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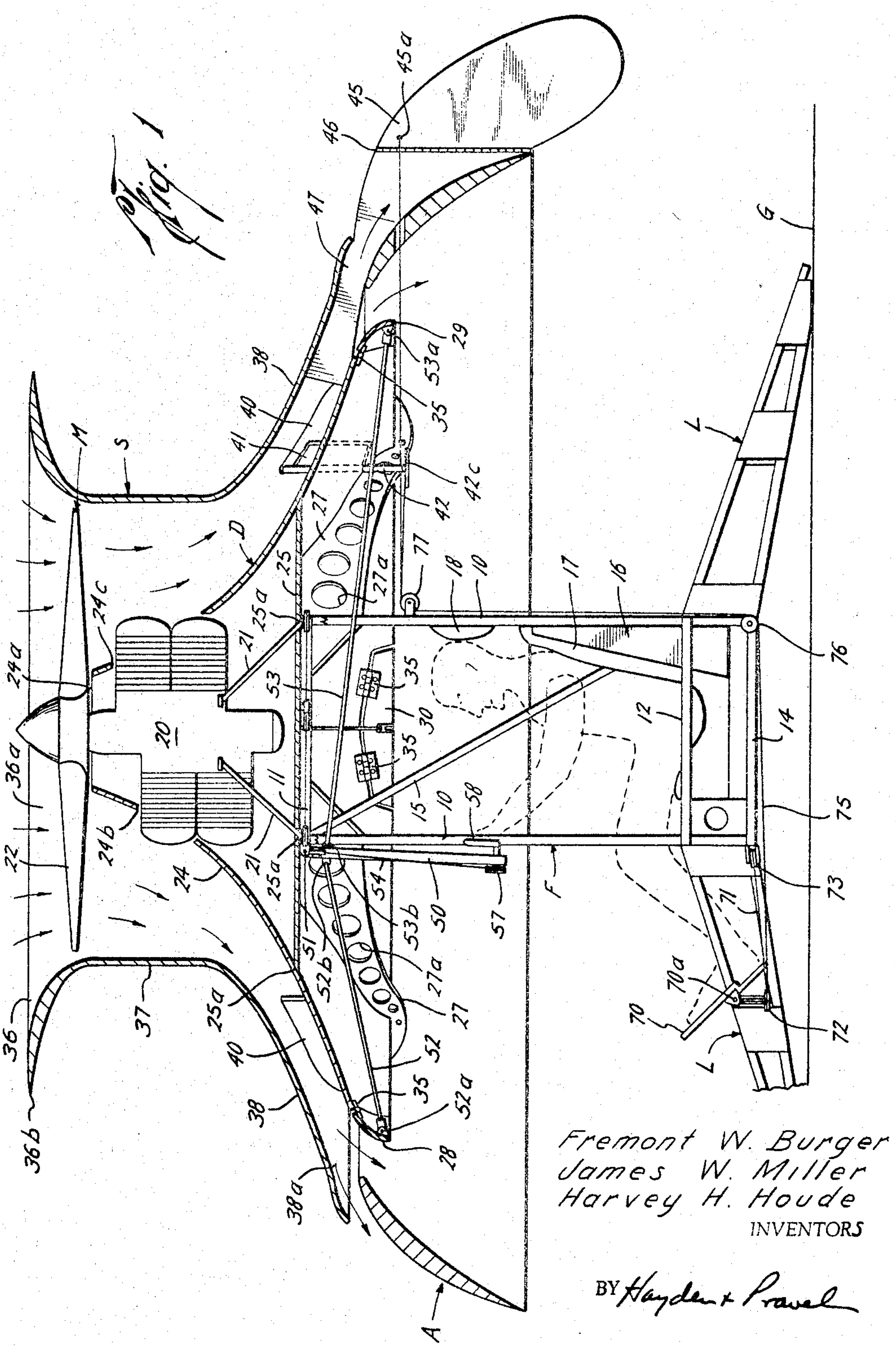
VTOL FLIGHT UNIT

