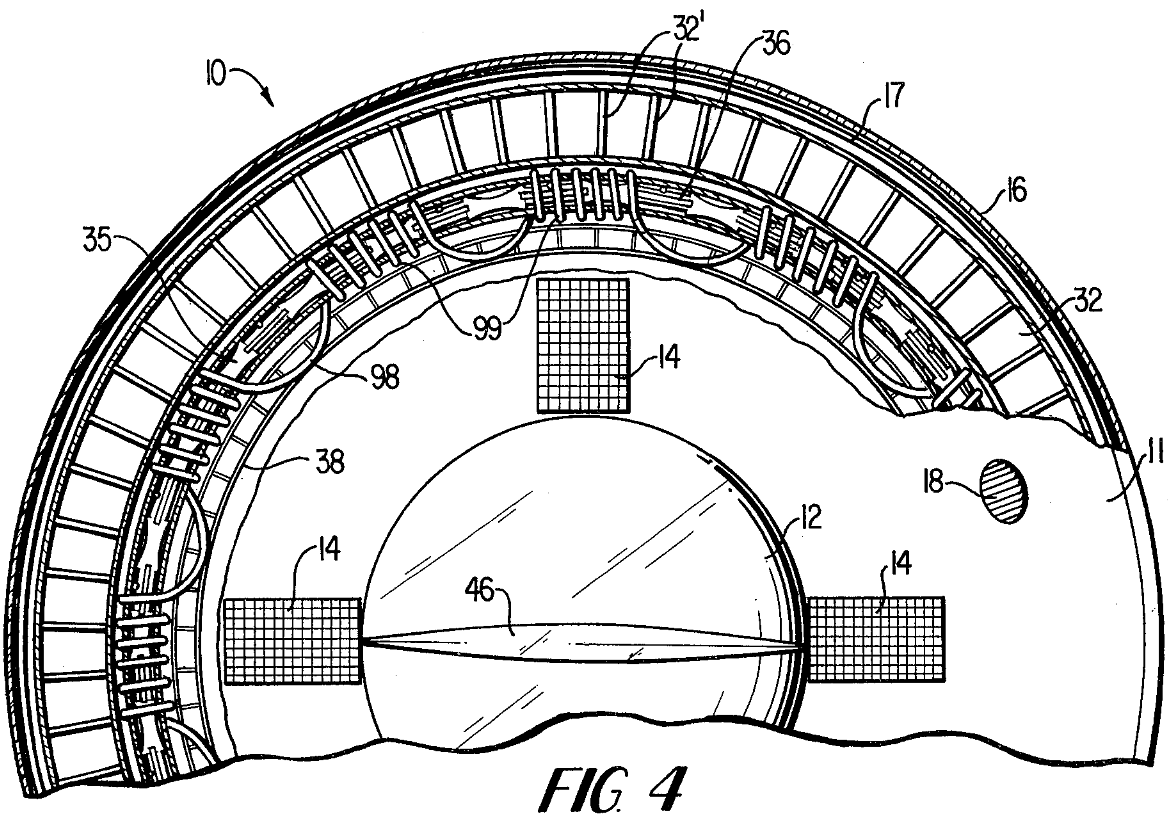


FIG. 4

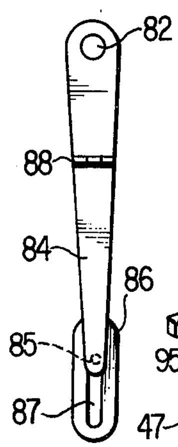


FIG. 5a

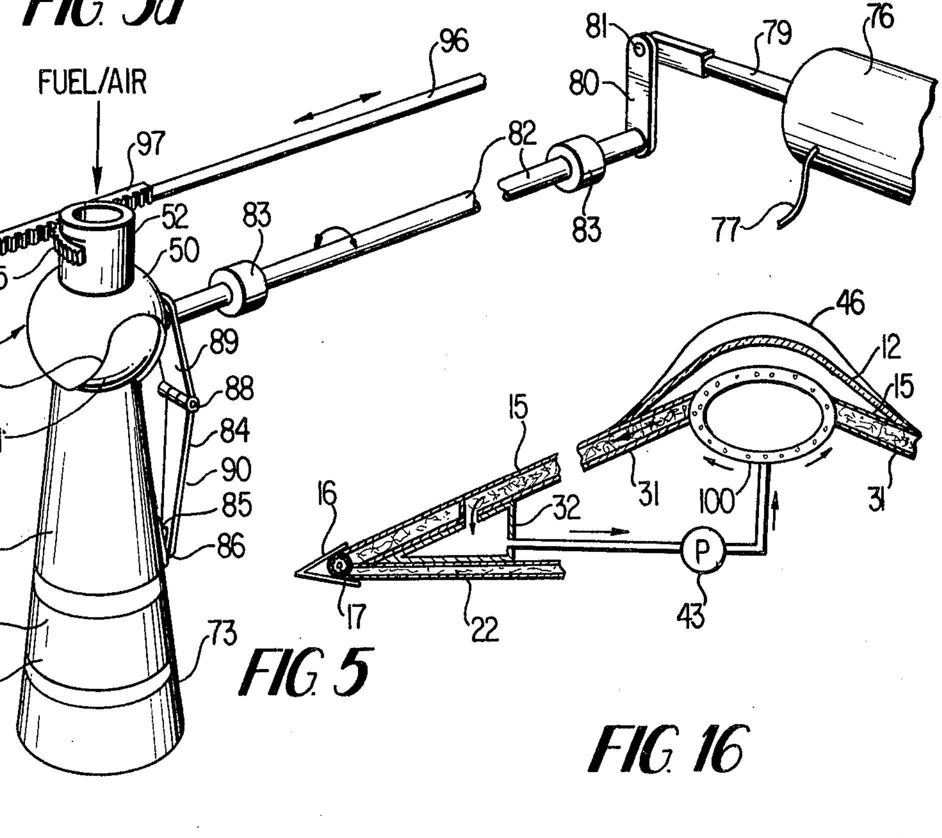


FIG. 5

FIG. 16

FIG. 6

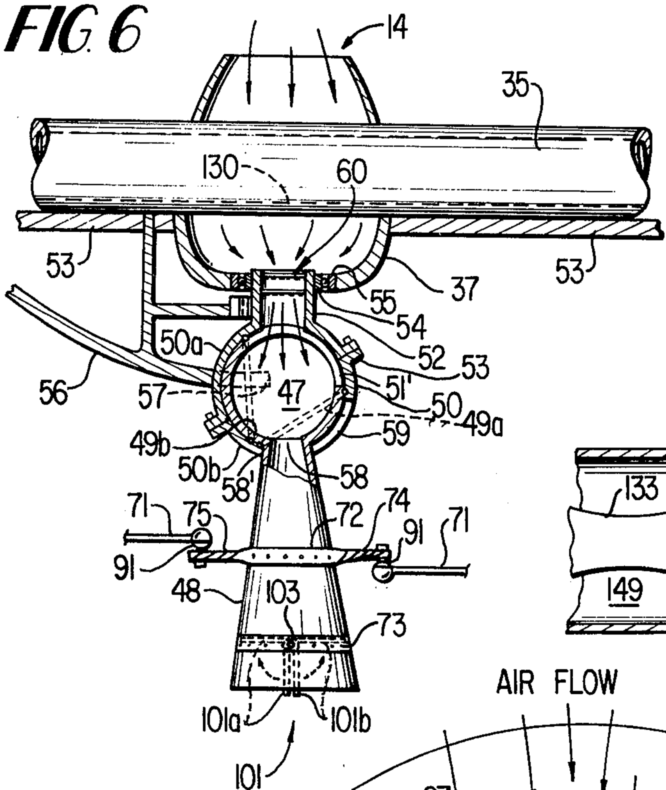
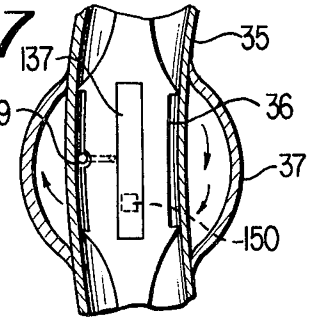


FIG. 7



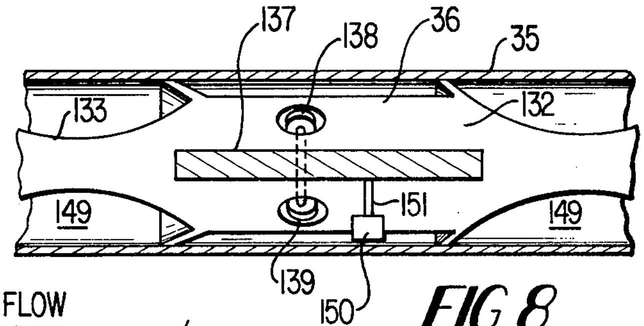
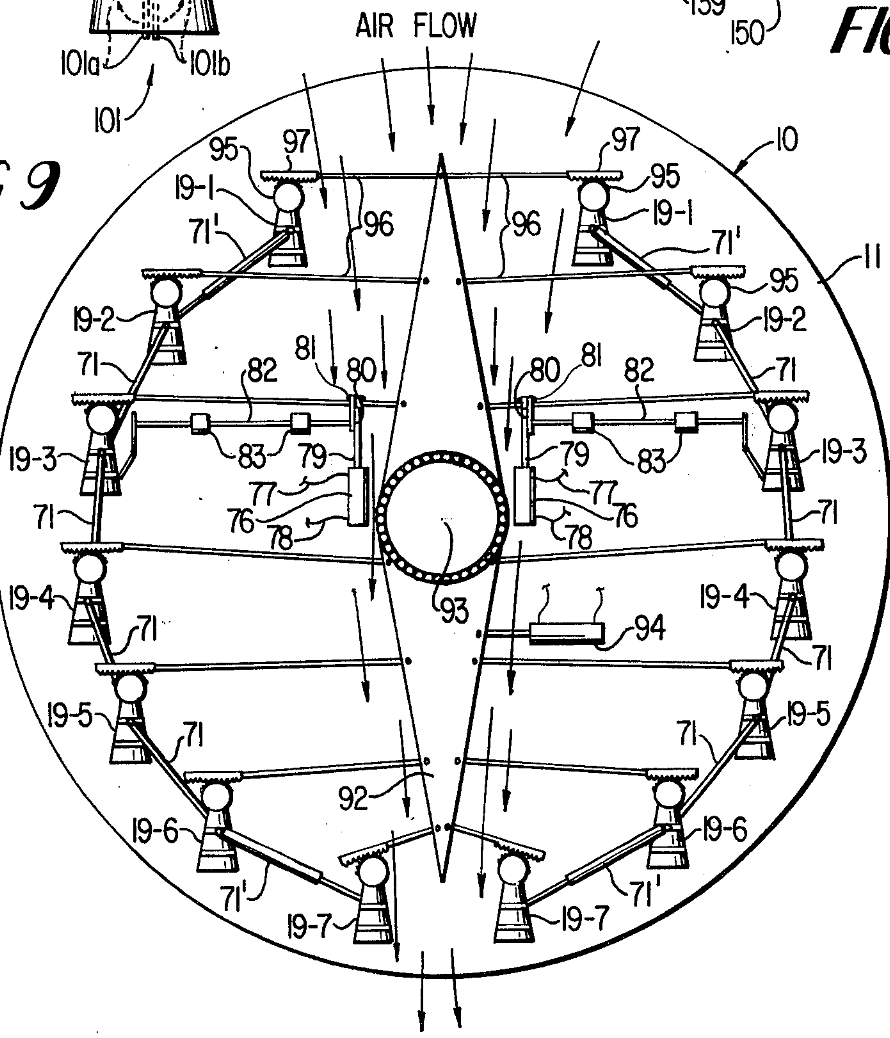