Filed Feb. 28, 1964 3 Sheets-Sheet 1



Fremont W. Burger
James W. Miller
Harvey H. Houde
INVENTORS

BY Hayden & Pravel

ATTORNEYS

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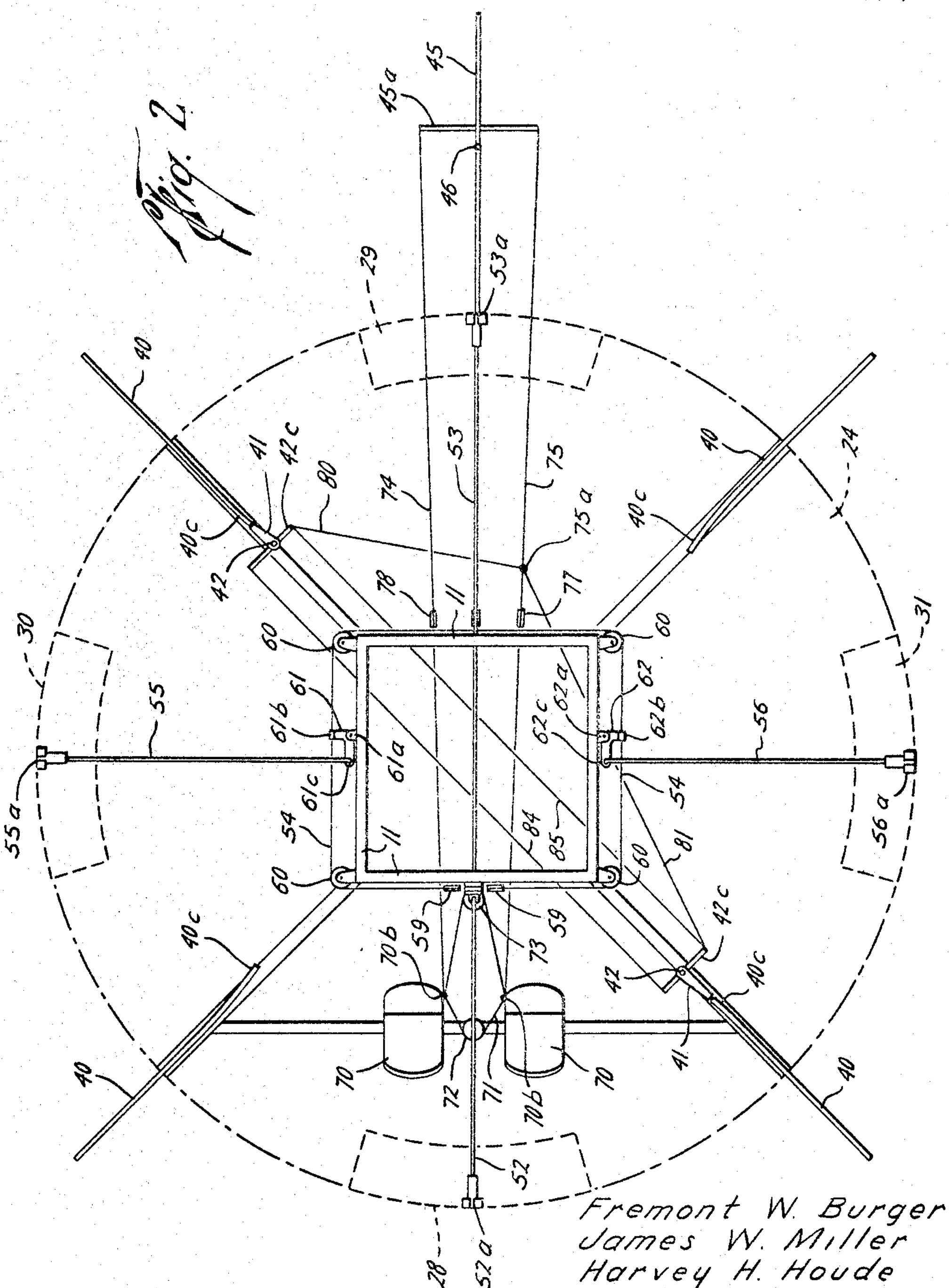
Fig. 2