FIG. 8

FIG. 9



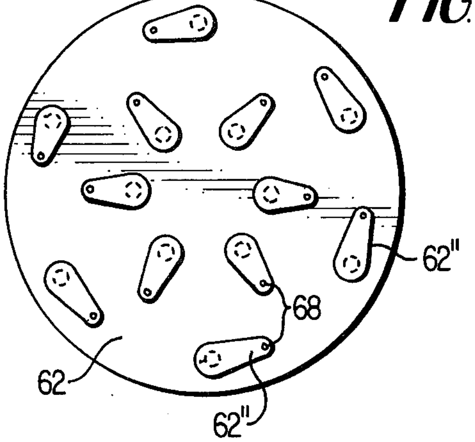


FIG. 10

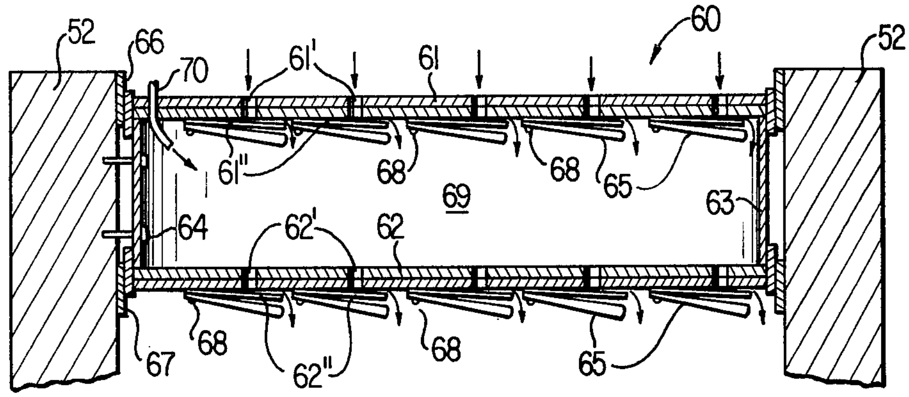


FIG. 11

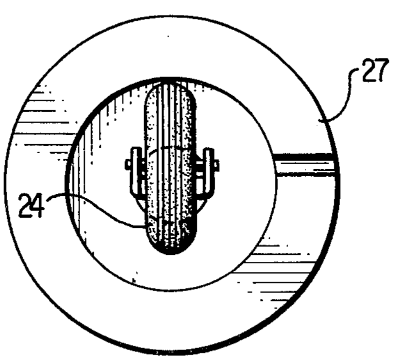


FIG. 12

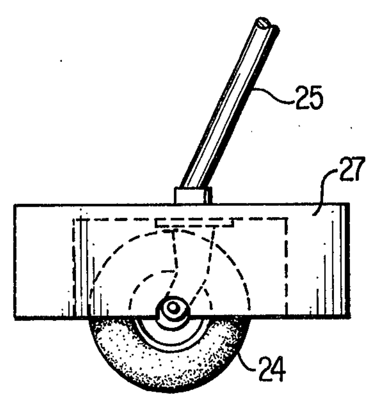


FIG. 13

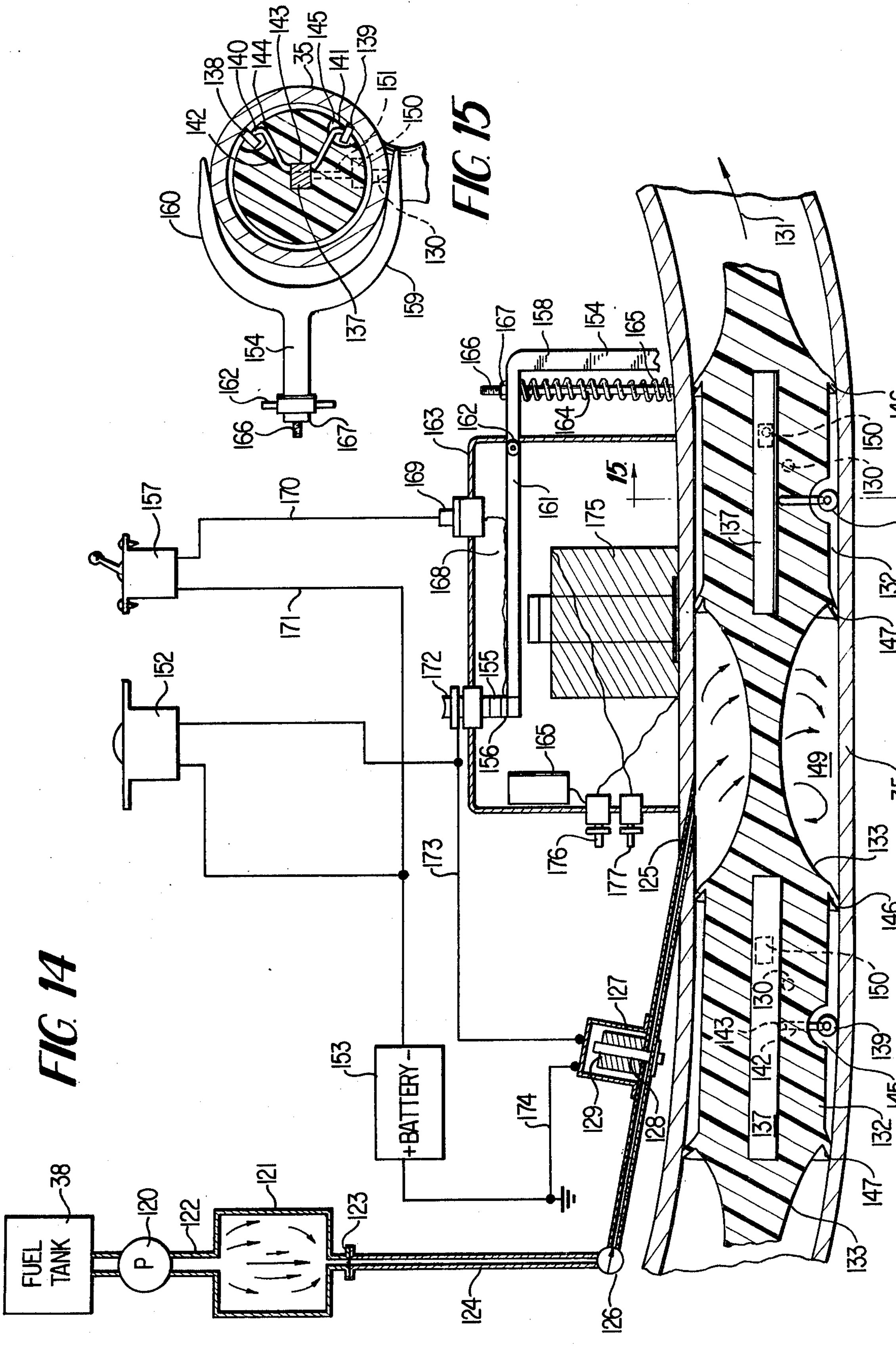


FIG. 14
FIG. 15
FUEL TANK
P
+BATTERY-

FLYING SHIP

This invention relates to an improved flying ship and particularly to one having a hollow saucer-shaped body and plural adjustably mounted jet engines which provide in one position vertical lift for take-off and descent, and which when rotated and tilted from the one position provide horizontal directional thrust and vertical lift.

It is an object of the invention to provide an improved flying ship which includes one or more of the following special features:

1. A degaussing system comprising a degaussing cable provided about the outer edge of the ship and encased in a V-shaped outer shield.

2. A coolant system for cooling the ship comprising an annular coolant tank provided within the ship inboard of and adjacent the degaussing cable, spaced inner and outer upper shells for the ship providing a fluid passage therebetween, a pump and conduits for causing the flow of coolant from the coolant tank to the top of the ship and an annular distributor pipe at the top of the ship for distributing the coolant evenly into the space between the inner and outer top shells so that the coolant flows between the shells and is returned to the coolant tank.

3. A gyroscopic stablizing system comprising an annular fluid motor having an annular fluid motor tube mounted coaxially within the ship, an endless train of pistons slidably mounted within the annular fluid motor tube, fluid injection means extending through the annular fluid motor tube for injecting pressurized fuel into the tube to give kinetic impact to the pistons and to cause the pistons to slide in one direction with sufficient speed to give gyroscopic stability to the ship, and plural outlets for the injected fluid.

4. An electrical generator system including the annular fluid motor of (3) above, and a generator coil wound around the annular fluid motor tube, each of the pistons of the endless piston train having a permanent magnet core which creates a flux field. The flux field, as the endless train moves through the annular motor tube and generator coil windings, is cut by the coil and causes electricity to be generated.

BRIEF DESCRIPTION OF THE DRAWINGS

With the foregoing more important objects and features in view and such other objects and features which may become apparent as this specification proceeds, the invention will be understood from the following description taken in conjunction with the accompanying drawings, in which like characters of reference are used to designate like parts, and in which:

FIG. 1 is a perspective view of the invention looking at its topside;

FIG. 2 is a vertical cross-sectional view taken along a fore and aft center line through the flying ship;

FIG. 3 is a side elevational view of the flying ship of this invention;

FIG. 4 is a partial top plan view of the flying ship with portions of the outer surface broken away to expose the interior structure;

FIG. 5 is a perspective view of one of the jet engines and controls for directing the jet engine;

FIG. 5*a* is a detail view of one of the control elements shown in FIG. 5;

FIG. 6 is a partial vertical sectional view through a portion of the bottom of the flying ship and one of the jet engines;

FIG. 7 is a detailed horizontal sectional view through a segment of the fluid motor tube and air intake shroud shown in FIG. 6;

FIG. 8 is a vertical sectional view through a segment of the fluid motor tube and a portion of the endless motor train therein;

FIG. 9 is a diagramatic top plan view showing the arrangment of the jet engines of the flying ship and directional controls therefor;

FIG. 10 is a bottom plan view of the fuel inlet control valve;

FIG. 11 is a vertical cross-sectional view through the fuel inlet control valve;

FIG. 12 is a bottom plan view of one of the landing gear of the flying ship according to this invention;

FIG. 13 is a side elevational view of the landing gear shown in FIG. 12;

FIG. 14 is a horizontal cross-sectional view of a portion of the fluid motor showing diagramatically the fuel injection system and the electrical controls for the fuel injection system;

FIG. 15 is a sectional view taken on line 15—15 of FIG. 14;

FIG. 16 is a fragmentary vertical sectional view through the upper surface portions of the ship showing the ship's cooling system.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Referring first to FIG. 1 of the drawings, a preferred embodiment of the flying craft of this invention is generally indicated by the arrow **10.** The flying craft **10** comprises a hollow, saucer-shaped body **11** at the top center of which is mounted a transparent dome-shaped canopy member **12** of Plexiglas, or other strong, transparent material, covering a cockpit, or passenger compartment **13.** Four solar energy panels **14** are mounted flush with the downwardly curved, generally convex, upper surface **15** of the flying craft **10** to convert solar energy into electrical energy for use in the carft. At the outer edge of the saucer-shaped body **11** is a V-shaped shield **16** which covers a degaussing cable **17** which will be subsequently described. A plurality of air intake grills **18** are mounted flush with the upper surface **15** in a circular arrangment to supply air to a plurality of jet engines **19** which are mounted under the flying craft **10.** Each air intake grill **18** supplies air to one jet engine **19** of which there are fourteen provided in the preferred embodiment.