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INVENTORS

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ATTORNEYS

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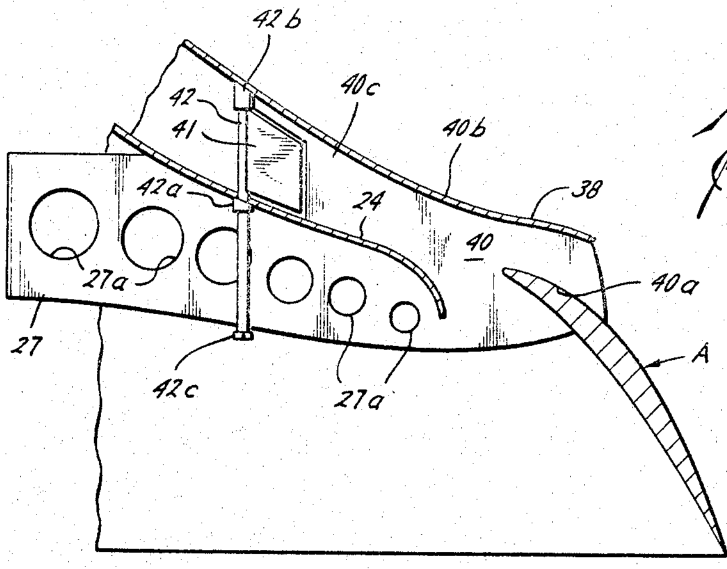

Fig. 3

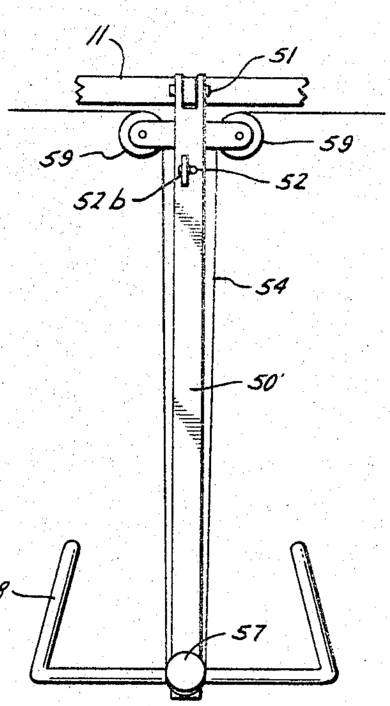

Fig. 4

Fremont W. Burger
James W. Miller
Harvey H. Houde
INVENTORS

BY Hayden & Pravel

ATTORNEYS

United States Patent Office

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VTOL FLIGHT UNIT

James W. Miller and Harvey H. Houde, San Antonio, and Fremont W. Burger, Houston, Tex., assignors to Astro Kinetics Corporation, a corporation of Texas

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2 Claims. (Cl. 244—12)

This invention relates to new and useful improvements in flight units, and particularly to flight units which are adapted to take-off and land substantially vertically.

In the past, efforts have been made to provide flight units adapted to take-off and land substantially vertically. The present-day helicopter is typical of such prior efforts. Although such prior units are workable, they provide a relatively low lift force, primarily due to the means by which the prior units obtain such lift force.

It is an object of this invention to provide a new and improved flight unit adapted for substantially vertical take-off and landing.

An important object of this invention is to provide a new and improved flight unit wherein a fan or other means is provided in a bell shroud for moving air relative to the shroud for creating a lift force.

Another object is to provide a new and improved flight unit having means therewith for creating a combination of different lifting forces so that the magnitude of such combined forces is sufficient to provide for sustained vertical and horizontal flight.

A further object of this invention is to provide a new and improved flight unit wherein a fan, propeller or other high velocity air-moving means is mounted in a shroud for directing moving air over the upper surface of the shroud, through the shroud and then over an airfoil to create multiple lifting forces which together effect vertical and horizontal flight of the unit.

Still another object of this invention is to provide a new and improved flight unit wherein an external shroud is mounted around an inner diffuser for diffusing air substantially radially over an airfoil for obtaining multiple lifting forces on the unit.

Yet a further object of this invention is to provide a new and improved flight unit having a new and improved control assembly therewith, including elevons for changing the attitude of the unit.

A particular object of this invention is to provide a new and improved flight unit having torque-control means for controlling torque forces acting on the unit to effect a control on the horizontal directional movement of the unit.

The preferred embodiment of this invention will be described hereinafter, together with other features thereof, and additional objects will become evident from such description.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof, wherein an example of the invention is shown, and wherein:

FIG. 1 is an elevation, partly in section, illustrating the preferred embodiment of the present invention;

FIG. 2 is a plan view illustrating in particular details of the control mechanism for controlling the attitude and the horizontal component of directional movement of the flight unit;

FIG. 3 is a view, partly in elevation and partly in section, illustrating a fragmentary portion of the flight unit of FIGS. 1 and 2, and illustrating in particular the details of construction of one of the internal rudders of such flight unit; and

FIG. 4 is a fragmentary view illustrating further details of the control mechanism which is preferably employed with the flight unit of this invention.