Looking now at the vertical section of the invention shown in FIG. **2,** the greater central portion **21** of the bottom surface **20** of the flying craft **10** is seen to be upwardly dished in a generally concave configuration, while the outer portion **22** is inclined downward from the outer edge and then rises to the concave portion **21** in a smooth curve. Extending beneath the dished portion **21** are plural landing gear **23,** each comprising a caster wheel **24** mounted on the end of a strut **25** which is retractable into the floor of the craft after take-off by means of the reciprocating fluid motors **26** of the piston and cylinder type. Hydraulic fluid for operating the motors **26** is supplied by pumping means **44.** A circular wheel cover **27** encompasses each caster wheel **24,** and fills a circular opening **28** provided in the bottom portion 21 when the strut 25 is retracted into the floor of the craft 10.

The hollow interior 29 of the flying craft 10 is provided with structural framework 30 comprising lightweight metal framing members preferably of magnesium or other lightweight, high strength material. The top wall of the craft 10 has spaced outer and inner surface coverings 15 and 31 respectively between which a coolant fluid flows by gravity from the upper portion of the wall into an annular coolant tank 32 provided adjacent the outer rum or shield 16. Coolant fluid 33 is pumped by suitable pumping means 43 from the tank 32 to the space between the skins 15 and 31 in the upper region thereof. An annular fluid motor tube 35 is provided inwardly of the coolant tank 32, and an endless train 36 of spaced pistons is slidably mounted within the tube. Surrounding the motor tube 35 are plural air ducts 37 which connect the air intake grills 18 with jet engines 19. Inwardly of the motor tube 35 is an annular fuel tank 38 for supplying fuel to the jet engines 19. The tank 38 has interior baffles 39 to prevent sudden shifting of the fuel in the tank. Small holes 39' in the baffles 39 allow fuel to bleed through in order to keep the craft balanced at all times. Directly beneath the cockpit 12 is an oxygen supply tank 40 for supplying oxygen to the sealed pressurized cockpit compartment 13 and to additional pressurized compartments 42,42 beneath the oxygen tank 40. A liquid oxygen tank 41 is mounted vertically at the center of the craft 10. The oxygen in the tanks 40 and 41 are for use in outer space to provide for the passengers on board the craft and to inject into the intake of the jet engines 19 in order to obtain a good burn. A battery pack 45 provides electrical energy for the electrical equipment of the craft. It is charged by the solar panels 14 and by an electric generator combined with the fluid motor 35.

The flying saucer 10 as seen in FIG. 1 faces forward in the direction of the arrow 9. A fin 46, surmounts the canopy 12 and is secured thereto to provide reinforcement for the canopy. The ridge of the fin 46 lies in a vertical plane through the vertical axis of the saucer in the fore and aft direction of the ship.

There are seven jet engines provided on each side of the saucer relative to the fin 46. The engines, starting at the front and counting toward the rear on each side of the saucer are numbered 19–1 through 19–7 consecutively (See FIG. 9). The number one engines on opposite sides of the ship are spaced a greater distance apart than the number 7 engines at the rear of the ship. The jet engines are positioned on a circle which is coaxial with the center axis of the saucer 10; they are spaced along the circle so that the circular arcs between adjacent engines on the same side of the saucer are equal. The arrangement of the jet engine 19 is seen most clearly in FIG. 9.

Each of the jet engines 19 includes a combustion chamber 47 and a jet nozzle 48. The combustion chamber 47 comprises an outer ball socket member 50 having an interior spherically formed surface and an inner ball member 51 having an exterior spherically formed surface. The inner ball member 51 fits closely within the outer socket member 50 and slides relative thereto in the manner of a ball and socket joint. The hollow interiors of members 50 and 51 form the combustion chamber 47.

The outer ball 50 comprises two hemispherical sections 50*a*, and 50*b* which are joined together by a bolted flange joint 53. The lower section 50*b* has a slot 59 formed therein through which the narrow throat portion 58' of the jet nozzle 48 projects. The slot 59 extends from the bottom of the ball 50 in a rearwardly and upwardly extending arc to permit the nozzle to swing from a vertically downward position (as shown in FIG. 9) to an approximately horizontal position (not shown).

The inner ball 51 is a completely spherical hollow ball. It is provided with a fuel inlet slot 51' in its upper portion which is of sufficient arcuate length to assure that there is communication between the interior of the inner ball 51 and the passage through the cylindrical stem 52 of the outer ball when the jet nozzle 48 is in a vertically down position as well as when the jet nozzle 48 is in an approximately horizontal position. A throat aperture 58 is provided at the bottom of the ball into which the small end 58' of the jet nozzle is fitted and secured by welding or other suitable means. The inner surface of the inner and outer ball and the jet nozzle are coated with a heat and corrosion resistant coating of hard metal alloy or other refractory material. The outer surfaces of the outer ball 50 and of the jet nozzle 48 are preferably provided with cooling fins (not shown). The outer surface of the inner ball and the inner surface of the outer ball are finished within close tolerances so that the inner ball is free to rotate within the outer ball. If properly finished, the inner and outer ball will be substantially self-sealing against the flow of gases from the combustion chamber 47 outwardly between the inner and outer ball surfaces. However, to insure a proper seal between the inner and outer balls 50,51, a pair of metallic sealing rings 49*a* and 49*b* are seated in grooves provided in the outer surface of the inner ball 51 so as to bear against the inner surface of the outer ball 50.

When assembling the jet engines 19, the two outer ball sections 50*a* and 50*b* are initially separate, and the jet nozzle is separate from the inner ball 51. The inner ball is first seated in the bottom half 50*b* of the outer-ball with the throat 58 aligned with the slot 59 in the outer ball section 50*b*. The small end of the jet nozzle 48 is then inserted in the throat 58 of the inner ball and is secured therein as by welding or other suitable means. Finally, the upper ball section 50*a* is placed over the upper portion of the inner ball 51 and the bottom portion 50*b* of the outer ball and is secured to the bottom portion 50*b* by means of the bolted flange joint 53.

As seen in FIG. 6, the outer ball-socket member 50 has a cylindrical stem 52 which projects outwardly therefrom in an upward direction so that the axis of the stem 52 passes through the geometric center of the inner and outer ball members 50 and 51. The stem 52 projects upwardly through a circular opening 55 in the air shroud 37 depending from the planar support member 53 secured to the bottom of the ship 10. An antifriction bearing 54 rotatably supports the stem 52 in the opening 55. A thrust brace 56 depending angularly from beneath the support member 53 in the direction of the combustion chamber 47, includes an arcuate yoke 57 which partially encompasses the outer ball member 50 and gives support thereto. The inner face of the arcuate yoke 57 may be provided with anit-friction surface means such as roller or ball bearings.

The jet nozzle 48 is of frusto conical shape and it is integrally connected to the inner ball 51 at its narrow end. The interior of the combustion chamber 47 opens outwardly through a throat 58 which is formed between the inner ball **51** and the nozzle **48**. The stem **52** provides an inlet passage for fuel and air (or oxygen) which is fed into the combustion chamber **47** through the fuel inlet slot **51'** of the inner ball **51**. The flow of fuel and air into the combustion chamber **47** is controlled by inlet control valve means **60** secured within the cylindrical stem **52**.

The combustion chamber inlet control valve means **60** (best seen in FIGS. **10** and **11**) includes axially spaced outer and inner apertured disks **61** and **62** closing the ends of a spacer cylinder **63** which is affixed to the interior wall of the stem **52** by bolts **64**. Upper and lower seals **66** and **67** seal the space between the perimeter of the disks **61** and **62** respectively and the interior wall of the stem **52**. The inner and outer disks **61** and **62** each have at least one valve passage **61'** and **62'** respectively therethrough and these are controlled by a like number of one-way valve elements **61''** and **62''** respectively which open to permit fluid flow through the apertures **61'** and **62'** respectively in the direction from outside of disk **61** into the combustion chamber **47** beneath the disk **62**. The one-way valve elements **61''** and **62''** as shown are reed valves which are secured by screws **68** beneath the disks **61** and **62** respectively so that they swing toward and away from the disks depending upon which side of the respective disks has the greater pressure. The chamber **69** between the disks **61** and **62** is a mixing chamber where fuel and air (or oxygen) mix prior to entrance into the combustion chamber **47**. An emergency fuel line **70** supplies fuel into the chamber **69** directly from a fuel supply system. Heat shields **65** are secured beneath each of the reed valves **61''** and **62''** in order to shield the valves from the heat of the gases in jet engine **19**.

The control mechanism for adjusting the jet engines **19** to vary the direction of thrust of the gases discharging from the jet nozzles **48** is best understood by referring to FIGS. **3**, **5**, **5*a***, **6** and **9**.

Looking first at FIG. **9**, the jets **19** on each side of a center fore and aft line are shown to be mechanically connected in a train by tie rods **71**. The nozzle **48** of each jet **19** has a pair of reinforcing rings **72**,**73** (See FIG. **6**) secured about the nozzle at longitudinally spaced intervals, the ring **73** being located near the exhaust end of the nozzle and the ring **72** being located further up the nozzle. The ring **72** has radially projecting ears **74** and **75** formed diametrically opposite each other. The ears **74** and **75** each have a hole extending therethrough to receive a universal pivot **91** to which an end of one of the tie rods **71** is pivotally connected.

The jets **19–1** and **19–7** closest to the front and rear of the ship **10** are each connected to the next adjacent jet engine on the same side of the ship by a stretchable tie rod **71'**. The tie rods **71'** include a pair of telescoping sections, which are normally spring biased to a foreshortened condition. The stretchable tie rods **71'** are required by the jet engines which turn the most about a vertical axis through the stem **52** (See FIG. **6**) in a manner described subsequently.

Hydraulic reciprocating motors **76**,**76** are provided to tilt the jet nozzles between a vertical, downwardly entending position substantially normal to a plane through the ship including the peripheral edge **16** thereof and a position inclined rearwardly from the vertical, downwardly extending position. Each of the hydraulic motors **76**,**76** include a piston and cylinder, and hydraulic lines **77**,**78** connected to a conventional hydraulic system (not shown) for selectively supplying high pressure hydraulic fluid to one side of the motor piston or the other and exhausting hydraulic fluid from the opposite side of the piston from which the hydraulic fluid is supplied. The piston rods **79** of each motor **78** is connected to a crank lever arm **80** by a pivot pin **81** (FIG. **5**). The crank lever arm **80** is affixed to a shaft **82** which is rotatably mounted in bearings **83** which are secured to the body of the ship. The end of the shaft **82** opposite from the crank arm **80** has affixed thereto a hinged lever arm **84**. The hinged lever arm **84** has affixed to its end opposite the shaft **82** a slide **85** which is retained to slide within the slot **87** of a slide connection **86** secured longitudinally to one side of the number **3** engine **19–3**. The hinged lever **84** includes an upper arm portion **89** which is non-rotatably affixed to the shaft **82** and a lower arm portion **90** which is swingably connected to the upper arm portion by hinge **88**. The axis of the hinge **88** is normal to a plane including the axis of the shaft **82** and a longitudinal center line through the upper arm portion **89**. Rotation of the crank arm **80** by the hydraulic motor **76** will cause rotation of the shaft **82** about the axis of the shaft **82**. Rotation of the lever **84** about the axis of the shaft **82** will cause the jet nozzle **48** to tilt.

Rotation of each of the jets **19** about the longitudinal axis of the rotatably mounted stem **52** of the outer ball **50** of each jet engine is effected by means of a diamond-shaped tapered lever **92** which is mounted to rotate about the vertical center axis **93** through the ship as seen in FIG. **9**. A reciprocating fluid motor **94**, comprising a piston and cylinder, is connected to turn the tapered lever **92**, when motive fluid is supplied from a fluid source (not shown) upon actuation of conventional fluid control means located in the pilot's cockpit. The stem **52** of each jet engine has a gear segment **95** at least partially encompassing the stem. A control rod **96**, having a gear rack **97** on one end which engages the gear segment **95**, is pivotally connected at its other end to the tapered lever **92** and is reciprocated backward and forward by the movement of the tapered lever **92** through small arcs in order to rotate the outer ball **50** and thereby to vary the horizontal direction of thrust of the jet engine when the jet is tilted.

The control mechanics illustrated in FIG. **9** are mounted between the sealed compartment **42** (see FIG. **2**) and the lower floor **21**. The jets **19** can be turned, after their nozzles **48** have been raised, from side to said thereby controlling the direction of movement of the ship **10**. The tapered lever **92** will cause the front and back jets **19–1** and **19–7** to turn the most, and the jets **19–3**, **19–4** amid ship to turn the least. This arrangement enables the ship to be turned in a very close turn. The jets **19** can be lowered or raised hydraulically for more or less lift, causing the saucer to tip up or down. When landing the jets **19** are moved straight down, and the fuel to the engines is reduced to cuase the ship to settle to the ground with the landing gear **23** down. The disc wheel covers **27** permit the ship to land on soft ground.

FIG. **14** shows the fuel injection system of the invention as well as a horizontal cross section through a portion of the motor tube **35** and motor train **36**. A high pressure fuel pump **120** pumps fuel from the annular fuel tank **38** and delivers the fuel under high pressure into the fuel distribution block **121** via the pump discharge line **122**. The fuel distribution block **121** has multiple outlets **123** (only one being shown) each of which is connected to a separate fuel line **124** which leads to a fuel injector 125. While only one outlet 123, one fuel line 124 and one fuel injector 125 are shown in FIG. 14, it will be understood that there are a plurality of each connected as shown in FIG. 14. Within each of the fuel lines 124 is located a one way valve 126 and a solenoid valve 127. The one way valve 126 is connected so as to permit flow of fuel from the fuel distribution block 121 toward the fuel injector tube 125, while blocking fuel flow in the opposite direction. The solenoid valve 127 includes a reciprocating valve element 128 which is normally biased to block the flow of fuel through the fuel line 124. A solenoid coil 129 surrounds the valve element 128, which is the solenoid armature, and opens the valve 127 when the coil 129 is energized. The injector tube 125 is press fitted into an inclined aperture in the annular motor tube 35 so that the inner end of the injector tube 125 is flush with the interior surface of the motor tube 35.

Within the annular motor tube 35, the motor train 36 is slidably mounted to move in the direction indicated by the arrow 131. The motor train 36 is made up of a plurality of solid cylindrical pistons 132 which are alternately interspersed with a plurality of hour glass shaped spacers 134 in an endless train. The pistons and spacers are molded together as a complete train of neoprene. Each piston 132 has an elongated permanent magnet core 137 extending coaxially throughout its length. The pistons 132 are of slightly smaller diameter than the inside diameter of the annular motor tube 35 so that they may slide through the tube without binding. Each piston 132 is provided with a set of two wheels 138 and 139 mounted to rotate on axles 140 and 141 respectively, formed at the opposite ends of an axle bar 142. The wheels 138 and 139 and their axles 140,141 are located in cavities 144, and 145 formed in the piston 132. The cavities 144 and 145 open outwardly and are of such size and shape to permit the wheels 138 and 139 to rotate freely therein. The axle bar 142 is mounted in a vertical plane normal to the longitudinal axis of the piston 132 and is bent to provide a vertical mid section 143 attached to the magnet core 137 and a pair of outwardly extending legs at the ends of which are formed the axles 138 and 139. The wheels 138 and 139 rotate on the axles 140,141 respectively and bear upon the inside surface of the motor tube 35 in order to support the piston 132 and assure the proper spacing of the piston relative to the radially outer wall portion of the motor tube 35 when the train 36 is rotating the centrifugal force acts on the piston tending to force it outwardly relative to the axis of the annular tube. The wheels 138 and 139 thus help to prevent binding of the pistons in the motor tube 35 when the train is rotating and subject to centrifugal force. The inside surface 35′ of the annular motor tube 35 is smooth to reduce friction and may be coated with a friction reducing material.

Outwardly flaring resilient cup seals 146 and 147 are provided at leading and trailing ends respectively of each piston 132. The seals 146 and 147 are normally biased outwardly against the inner surface 35′ of the motor tube 35 to provide a fluid tight seal.

Each hour glass shaped spacer 133 between adjacent pistons in the train 36 provides an annular cavity 149 between the spacer and the tube 35 and between seals 146 and 147 at opposite ends of the spacer.

Motion of the train 36 is caused by the force of intermittant bursts of fuel injected through the fuel injector tube 125 against the trailing end of the pistons 132. The angle of inclination of the injector tube relative to the motor tube 35 is selected so that the kinetic force of the injected fuel has a major force component in the direction of train movement indicated by the arrow 131. Except when the train is being started, the fuel injection is controlled automatically by the movement of the train in a manner which will be subsequently described. Fuel injected into the chamber 149 between the spacer 133 and the motor tube 35 is carried forward by movement of the train 36 until a fuel discharge port 130 through the bottom of the motor tube 35 is uncovered by the leading end of the spacer 133 and the piston seal 147. The fuel discharges through the port 130 while the chamber 149 is in communication with the fuel discharge port 130. The fuel discharge port 130 empties into an air intake duct, or shroud 37, surrounding the motor tube where it is mixed with air before being admitted into the combustion chamber of an associated jet engine 19 through the combustion chamber inlet control valve means 60 shown in FIG. 11.

Each piston 132 is further provided with a pendant weight 150 which hangs by a support rod 151 beneath the magnet core 137 into the motor tube 35. The weight 150 provides proper orientation for each piston within the tube 35.

The electrical control system for the fuel injection solenoid valve 127 as seen in FIG. 14 includes motor starting circuit comprising a push button starting switch 152 located in the control cockpit and connected in series circuit with a battery 153 and the coil 129 of the solenoid fuel valve. Momentary depression of the push buttom starting switch 152 completes the starting circuit thus energizing the fuel injection solenoid valve 127 and holding it open until the starting switch 152 is released. Although the starting switch 152 and battery 153 are shown connected to only one solenoid valve, it will be understood that the starting switch and battery 153 are connected to energize simultaneously each of the fuel injection solenoid valves for the plural injectors 125 supplying fuel to the jet engines 19.

The automatic means for energizing the fuel injection solenoid valves 127 includes a pivoted ferro magnetic yoke 154 which intermittently opens and closes a pair of switch contacts 155 and 156 connected in series circuit with the fuel injection solenoid valve 127, battery 153 and on-off switch 157. The yoke 154 includes a main central stem portion 158 extending radially inwardly from the inside wall portion of the motor tube 35 toward the center of the annular motor tube and arcuate yoke portions 159 and 160 diverging in opposite directions from the end of the stem portion 158 nearest the motor tube and partially surrounding the motor tube 35. The yoke 154 further includes a lever arm 161 bent at a right angle to the main stem portion 158 on its end opposite the arcuate yoke portions 159 and 160. The lever arm 161 is pivoted by a vertical pivot pin 162 located intermediate its ends to a housing 163 affixed to the inside wall portion of the motor tube 35. A rod 164 having one end affixed to the motor tube 35 entends radially inwardly from the annular tube 35 toward the axial center of the annular tube and projects through an aperture in the lever portion 161 between the main stem 158 and the pivot pin 162. A compression spring 165 is mounted on the rod 164 between the lever arm 161 and the motor tube 35. The threaded end 166 of the rod 164 projects through the lever arm 161 and threadedly engages a nut 167 to provide means for adjusting the bias of the spring 165 and to limit the counterclockwise motion of the main stem portion 158 relative to the pivot pin 162. A switch contact 156 is secured on the end of the lever arm 161 opposite the main stem 158 facing the switch contact 155. A conductor 168 extends between the switch contact 156 and an insulated connector post 169. The post 169 extends through the housing 163. A conductor 170 connects the connector post 169 to one side of the on-off switch 157 and a conductor 171 connects the other side of switch 157 to the negative side of battery 153. The intermittent switch contact 155 is affixed to the inner end of insulated connector post 172 which extends through housing 163. A conductor 173 connects the connector post 172 to one side of the solenoid valve coil 129 and a conductor 174 connects the other side of the solenoid valve coil to the positive side of battery 153 thus completing the automatic control circuit for the fuel injection solenoid valve 127.

The on-off switch 157, like the starting switch 152, is located in the control cockpit of the flying saucer and will be turned on when the pilot wishes to start the ship. With the on-off switch 157 turned on, the solenoid valve 127 is automatically energized intermittently as a result of motion of the motor train 36 once it has been set in motion. The bar magnet core of each piston 132 passing through the ferro magnetic yoke 154 will rock the yoke about its pivot pin 162 to open and close the switch contacts 155 and 156. Closing the contacts 155,156 completes the automatic control circuit, thus energizing the fuel injection solenoid valve 127. Opening the contacts 155,156 breaks the automatic control circuit thereby de-energizing the fuel injection solenoid valve and shutting off the fuel line 124 from the motor tube 35.

Also lacated within the housing 163 is a field winding 175, the coils of which are cut by the magnetic flux of the core magnet 137. A voltage is thus induced in the field winding 175 each time one of the pistons 132 passes adjacent the winding. The opposite ends of the field winding 175 are connected to connector posts 176 and 177 respectively which extend through the housing 163. A capacitor 165 is mounted on the inside of the housing 163 and is connected to cooperate with the coil 175 to provide a voltage impulse to ignite the fuel inside of the combustion chamber of one of the jet engines.

The powerful degaussing cable 17, shown in FIG. 16, is mounted about the circumferential edge of the ship 10. It is provided with electrical energy from the ships power system so that electric current flowing through the cable creates a magnetic field about the cable and the leading edge of the ship. This magnetic field interacts with the magnetic field of atoms and molecules in the atmosphere surrounding the ship tending to repulse them by pushing them away as the ship travels in flight, and causing less stress on the ship as the ship's speed increases. The magnetic field around the degaussing cable also interacts with the earth's magnetic field helping to lift the ship.