In the drawings, the letter F designates generally the support frame of the flight unit. An air-moving means M is mounted on said support frame F and is surrounded by an annular shroud S for controlling the air flow and creating air lift forces as will be further explained. An inner diffuser D is disposed inwardly of the shroud S, with means being provided for supporting both the diffuser D and the shroud S on the support frame F, as will be further explained in detail. An annular airfoil A is disposed below the shroud S for providing an additional air lift force as the air which is discharged from the shroud S passes over such airfoil A. Also, some of the air which is discharged from the shroud S is directed inwardly of the airfoil A for creating a static thrust and therefore an additional air lift force. As will be explained more in detail, the flight unit of this invention has a plurality of air-lifting forces acting thereon, preferably four in number, in order to provide sustained vertical movement of the flight unit as well as horizontal flight.

Considering the invention more in detail, the support frame F, in its preferred embodiment, includes four substantially vertical or upright frame members **10**, each of which is preferably formed of tubular stock or pipe and which are joined together at their upper ends by laterally extending frame members **11** (FIGS. 1 and 2), each of which is also preferably formed of tubular stock or pipe. Laterally extending frame members **12** and **14**, which preferably correspond with the frame members **11**, are connected to the lower portions of the uprights **10**. Such frame members **11**, **12** and **14** are secured to the vertical frame members **10** by welding or other suitable securing means.

A plurality of landing legs L, preferably four in number, are secured to the vertical frame members or uprights **10** by welding or other suitable connection means. Preferably the landing legs L extend diagonally outwardly from each of the vertical or upright members **10** so as to provide a relatively large base for engaging the ground G or other surface upon which the unit lands or is placed at rest.

To rigidify the support frame F, one or more diagonally extending braces **15** is provided. Such brace or braces **15** is formed of tubular stock or other material which is welded or otherwise secured to the upper end of one of the vertical uprights **10** and the lower end of another of the vertical uprights **10**. Also, the support frame F preferably has a fuel tank **16** welded or otherwise mounted thereon and which preferably forms the back portion of a seat **17** for the operator of the flight unit of this invention (operator shown in dotted lines). A suitable headrest **18** may also be mounted on the support frame F for the comfort of the operator if desired. The tank **16** is connected in a conventional way by hoses (not shown) with the engine of the air-moving means M. It will be appreciated that additional tanks for the fuel may also be provided if necessary for increasing the range of operation of the flight unit of this invention.

The air-moving means M of this invention may be of any suitable type such as a fan, propeller, counter-rotating propellers, a unit with multiple blades, or any other suitable air-moving means. As illustrated in the drawing, the air-moving means M includes a gasoline engine **20** which has four inclined leg supports **21** welded, bolted or otherwise secured thereto and also secured to the upper end of the support frame F. In the specific form of the air-moving means M illustrated in the drawings, a propeller or rotatable fan blade **22** is rotatably mounted at the upper end of the engine **20** and is rotated by the engine 20. As will be understood by those skilled in the art, the shape of the propeller 22 may be varied, but such shape must be such as to produce a downward flow of air when the blade 22 is rotated as indicated by the arrows in FIG. 1.

The diffuser D has an external annular wall 24 which is curved downwardly and outwardly from a point below the rotating blade 22. Although the diffuser wall 24 is not truly conical, it generally resembles a conical shape and for the purposes of description herein is described as being substantially conical. The upper end 24*a* of the wall 24 may be open as shown in FIG. 1, or it may be closed if desired. In any event, the upper end 24*a* of the diffuser D is disposed in close proximity to the rotating propeller blade 22 so that the maximum amount of air is moved externally of the wall 24. The wall 24 may have suitable openings 24*b* and 24*c* therethrough through which portions of the gasoline engine 20 or other power source may extend in the event the shape of the wall 24 does not confine such engine 20 or other suitable power means.

An internal laterally extending reinforcing plate 25 is provided within the wall 24 with its outer annual edge 25*a* welded or otherwise secured to the internal surface of the wall 24. Such plate 25 preferably rests upon the upper frame members 11 and suitable openings 25*b* are provided through which the support legs 21 extend. The diffuser D is further supported on the support frame F by a plurality of diagonally extending support ribs 27, each of which is preferably welded or otherwise secured to one of the vertical support members 10 and also to the lower side of the reinforcing plate 25. In order to reduce the weight of such structural ribs 27, holes 27*a* are preferably provided as illustrated in FIGS. 1 and 3. In the usual case, there are therefore four of such structural rib supports 27 spaced 90 degrees from each other. Each of the support ribs 27 preferably extends outwardly beyond the outer annular periphery of the wall 24 for connecting to the airfoil A and the shroud S, as will be more fully explained (FIG. 3).