The flying saucer 10 is made of light non-magnetic material, such as magnesium. The degaussing cable 17 is shielded as much as possible to throw its field outward and downward.

The flying saucer of this invention may be of various sizes, however, in one form, a ship having a diameter of forty feet and a height (without the canopy 12) of ten feet is contemplated.

The coolant system for the ship 10 includes a pump 43 and conduit means for pumping coolant fluid from the cooling tank 32 to near the top of the ship, where the coolant is distributed by an annular distribution pipe 100 to the space between the inner and outer layers 15 and 31. The coolant then flows downward between the layers 15 and 31 and is returned to the coolant tank 32.

The fluid motor tube 35 is surrounded by an electrical generator winding 98 best seen in FIG. 4. The winding 98 includes a plurality of interconnected spaced coil sections 99 encircling the fluid motor tube 35. As the endless train 36 moves through the tube 35 and the magnetic flux surrounding the core magnets 137 cuts the coils of the winding 98, voltages are induced in the winding 98 which cause electricity to be generated. The electrical generator supplies the electrical load system of the ship.

The circular motion of the train 36 when it reaches full speed causes the train to function as a huge gyroscope to provide stability for the ship. When in outer space, a smaller gyroscope provided, but now shown, helps maintain the ship in the correct attitude so that the large fluid motor train 36 can be stopped to save fuel. The four solar batteries 14 will then be used to keep the ships batteries charges.

OPERATION

The flying ship 10 when on the ground and supported by the extended landing gear 23 (of which there are four) is readied for take-off by directing the jet engine nozzles 48 vertically downward. This is done by the pilot in the cockpit 13 using conventional hydraulic controls to actuate the engine tilt motors 76. The tilt motors 76 on opposite sides of the ship operate through the control mechanisms shown in FIG. 5 to rotate the number 3 engines down, whereupon the remaining engines are rotated down by means of the tie rods 71,71' connecting all of the jet engines on one side of the ship in a train.

Referring now to FIG. 14, the pilot throws the on-off switch 157 to on and presses the start button 152 in the starting circuit for the jet engines. In so doing, the pilot energizes all of the fuel solenoid valves 127 of which there are eight in parallel (only one being shown). Jet engine fuel is then supplied under high pressure from the fuel tank 38, pump 120, distribution block 121 and the now open fuel lines 124 to the fuel injectors 125. A burst of fuel is injected behind pistons 132 in the train 36 which causes the train to move forward in the direction of the arrow 131 (FIG. 14). The injected fuel in cavity 149 is carried forward by the train until an outlet port 130 in the bottom of the tube 35 is uncovered whereupon the fuel from cavity 149 is discharged through outlet port 130 into the air inlet shroud 37, where it is mixed with air and then enters through the jet inlet control valve 60 into the combustion chamber 47 of the jet engine (see FIG. 6). Motion of the train 36 also causes intermittent electrical electrical impulses to be generated at the terminals 176,177 which are conducted by suitable conductors (not shown) to an ignitor (not shown) provided in the combustion chamber 47. After the initial burst of fuel has been supplied to start the fluid motor 36 forward, the automatic fuel injection circuit including the on-off switch 157, interrupter contacts 155,156 solenoid valve 127 and battery 153 now takes over to automatically and intermittently supply bursts of fuel through the injectors 125, each time a magnet core **137** passes through the ferro magnetic yoke **154**, to rock the yoke. Once the jet engines **19** have fired, the upwardly directed thrust on the ship caused by the downwardly directed jets lifts the ship from the ground. Once airborn, the jets are tilted rearwardly to provide a horizontal thrust component which moves the ship forward as well as up. Level flight can be maintained by tilting the jets sufficiently toward the horizontal so that the downward force of gravity on the ship is balanced by the vertical lift component of the jet engines and the aerodynamic lift resulting from the aerodynamic configuration of the saucer as the saucer moves through the earth's atmosphere. A tunnel of air flows through the bottom of the ship as illustrated in FIG. **9**. The pilot moves the ship to the right or left by actuating the fluid motor **94** to rotate the lever **92**, and to move the jet nozzles **48** from side to side.

On landing the ship **10** can be flown under power toward the surface of the earth in an inclined flight path, and when near the ground the ship can be set down vertically by directing the jets vertically downward and by reducing the fuel supplied to the jets so that the lift provided by the the jets is gradually reduced to allow the ship to settle gradually to the ground under its own weight.

The generator winding **98** is connected in circuit with the main battery **45** through a battery charger (not shown) for charging the battery **45** when the fluid motor train **36** is rotating. The generator winding is also connected through appropriate switching means (not shown) to an electrical distribution system in order to supply electrical energy directly to various electrical load devices such as electric lights, pump motors, etc.

As shown in FIG. **6**, each of the jets **19** includes a wink valve **101** at the outlet end of the jet nozzle **48** to control the flow of gases from the nozzle. The wink valve **101** includes a pair of blades **101*a*** and **101*b*** which are pivoted about parallel shafts **103,103** extending centrally through the discharge end of nozzle and pivotally mounted therein. The blades **101*a*** and **101*b*** are each curved outwardly at their outer end to direct the jet gases outwardly. The blades pivot between the open outwardly extended position shown in full lines to the closed position shown by dotted lines. Suitable control means (not shown) are provided to move blades **101*a*** and **101*b*** between the open and closed positions.

The skins **15** and **31** at the top of the ship **10** are spaced about three and one-half inches apart and the space between the skins is filled with loosely packed fibers **104**. The fibers retard and distribute the flow of coolant between the skins.

Suitable coolants for use in the coolant system of the flying ship **10** are antifreezes, suchf as Prestone and the like, and are preferably coolants which include a large proportion of ethylene glycol which reduces corrosion.

An additional feature which may be included but which is not shown, is the provision of an annular helium bag within the ship **10** to provide additional lift. One or more of the braces within the ship may be removed or relocated to make room for the helium bag.

The bottom of the ship **10** has a double floor, similar to the double skin at the top. The spacing between the floor preferably tapers as it extends from the center of the ship. The floor under the annular fluid motor tube **35** is preferably a removable annular section which may be lowered in order to lower the annular fluid motor tube **35** from the ship for repair.

While in the foregoing there has been described and shown a preferred embodiment of the invention, various modifications and equivalents may be resorted to within the spirit and scope of the invention as claimed.

What is claimed is:

1. A flying ship comprising a hollow saucer-shaped body, plural jet engines for lifting and propelling said ship, an annular fluid motor tube concentrically mounted within said saucer-shaped body, an endless train of spaced pistons slidably mounted within said annular fluid motor tube, injection means for injecting high pressure jets of fuel into said fluid motor tube behind said pistons to cause sliding movement of said train of pistons in one direction within said tube, plural fuel outlet means from said fluid motor tube for conducting fuel from said fluid motor tube to said jet engines, jet mounting means for adjustably mounting each of said jet engines to said body beneath said annular fluid motor tube, each of said jet engines having fuel inlet means in communication with one of said plural fuel outlet means from said fluid motor tube, and control means for varying the direction of fluid thrust produced by said engines, said endless train of pistons when moved by said high pressure fuel jets providing gyroscopic action to stabilize said flying ship in flight.

2. The flying ship according to claim **1** wherein each of the pistons of said endless train has a permanent magnet core, electric generator coil means encircling said annular fluid motor tube for the generation of an electric current within said coil means in response to the passage of said train of pistons through said tube and encircling generator coil means, and load means in circuit with said electric generator coil means for utilizing said electric current.

3. The flying ship according to claim **2** together with a storage battery, and charging means in circuit with said generator coil means and said storage battery for charging said battery.

4. The flying ship according to claim **1** wherein each of said jet engines comprises a ball and socket joint and a jet nozzle projecting from said ball and socket joint, said ball and socket joint including a hollow outer ball socket, and a hollow inner ball having sliding bearing contact within said outer ball socket, said outer ball socket having an open cylindrical stem projecting radially outwardly therefrom and having an opening in its side oppposite said cylindrical stem, said inner ball having openings on opposite sides to provide a fluid passage therethrough, said jet nozzle being connected with said inner ball about one of said openings of said inner ball and projecting outwardly therefrom through the opening in said outer ball socket which is opposite said stem, said inner ball and said outer ball sockets forming the combustion chamber of said jet engine, and said hollow stem providing the fuel inlet means in communication with the combustion chamber, and one way valve means provided in said cylindrical stem to permit fluid flow through the cylindrical stem into said combustion chamber while preventing fluid flow in the opposite direction.

5. The flying ship according to claim **4** wherein said jet mounting means for each of said jet engines includes rigid support means mounted beneath one of the plural fuel outlet means from said annular fluid motor tube; a rotary bearing carried by said rigid support means, said rotary bearing including an outer race affixed to said rigid support means, and an inner race affixed concentrically to said cylindrical stem of said outer ball socket, said inner race being rotatably supported within said outer race whereby said outer ball socket may be rotated about the axis of said cylindrical stem.

6. The flying ship according to claim **5** wherein said jet mounting means further includes a thrust brace extending downwardly from said body into contact with the outer surface of said outer ball socket, said thrust brace having an arcuate bearing portion partially encircling said outer ball socket, and antifriction bearing means interposed between said arcuate bearing portion and said outer ball socket to permit rotation of said outer ball socket relative to said thrust brace.

7. The flying ship according to claim **4** wherein said nozzle of each of said jet engines has a discharge end remote from said inner ball, and a wink valve mounted in said discharge end for opening and closing said nozzle.

8. The flying ship according to claim **4** together with a separate air duct for each of said jet engines, each of said air ducts having an air intake louver mounted in the upper surface of said flying ship above one of said jet engines and an outlet communicating with the fuel inlet means of said jet engine.

9. The flying ship according to claim **8** wherein said annular fluid motor tube passes through each of said air ducts forming a barrier which causes air flow flowing through the duct to divide and pass on opposite sides of said annular fluid motor tube.

10. The flying ship according to claim **4** wherein said one-way valve means comprises a pair of axially spaced parallel disks mounted transversely within said cylindrical stem of said outer ball socket, at least one valve passage through each of said spaced disks, and a valve closure element for each of said valve passages, each valve element being mounted to close an associated valve passage when the pressure on the side of the disk closest to the combustion chamber exceeds the pressure on the opposite side of the disk, and to open an associated valve element when the pressure is reversed.

11. The flying ship according to claim **10** wherein the space between said spaced disks provides an air fuel mixing chamber, and a fuel inlet duct projects through the outer most of said disks to inject fuel into said air fuel mixing chamber.

12. The flying ship according to claim **10** wherein said valve elements are flap valves pivotally mounted on the side of an associated disk closest to said combustion chamber to swing toward and away from the disk on which it is mounted.