The inner diffuser D is provided with four elevons 28, 29, 30 and 31 (FIGS. 1 and 2) in the preferred form of the invention. Each of such elevons is pivotally connected to the wall 24 by any suitable type of hinge 35 which permits movement backwardly and forwardly, as will be more fully explained.

The shroud S has an upper airfoil surface 36 over which air is caused to pass at a relatively high velocity by the air moving means M to provide an air lift force on the underside of such airfoil surface 36. Such airfoil surface 36 surrounds the upper end 36*a* of the shroud S and it merges with an intermediate tubular portion 37 within which the blade or propeller 22, or other suitable air-moving means is disposed. The shroud S also has a downwardly extending outwardly flared lower portion 38 which extends from the intermediate or central tubular portion 37 and which generally conforms in shape to the wall 24 of the inner diffuser D. For maximum efficiency, the outer periphery 36*b* of the airfoil 36 should not have a greater diameter than five times the diameter of the intermediate portion 37 at the intake opening lying in th plane of rotation of the propeller or other air-moving means 22. Also, the area of the annular discharge 38*a* between the outwardly extending portion 38 of the shroud S and the wall 24 of the diffuser D should preferably be approximately the same as the area at the air inlet lying in the plane of the propeller 22 or other air-moving means within the shroud S.

The air which discharges through the outlet or discharge opening 38*a* at the lower end of the shroud S is directed outwardly over the external surface of the airfoil A and is also directed inwardly thereof as indicated by the arrows in FIG. 1. It should be noted that the airfoil A is maintained in a fixed relationship to the wall 24 of the diffuser D and the outwardly flaring portion 38 of the shroud S, preferably by having its upper portion welded or otherwise secured to the upwardly extending extension 40 of each support rib 27. Thus, each extension 40 has a suitable notch 40*a* formed therein for receiving the upper portion of the airfoil A which is welded or otherwise secured therein. It is also to be noted that the upper portion or edge 40*b* of the extension 40 is welded or otherwise secured to the lower surface of the outwardly extending flared portion 38 to integrally connect the shroud S to each rib 27 and thus to the support frame F.

The upper portion of the rib extension 40 which is disposed between the wall 24 and the outwardly flared portion 38 for each of such rib supports 27, serves as an anti-torque plate. For this purpose, the extreme upper portion 40*c* of each extension 40 is slightly curved as best seen in FIG. 2. Such curvature is preferably of the magnitude of five degrees at the upper portion 40*c* but is otherwise radial. Such curvature in the upper portion 40*c* offsets any tendency of the unit to rotate due to a reaction force of the air being moved downwardly by the air-moving means M with a slight amount of rotation. Thus, as viewed in FIG. 2, assuming there is a slight reaction force on the shroud S tending to move the unit clockwise by reason of the slight rotational movement of the air flowing downwardly from the air-moving means M, the curved portions 40*c*, when contacted by the slightly rotating air, will offset such reaction force and maintain the entire unit in a stable non-rotative condition. Of course, it will be understood that if the air-moving means M includes counter-rotating propellers so that there is no reaction force tending to rotate the unit in either direction, such slight curvature 40*c* on each anti-torque extension 40 may be unnecessary.

In some instances, it is desirable to control the rotational position or the horizontal component of directional movement of the flight unit by the use of internal rudders 41 (FIGS. 1–3). Each rudder 41 is mounted for pivotal movement on a pivot rod 42 mounted in suitable bearings or guides 42*a* and 42*b*. The lower end of the pivot rod 42 has an operating bar 42*c* (FIG. 3) thereon which is actuated for pivoting the internal rudder 41 as will be explained in detail hereinafter. In the preferred case, two of such rudders 41 are provided at diametrically opposite positions as illustrated in FIG. 2 and they are operable together for effecting a rotational or turning movement of the entire flight unit as will be more fully explained.

In some instances, it is desirable to also have an external rudder 45 (FIGS. 1 and 2) which is pivotally mounted at hinge or pivot 46 to a connecting plate 47 which extends over the external surface of the airfoil A and is welded or otherwise secured between the shroud S and the diffuser D as best seen in FIG. 1. An outwardly extending control rod 45*a* is provided on the rudder 45 for controlling the movement and position of the rudder 45, as will be explained.