* * * * *

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DeToia [45] **Sept. 27, 1977**

[54] **GYRO FOIL**

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[52] **U.S. Cl.** .... **244/23 C;** 244/12.2
[58] **Field of Search** .... 244/12.2, 23 C, 39, 244/73 C, 73 B, 23 B

[56] **References Cited**

U.S. PATENT DOCUMENTS

2,736,514	2/1956	Ross	244/23 C
3,002,709	10/1961	Cochran	244/12.2
3,395,876	8/1968	Green	244/23 C
3,774,865	11/1973	Pinto	244/23 C

FOREIGN PATENT DOCUMENTS

678,700	1/1964	Canada	244/23 C
583,318	10/1958	Italy	244/12.2
648,346	10/1962	Italy	244/23 C

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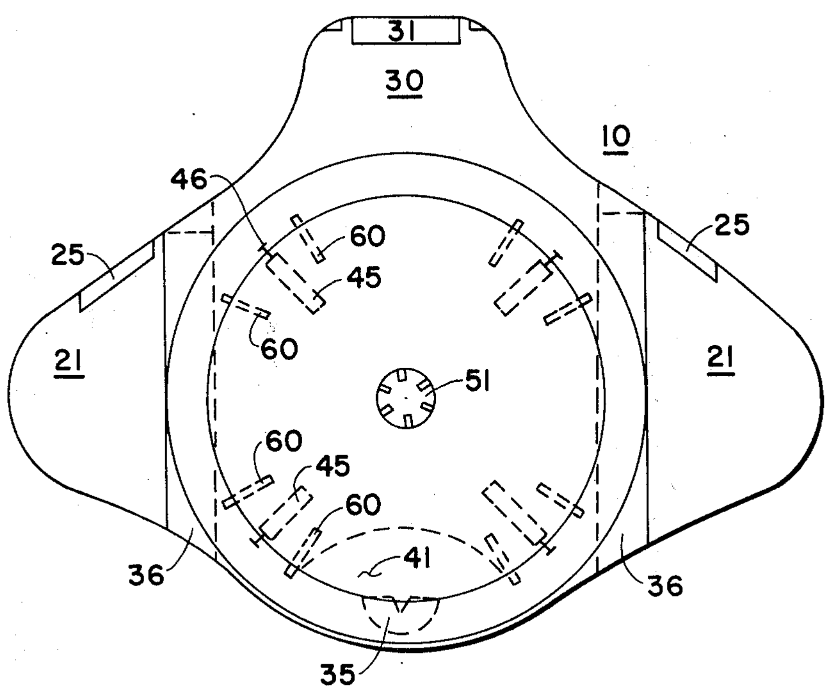
[57] **ABSTRACT**

A flying vehicle in the form of a fixed structure fitted with propulsion engines and in the form of a fixed wing and tail section mounted to a pair of counter-rotatable discs, one below and one above the fixed structure, with the discs when rotating providing both aerodynamic lift and gyroscopic stability.

1 Claim, 4 Drawing Figures



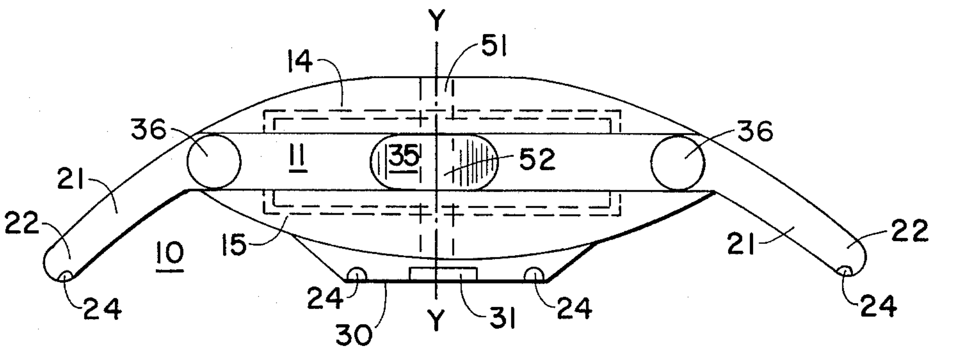


FIG. 1

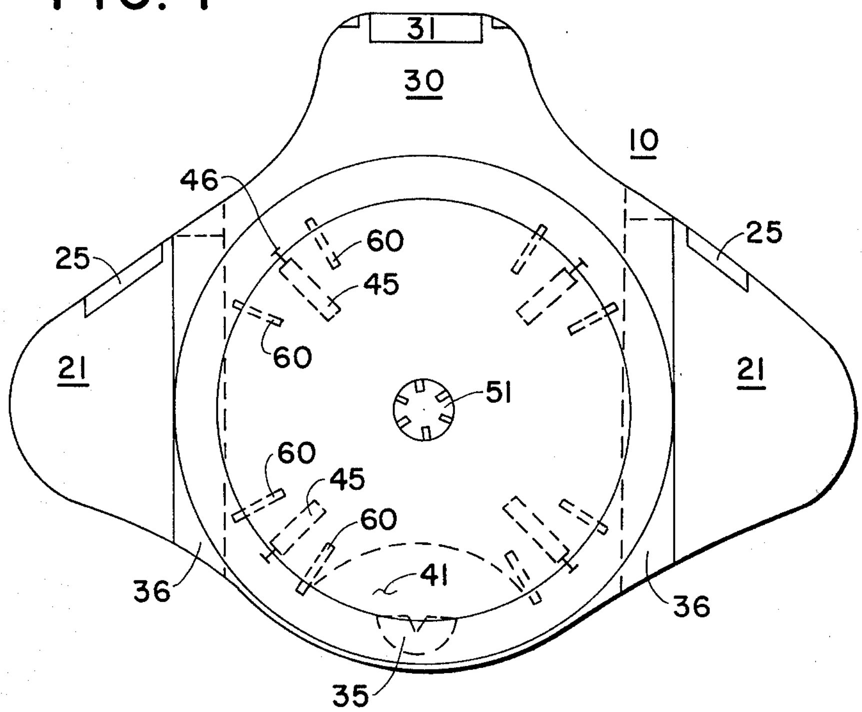


FIG. 2

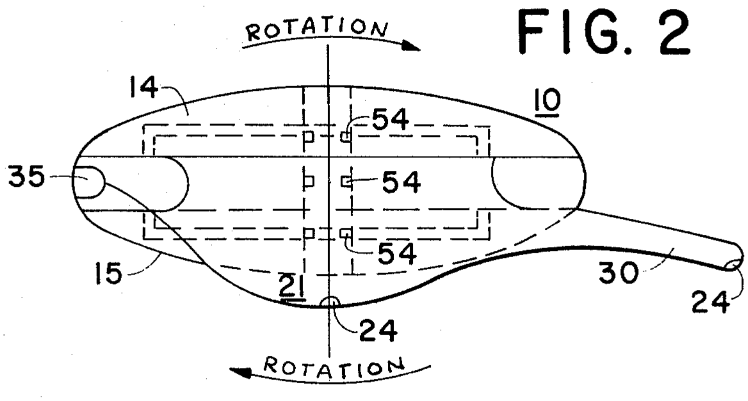


FIG. 3

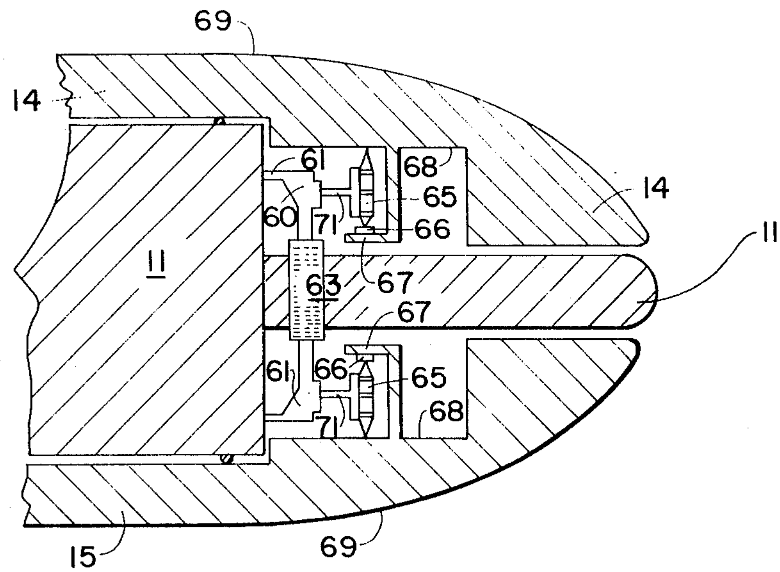


FIG. 4

GYRO FOIL

SUMMARY OF THE INVENTION

My invention is a flying vehicle in the form of a fixed structure fitted with propulsion engines and in the form of a fixed wing and tail section mounted to a pair of counter-rotatable discs, one below and one above the fixed structure, with the discs when rotating providing both aerodynamic lift and gyroscopic stability.

BRIEF DESCRIPTION OF THE DRAWINGS:

The objects and features of the invention may be understood with reference to the following detailed description of an illustrative embodiment of the invention, taken together with the accompanying drawings in which:

FIG. **1** is a front end view of the invention:

FIG. **2** is a plan view of the invention;

FIG. **3** is a side view of the invention; and

FIG. **4** is a detail elevation view of the disc holding bracket assembly and brake shoe.

DESCRIPTION OF THE PREFERRED EMBODIMENT:

Turning now descriptively to the drawings, in which similar reference characters denote similar elements throughout the several views, FIGS. **1-3** illustrate the air vehicle **10** which is formed of a fixed structure section **11**, above and below which are mounted each of a pair of discs **14** and **15** to rotate in opposite direction about the vertical axis Y—Y of the vehicle to provide aerodynamic lift and gyroscopic stability.

Fixed structural section **11** is formed with a pair of wing sections **21** each extending to a side of the vehicle **10** and downwards, with the end tip **22** of each wing section **21** fitted with a retractable landing gear assembly **24**. An aileron **25** is mounted in the trailing edge **26** of each wing section.

A tail section **30** extends from the rear of the fixed section **11** and is fitted with an elevator panel **31** on its trailing edge, with tail section **30** extending downwards and fitted at opposed lateral sides with retractable landing gear assemblies **24**.

A pilot's cabin **41** fitted with a transparent windshield **35** is mounted in the forward central section of the fixed section **11**.

A jet engine assembly **36** is internally mounted in the fixed structure adjacent to each wing section **21** to provide forward propulsion to the vehicle.

An upper disc **14** and a lower disc **15** are rotatably mounted above and below the fixed structure **11** with each disc rotatably latched by a plurality of bracket assemblies **60** to the fixed structure **11** adjacent at the periphery of each disc **14** and **15** with each disc **14** and **15** internally fitted with a plurality of drive engines **45** each joined to a drive wheel **46** that rotates against the fixed structure **11** to rotate each disc **14** and **15**.

Each disc **14** and **15** is formed with a through concentric opening **51** joined to a through concentric opening **52** in the fixed structure, with the walls of openings **51** and **52** fitted with turbine blades **54** for generating an upward thrust through openings **51** and **52** when the discs are rotating in opposite directions. Alternately a vertical jet engine may be mounted in concentric opening **52** of the fixed structure **11**.

Each disc **14** and **15** is held to the fixed structure **11** by a pluarality of holding brackets **60**.

Holding bracket **60** is formed of a pair of support members **61** each joined to the fixed structure **11** and joined to each other by a hydraulic cylinder **63** or spring means to apply a tension to draw support members **60** together, with each support member **61** fitted with a rotatable gear **65** that bears on a ring track **66** mounted on a flange **67** attached to the internal face **68** of the discs **14** or **15** so as to furnish a rotatable clamp to the disc to join it to the support structure. Gears **65** of each disc **14** and **15** may be fitted about their shafts **71** with a brake so as to vary the rotational speed of a disc **14** or **15** to produce yaw.