For controlling the movement of the various elevons 28, 29, 30 and 31, it is preferable to provide a control arm or column 50 (FIGS. 1 and 4) which is pivotally connected to the support frame F by a pivot pin 51 or other suitable pivotal connection means. As viewed in FIG. 1 the pivot pin 51 permits a pivotal movement of the control bar or column 50 forwardly (left in FIG. 1) and rearwardly (right in FIG. 1) as desired by the operator. The forward elevon 28 is connected to the control rod or arm 50 by a push-pull rod 52 which has a pivotal connection 52*a* to the elevon 28 and a pivotal connection 52*b* to the rod or column 50. Similarly, the rear elevon 28 is connected to the column 50 by a push-pull rod 53 which has a pivotal connection at 53*a* to the elevon 29 and a pivotal connection 53*b* to the column 50. Thus, as the column 50 is moved forwardly (to the left as viewed in FIG. 1) the rod 52 pushes the elevon 28 forwardly while the rod 53 pulls the elevon 29 forwardly, both moving together. By moving the elevon **28** forwardly, the area between such elevon **28** and the inner surface of the outwardly flaring portion **38** of the shroud S is restricted, causing a reaction force downwardly on such elevon **28** to tilt the forward portion of the entire flight unit downwardly to thereby change its attitude with respect to the ground level.

On the other hand, when the control rod or column **50** is moved rearwardly (or the right as viewed in FIG. 1) the push-pull rod **53** is pushed to move the rear elevon **29** rearwardly while the push-pull rod **52** is pulled to move the elevon **28** rearwardly, thereby creating a restriction between the elevon **29** and the shroud S which causes a downward tilting of the rearward portion of the flight unit with respect to ground level.

For controlling the movements of the side elevons **30** and **31**, an endless cable **54** (FIGS. 1, 2 and 4) is provided which is operably connected with push-pull rods **55** and **56** for the elevons **30** and **31**, respectively. The cable **54** extends around a pulley or drum **57** which is connected with a steering wheel or handle **58** so that an operator may move the drum **57** by a manipulation of the steering wheel or handle **58** to thereby effect movements of the cable **54**. The cable **54** extends upwardly around pulleys or guide rollers **59** and then is guided in a lateral plane at the upper end of the support frame F by pulleys **60** disposed at each corner of the support frame F (FIG. 2) A pivoted bell crank level **61** is mounted on one of the upper laterally extending frame members **11** for pivoting about a pivot pin **61***a*. The outer portion **61***b* of the bell crank lever **61** is secured to the cable **54** for movements in response thereto. The inner end **61***c* of the bell crank lever **61** is pivotally connected to the push rod **55**. The push-pull rod **55** is itself pivotally connected at its outer end **55***a* to the lower portion of the elevon **30**.

The push-pull rod **56** is similarly connected to the cable **54** through a bell crank lever **62** which is pivoted at **62***a*, connected to the cable **54** at **62***b* and connected to the rod **56** at pivot **62***c*. The rod **56** is likewise pivoted at **56***a* to the elevon **31**.

With such construction, it will be understood that as the operator turns the steering handle **58**, so as to effect a movement of the cable **54** in a generally clockwise movement as viewed in FIG. 2, the push-pull rod **55** is moved to pivot the elevon **30** outwardly while the push-pull rod **56** is pivoted to pull the elevon **31** inwardly. Upon a movement of the cable **54** in a generally counterclockwise direction as viewed in FIG. 2, the opposite movements of the elevons **30** and **31** will be produced. Thus, the elevons **30** and **31** are moved simultaneously or together in the same direction so as to cause the flight unit to move either downwardly to the right or downwardly to the left, as controlled by the steering wheel or handle **58**. Thus, all four of the elevons **28, 29, 30** and **31** are readily controlled manually by the operator of the flight unit.

In the preferred form of the invention, the control of the internal rudders **41** and the external rudder **45** is obtained through two foot pedals **70** which are preferably operated by the feet of the operator. Such pedals **70** are preferably interconnected by an endless balance cable **71** which is secured to each of such pedals **70** at connection points **70***b* (FIG. 2) and which extends around pulleys or guide rollers **72** and **73**. Thus, as the left pedal **70** is pushed downwardly so that its lower portion below the pivot **70***a* pivots downwardly, the portion of the right pedal **70** below its pivot **70***a* moves upwardly. Similarly, when the right pedal **70** is pivoted downwardly, the left pedal **70** is pivoted upwardly.

Rudder cables **74** and **75** are also connected to the pedals **70** at the connection points **70***b* or other similar connection points. As best seen in FIG. 1, the cable **75** is passed rearwardly from the left pedal **70** to a guide pulley **76** and then is passed upwardly over a guide pulley **77**. The cable **75** then extends rearwardly to one end of the pivot pin or rod **45***a*. The cable **74** is connected and is directed in the same manner as described in connection with the cable **75**, one of thte pulleys **78** being illustrated in FIG. 2, which pulley **78** corresponds with the pulley **77** for the cable **75**, and it will be understood that a pulley corresponding to the pulley **76** is also provided for the directional control of the movement of the cable **74**. The rearward end of the cable **74** is connected to the pivot pin or rod **45***a*. Thus, by moving the cable **74** forwardly (to the left in FIG. 2) the cable **75** is moved rearwardly as the pivot rod **45***a* pivots in a counterclockwise direction as viewed in FIG. 2. Such movement shifts the rudder **45** about the pivot **46** so that its outer end moves upwardly as viewed in FIG. 2. It will be appreciated that when the cable **75** is pulled forwardly, the reverse movement of the external rudder **45** is produced.

For operating the internal rudders **41** in conjunction with the external rudder **45**, a short cable **80** is connected to one end of the pivot bar **42***c* on one of the internal rudders **41**. The other end of the cable **80** is secured at a fixed point **75***a* to the cable **75** so that as the cable **75** moves forwardly (left in FIG. 2), such movement is transmitted to the cable **80**, pulling the pivot bar **42***c* to pivot same in a clockwise direction as viewed in FIG. 2. Similarly, a cable **81** is connected to one end of the other pivot bar **42***c* on the other internal rudder **41** illustrated in FIG. 2. The opposite end of the cable **81** is secured to the cable **75** at a fixed point such as the connection **75***a* so that the rearward movements (to the right in FIG. 2) of the cable **75** is transmitted to the cable **81** for pivoting the bar **42***c* counterclockwise as viewed in FIG. 2. Balance cables **84** and **85** are connected to the opposite ends of the two pivot bars or pins **42***c* to provide simultaneous coordinated movement of the two internal rudders **41**. Thus, when the upper rudder **41** (FIG. 2) is pivoted clockwise by pulling on the cable **80** as the cable **75** moved forwardly, the lower rudder **41** (FIG. 2) is also pivoted clockwise by an equal amount by means of balance cable **84**. Also, when the lower rudder **41** (FIG. 2) is pivoted counterclockwise by pulling on the cable **81** as the cable **75** moves rearwardly, the upper rudder (FIG. 2) is also pivoted counterclockwise by an equal amount by means of such balance cable **84**. Cable **85** could be omitted in this form of invention if desired.

It will be appreciated that the internal rudders **41** are operable even though the flight unit has no forward or other horizontal component of movement, but the external rudder **45** is effective only during forward or horizontal movement of the unit.

In the operation of the flight unit of this invention, the operator assumes the position indicated in dotted lines in FIG. 1 on the seat **17**. It will be understood of course that the support frame F may be enclosed to protect the operator in flight. Also, to improve the visibility of the operator, it is preferable to provide an airfoil A of a transparent material, or at least an airfoil A having sections of transparent material.

With the operator thus in the seated position illustrated in FIG. 1, the speed of the air-moving means M is developed or increased through the manipulation of suitable controls (not shown) until the air flow from such means M is adequate for lifting the flight unit upwardly from the ground G.

As previously explained, the present invention actually has four principal lifting forces created which are acting upwardly as a unitary combination force for effectively lifting the flight unit of this invention. The first lifting force is created by the rotation of the propeller or other air-moving means M, which creates a low pressure area thereabove. The air above the means M moving over the airfoil surface **36** creates an upward lifting force by reducing the air pressure above such airfoil surface **36**. Another upward lift force is provided by the substantially radial diffusion of the air over the airfoil A which creates an aerodynamic lift. The fourth lift force is due to the static thrust created by the propeller or other air-moving means as the air is discharged downwardly through the shroud and inwardly of the airfoil A.