The exterior face **69** of each disc may be shaped to provide aerodynamic characteristics, as desired to each disc when rotated.

Since obvious chances may be made in the specific embodiment of the invention described herein, such modifications being within the spirit and scope of the invention claimed, it is indicated that all matter contained herein is intended as illustrative and not as limiting in scope.

Having thus described the invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. An air vehicle formed of a fixed structure to which one of a pair of solid rotatable convex discs is rotatably mounted externally above, and the other of a pair of said discs rotatably mounted externally below said fixed structure about a common vertical axis for providing stability and lift to said structure, together with means to rotate each disc with respect to the said structure in counter-rotating directions relative to each other, in which

the fixed structure is fitted with wings and a tail section that extend beyond the discs, and in which

each disc is formed with a through concentric opening joining a through concentric opening in the fixed structure through said vertical axis, with the internal walls of said openings in the discs and fixed structure fitted with turbine blades to generate lift when the discs are rotated, and with

the external surface of each disc shaped to provide aerodynamic lift characteristics when rotated.

* * * * *

United States Patent [19]

Vrana

[11] **4,117,992**

[45] **Oct. 3, 1978**

[54] **VERTICAL LIFT DEVICE**

[76] Inventor: **Charles K. Vrana,** P.O. Box 686, La Belle, Fla. 33935

[21] Appl. No.: **736,444**

[22] Filed: **Oct. 28, 1976**

[51] **Int. Cl.**^{2} **B64C 29/02**

[52] **U.S. Cl.** .... **244/23 C;** 244/12.2

[58] **Field of Search** .... 244/12.2, 23 C, 73 B, 244/73 C

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,410,507	11/1968	Moller	244/23 C
3,785,592	1/1974	Kerruish	244/23 C X

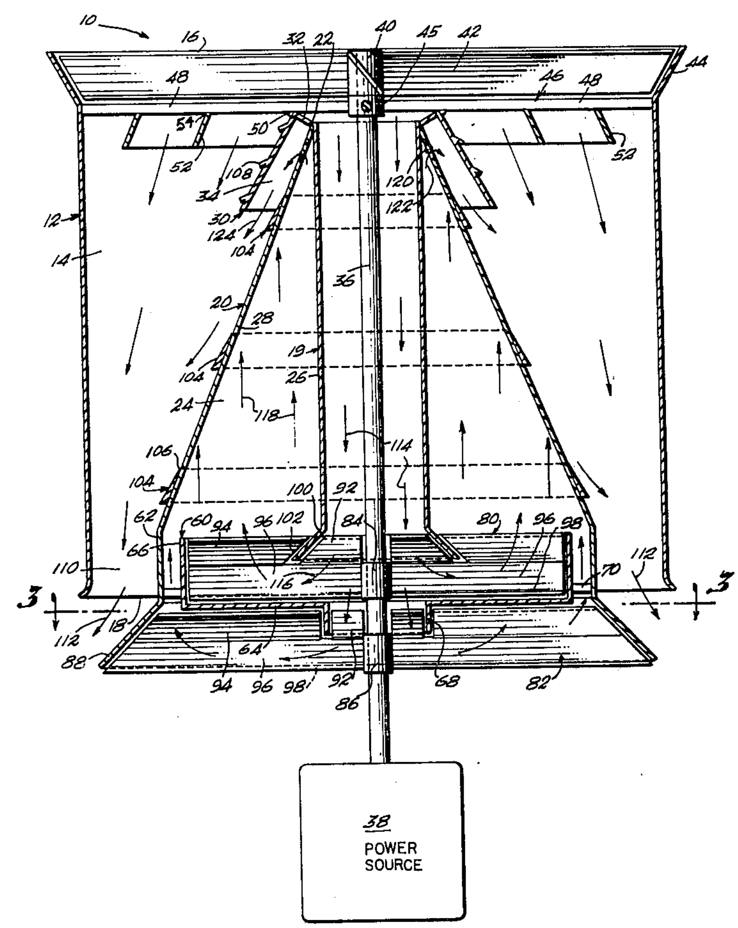
Primary Examiner—Barry L. Kelmachter

Attorney, Agent, or Firm—Alfred E. Wilson

[57] **ABSTRACT**

A vertical lift device comprised of a generally vertically disposed cylindrical tunnel, open at the top and bottom ends, with a driven propeller axially mounted at the open top end to direct a stream of air downwardly through the tunnel. A first portion of the stream of air is spirally directed outwardly through a peripheral portion of the open bottom end to create first lift forces for the device by using jet stream action. A second portion of the air stream is directed downwardly through a central axially disposed tube in the cylindrical tunnel to twin fans which redirect the second portion upwardly into a truncated cone, surrounding the central tube, to increase the pressure against the inner wall surface of the cone to create second lift forces.