During the upward lift by the aforesaid combination action, the elevons **28**, **29**, **30** and **31** are normally maintained in the neutral positions illustrated in the drawings. Also, the internal rudders **41** are in a neutral position in alignment with their corresponding anti-torque plates **40** while the external rudder **45** is in the neutral position illustrated in FIGS. 1 and 2.

When the flight unit has moved upwardly to a sufficient altitude to clear the surrounding buildings and other objects, a horizontal component of movement may be obtained by tilting the flight unit at an angle from the horizontal attitude shown in FIG. 1. Such tilting may be accomplished by moving the control arm **50** forwardly (to the left as viewed in FIG. 1) which moves the elevons **28** and **29** as heretofore described to cause the forward portion of the flight unit to tilt downwardly. When the proper angle or attitude is thus acquired, a component of horizontal force is obtained together with some vertical lifting action. Various changes in the attitude of the unit may be obtained by moving the two pairs of elevons as desired. Also, it will be appreciated that by controlling the speed of the air-moving means and by controlling the attitude of the flight unit, the desired relationship between vertical lift and horizontal movement may be obtained in any given situation.

The horizontal component of directional movement is controlled by the foot pedals **70** as previously explained so as to effect a change in angle of the internal rudders **41** and the external rudder **45**. The particular angle at which such rudders are positioned determines the extent and rapidity with which the flight unit changes its horizontal component of directional movement. When the desired horizontal direction is obtained, the rudders **41** and **45** are returned to their neutral positions.

When it is desired to return the flight unit to the ground, the normal horizontal attitude illustrated in FIG. 1 is obtained as nearly as possible, and then the speed of the air-moving means M is reduced so that the gravity force acting on the flight unit slowly and gradually returns the unit to the ground G, with the legs L contacting the ground G with a minimum of impact.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made within the scope of the appended claims without departing from the spirit of the invention.

What is claimed is:

1. A flight unit adapted to be used for substantially vertical take-off and landing, comprising:

(a) an annular shroud having an open upper end and an open lower end,

(b) an air-moving means mounted in said shroud for causing an air flow into said open upper end of said shroud and out of said lower open end thereof for creating a first lifting force,

(c) an airfoil disposed below the lower end of said shroud and over which air flowing from said lower end passes for creating another lifting force,

(d) an inner diffuser member extending into said shroud for diffusing the air outwardly as the air discharges from said open lower end of said shroud and for directing such diffused air over said airfoil,

(e) a plurality of circumferentially spaced elevons pivotally connected to said diffuser member for movement into and away from the air being discharged from said open lower end for changing the attitude of the unit in flight,

(f) said elevons being two pairs, each pair of which has substantially diametrically disposed elevons,

(g) a control member pivotally mounted on said diffuser member, and

(h) a control rod extending from said control member to each of said elevons in one of said pairs for pivoting same together.

2. A flight unit adapted to be used for substantially vertical take-off and landing, comprising:

(a) an annular shroud having an open upper end and an open lower end,

(b) an air-moving means mounted in said shroud for causing an air flow into said open upper end of said shroud and out of said lower open end thereof for creating a first lifting force,

(c) an airfoil disposed below the lower end of said shroud and over which air flowing from said lower end passes for creating another lifting force,

(d) an inner diffuser member extending into said shroud for diffusing the air outwardly as the air discharges from said open lower end of said shroud and for directing such diffused air over said airfoil,

(e) a plurality of circumferentially spaced elevons pivotally connected to said diffuser member for movement into and away from the air being discharged from said open lower end for changing the attitude of the unit in flight,

(f) said elevons being two pairs, each pair of which has substantially diametrically disposed elevons,

(g) a control member pivotally mounted on said diffuser member,

(h) a control rod extending from said control member to each of said elevons in one of said pairs for pivoting same together, and

(i) control means operably mounted in conjunction with said control member and having connection with the other pair of said elevons for pivoting same together.

References Cited by the Examiner

UNITED STATES PATENTS

1,123,589	1/1915	Porter	244—23
2,008,464	7/1935	Nishi	244—73
2,978,206	4/1961	Johnson	244—73
3,041,009	6/1962	Wharton	244—73
3,107,071	10/1963	Wessels	244—73

FOREIGN PATENTS

15,735	1912	Great Britain.

MILTON BUCHLER, *Primary Examiner.*

FERGUS S. MIDDLETON, *Examiner.*

R. G. BESHA, L. C. HALL, *Assistant Examiners.*