9 Claims, 4 Drawing Figures



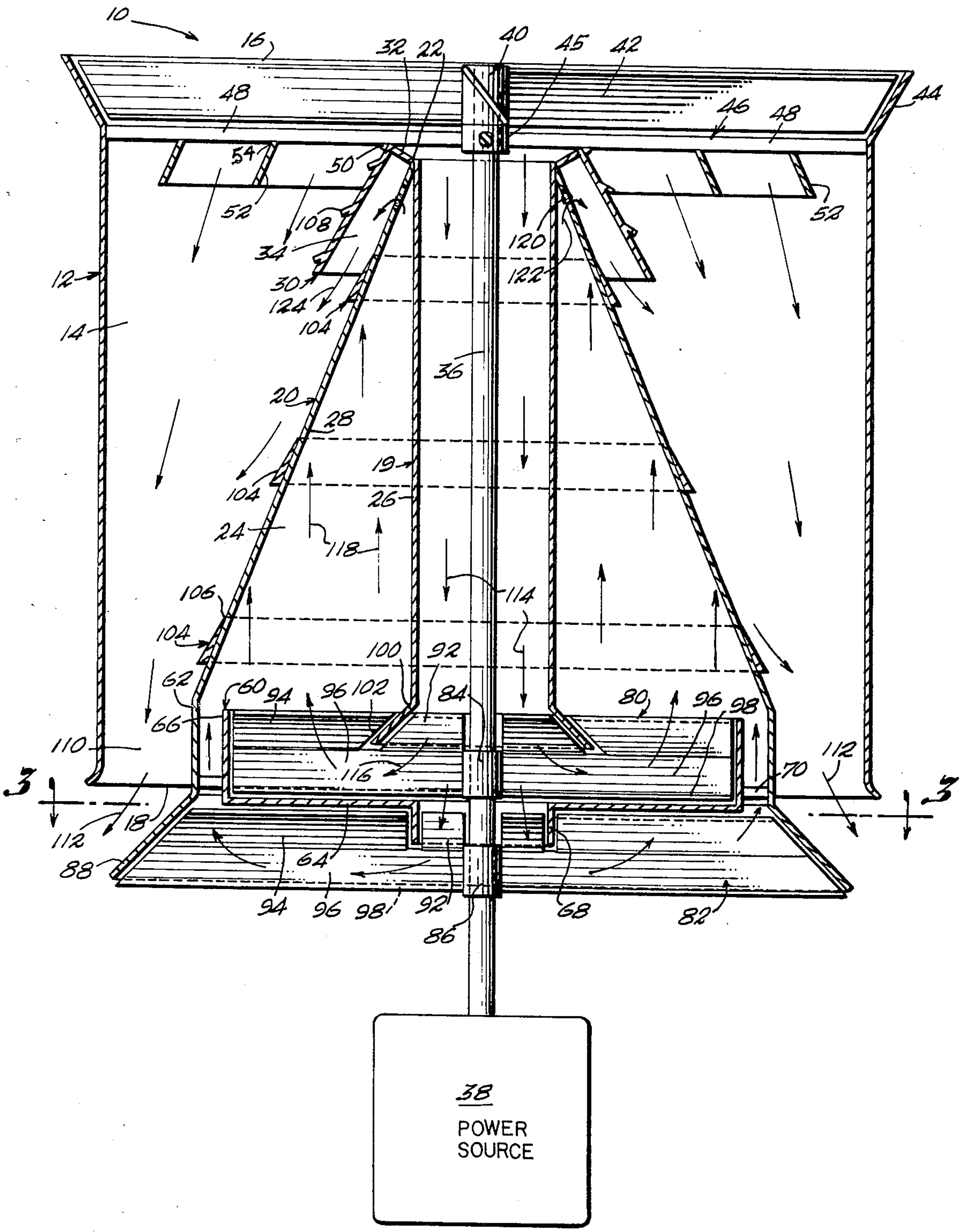


Fig. 1

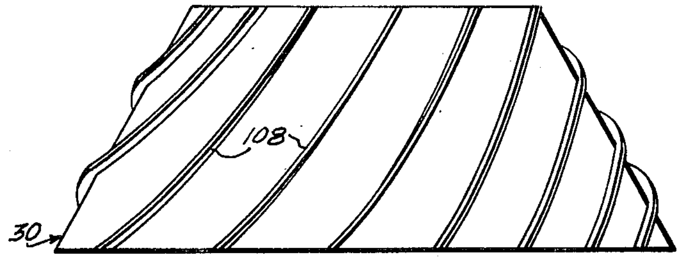


Fig. 2

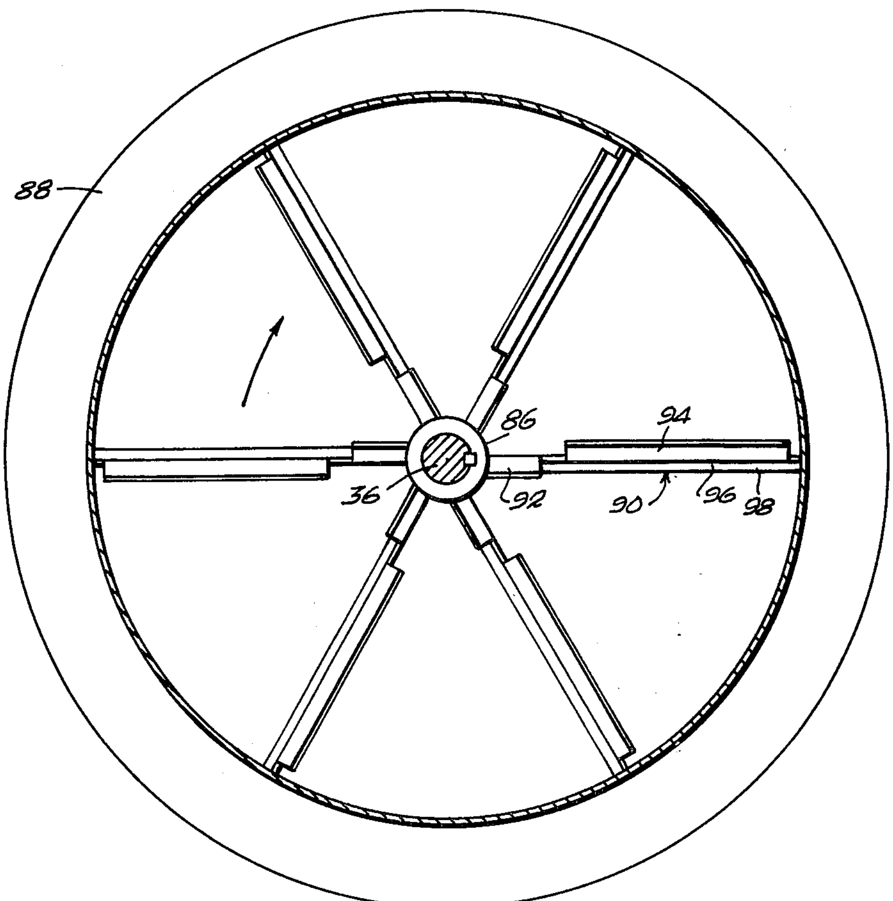


Fig. 3

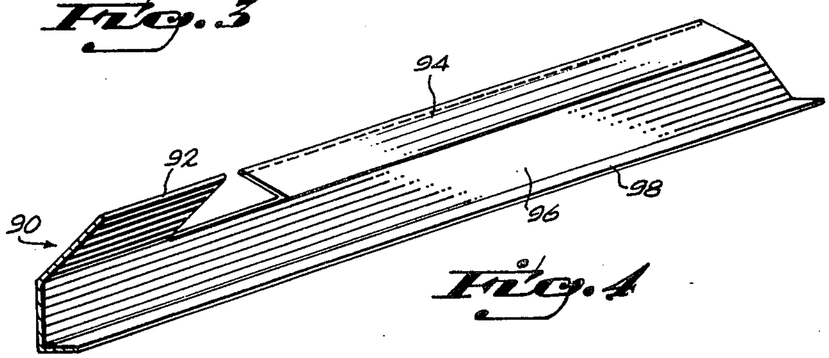


Fig. 4

VERTICAL LIFT DEVICE

FIELD OF THE INVENTION

This invention pertains to a lift device and more particularly to a vertical lift device for use in combination with a generally conventional type of heavier than air aircraft, or for use as a personal lift means.

OBJECTS AND ADVANTAGES OF THE PRESENT INVENTION

One of the principal objects of the present invention is to provide a vertical lift device which may be used in combination with a generally conventional type of heavier than air aircraft to assist the aircraft in taking off from the ground by substantially shortening the take-off run thereof.

Another object of this invention is to provide a vertical lift device which may be applied to a personal lift vehicle, and which device may also be swung into various angles to horizontal position for forward flight.

A further object of the present invention is to provide a vertical lift device utilizing a main driven propeller to provide a strong spiral downdraft, a first portion of which is utilized to provide first lift forces in the form of a downwardly directed jet stream of air and a second portion which is directed to twin fans which redirect said second portion upwardly against the inner wall surface of a truncated cone to create second lift forces.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical cross sectional view of the vertical lift device of the present invention;

FIG. 2 is an enlarged side elevational view of a secondary top cone utilized in the vertical lift device;

FIG. 3 is a horizontal cross sectional view taken along line 3—3 of FIG. 1; and

FIG. 4 is an enlarged detailed perspective view of one blade of the fan illustrated in FIG. 3.

DESCRIPTION OF A PREFERRED EMBODIMENT OF THE VERTICAL LIFT DEVICE

With reference to the drawings in which like reference characters designate like or corresponding parts throughout the various views and with particular reference to FIG. 1, the vertical lift device of the present invention , indicated generally at **10**, includes a main cylindrical housing **12** defining a tunnel **14** having open upper and lower ends **16** and **18**. A central axially disposed tube **19** extends through the main height of the tunnel **14**, said tube **19** surrounded by an axially extending truncated cone number **20**. The small upper end of cone **20** is fixed as by welding at **22** to the upper end outer periphery of tube **19**.

As seen in FIG. 1, a chamber **24** is defined between the outer wall surface **26** of tube **19** and the inner wall surface **28** of cone **20**. A top, secondary outer truncated cone **30** of a substantially reduced height relative to cone **20**, is fixed as by welding to the top connection **22** of cone **20** and tube **19** by a top closure ring **32**. As illustrated in FIG. 1, the top cone **30** is circumferentially enlarged relative to the top end of cone **20** to define a chamber **34** therebetween.

A drive shaft **36** extends axially, vertically through the tube **19** from a power source **38**, below the lift device **10**, to a point of connection **40** to a downdraft producing propeller **42** disposed in an outwardly flared top mouth portion **44** of cylindrical housing **12**. Drive shaft **36** and propeller **42** are rotatably journaled in a support bearing **45**, centrally fixed relative to a support spider **46** comprised of a plurality of radially extending arms **48** fixed between the bearing **45** and the inside surface of the upper end of housing **12**. The assembly of the cones **20** and **30** is fixed as by welding at **50** to the arms **48**. A plurality of annular, outwardly angled, air stream directional baffles **52** are also fixed as at **54** to the underside of arms **48**.

An upwardly opening annular housing **60** is fixed within the lower end of **62** of cone member **20**. Housing **60** is comprised of a bottom wall **64**, an annular side wall **66**, spaced inwardly of the main cylindrical housing wall **12** and a central, axially downwardly opening tubular portion **68**. A plurality of connector bars **70**, fixed between the side wall **66** and the lower end **62** of cone member **20**, support annular housing **60**.

A pair of closely adjacent bottom fans **80** and **82** are fixed at **84** and **86** to the drive shaft **36**. The uppermost fan **80** of said pair is disposed in annular housing **60** and the fan **82** is immediately therebelow in an outwardly flared lower end portion **88** of cone **20**.

With reference to FIGS. 3 and 4 and particularly to FIG. 4, each blade, such as **90**, of both fans **80** and **82** includes a first inner portion **92**, pitched in a first direction, a second, outer, reversely pitched portion **94** and a third, lower, vertically disposed portion **96**, extending the entire length of the blade **90** and connecting between first and second blade portions **92** and **94**. A horizontally extending flange **98** is formed along the length of the lower edge of the vertical blade portion **96**.

With further reference to FIG. 1 an outwardly flared lower end portion **100** of tube **19** extends into a slot **102**, defined between first and second pitched blades portions **92** and **94** of each blade of fan **80**, in a separating relation therebetween. The tubular portion **68** of housing **60** serves to separate the blade portions **92** and **94** of the lower fan **82** in the same manner as above described.

Referring again to FIG. 1, a plurality of spaced apart rings **104** are fixed about the outer surface of cone **20**. The rings **104** are wedge shaped in vertical cross section, increasing in the thickness downwardly from a top point **106**. As seen in FIG. 2 a pluralty of downwardly spiralling baffle ridges **108** are provided on the outer surface of the top, secondary cone **30** for a purpose to be hereinafter described.

The power source **38** may be any appropriate type of motor as illustrated, or may be comprised of a suitable power train from a remote power source.

In operation, the power source is energized to cause rotation of the propeller **42** to create a downwardly directed spiral stream of air by means of baffles **52** and spiral baffles **108**. The air stream is tornado like in nature, a confined downward whirling stream of air at high velocity, and is substantially directed along and around the outer circumferential portion of tunnel **14** away from the outer wall surface of cone **20**, while at the same time within cone **20** there is an upward moving force of air supplied through tube **19** by means of rotating fans **80** and **82**. This arrangement causes positive lift.

A first portion of the air stream is directed through the circumferential opening **110** at the outer bottom of tunnel **14** providing a first lift force, indicated by arrows **112**.

A second portion of the air stream is directed downwardly through tube **19** to the fan **80**, indicated by arrows **114**. Inner blade portions **92** of blades **90** thereof are pitched to direct a stream of air downwardly for radial movement across the vertical blade portion **96**, indicated by arrows **116**. Reverse pitch blade portions **94** thereafter direct the air stream upwardly as indicated by arrows **118** to create a second lift force in the cone chamber **24** against the inner cone walls **28**.

A portion of the air pressure in cone chamber **24** escapes through a pluralty of annularly spaced ports **120**, disposed about the top portion of cone **20** as indicated by arrows **122**. The escaping air passes outwardly through chamber **34** for downward passage through tunnel **14** as indicated by arrows **124**. As further indicated by arrows **124**, the escaping air stream is directed outwardly away from the outer surface of cone **20** by the wedge shaped rings **104**. In this manner the air pressure forces against the outer surface of cone **20** are kept to a minimum, thereby maximizing the lift effect of the high pressure forces in cone chamber **24**.

While one preferred form of the invention has been disclosed, it will be obvious to anyone skilled in the art that various changes and modifications can be made therein without departing from the true spirit of the invention as defined in the appended claims.

I claim:

1. A vertical lift device comprising,
   - a main cylindrical housing defining a vertically extending tunnel having open top and bottom ends,
   - a tube, extending axially through the main control height of said tunnel and having upper and lower open ends,
   - an axially disposed main truncated hollow cone in said tunnel having a relatively small open upper end and an enlarged open lower end, said cone being disposed about said tube, defining an inner conical chamber between an inside wall surface of said cone and an outside wall surface of said tube, said cone and tube open upper ends being fixed relative to each other inwardly of said tunnel open top end,
   - means to fixedly support said tube and cone in said tunnel,
   - a drive shaft, extending axially upwardly through said tube,
   - a downdraft producing propeller disposed in said tunnel open top end and being fixed to said drive shaft above said tube open upper end,
   - fan means disposed in said enlarged open lower cone end and being fixed to said drive shaft,
   - a power source operably connected to an outwardly extended end of said drive shaft to operate said propeller and said fan means, said propeller thereby creating an air stream having a first air stream portion passing downwardly through said tunnel outwardly of said cone and out through said tunnel open bottom end, to create first lift forces and a second air stream portion passing downwardly through said tube.
   - said fan means having blade means positioned to intercept said second air stream portion at said tube open lower end and to divert it upwardly into said conical chamber to create second lift forces.

2. The vertical lift device as defined in claim **1** wherein said means to fixedly support comprises a spider fixed adjacent to said open top tunnel end with a central fixed journal bearing for said drive shaft, said tube and cone being fixed as by welding at their upper ends to said spider.

3. The vertical lift device as defined in claim **2** including a top, secondary, truncated cone fixed relative to the top end of said main cone, said secondary cone being of a substantially reduced height relative to said main cone and circumferentially enlarged relative thereto to define a bottom opening chamber therebetween.

4. The vertical lift device as defined in claim **3** including a first baffle means, fixed to said spider, and extending downwardly from and outwardly angled relative thereto, and a second baffle means comprised of a plurality of downwardly spiralling ridges on the outer surface of said secondary cone.

5.The vertical lift device as defined in claim **1** wherein said fan means comprises a pair of vertically adjacent fans, each of said fans having blade means, said blade means comprising a plurality of equally spaced, radially outwardly projecting impeller blades.

6. The vertical lift device as defined in claim **5** wherein each blade comprising a first, inner portion pitched in a first direction, a second, outer, reversely pitched portion and a third, lower, vertically disposed portion, extending the length of said blade and interconnecting said first and second blade portions.

7. The vertical lift device as defined in claim **6** including a horizontally extending flange formed along the length of the lower edge of said vertical blade portion.

8. The vertical lift device as defined in claim **3** including a plurality of annularly spaced ports opening through the top end portion of said main cone adjacent said top end thereof.

9. The vertical lift device as defined in claim **8** including a plurality of spaced apart wedge shaped horizontal rings fixed about the outer surface of said main cone.

* * * * *