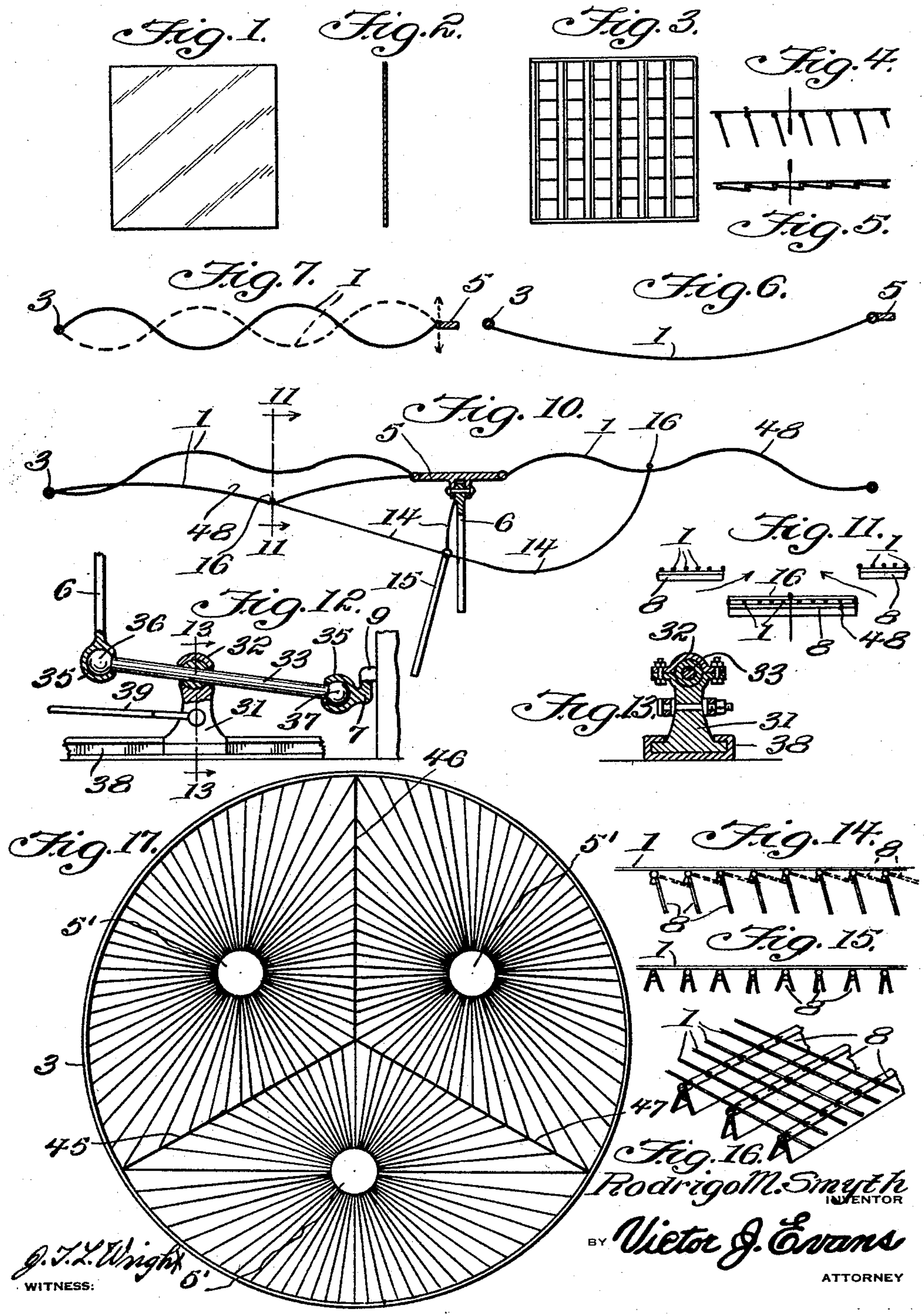
June 16, 1931. R. M. SMYTH 1,810,114

FLYING MACHINE

Filed Feb. 24, 1928 2 Sheets-Sheet 1



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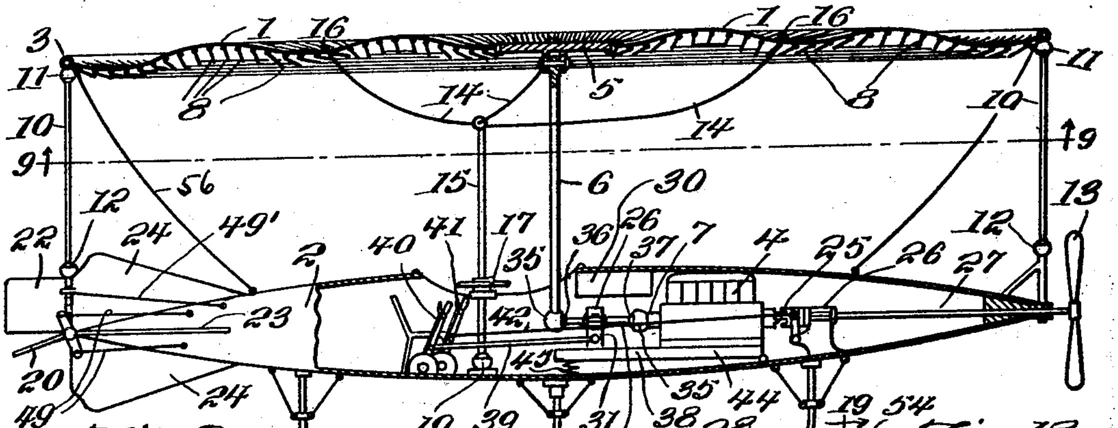

Fig. 8.

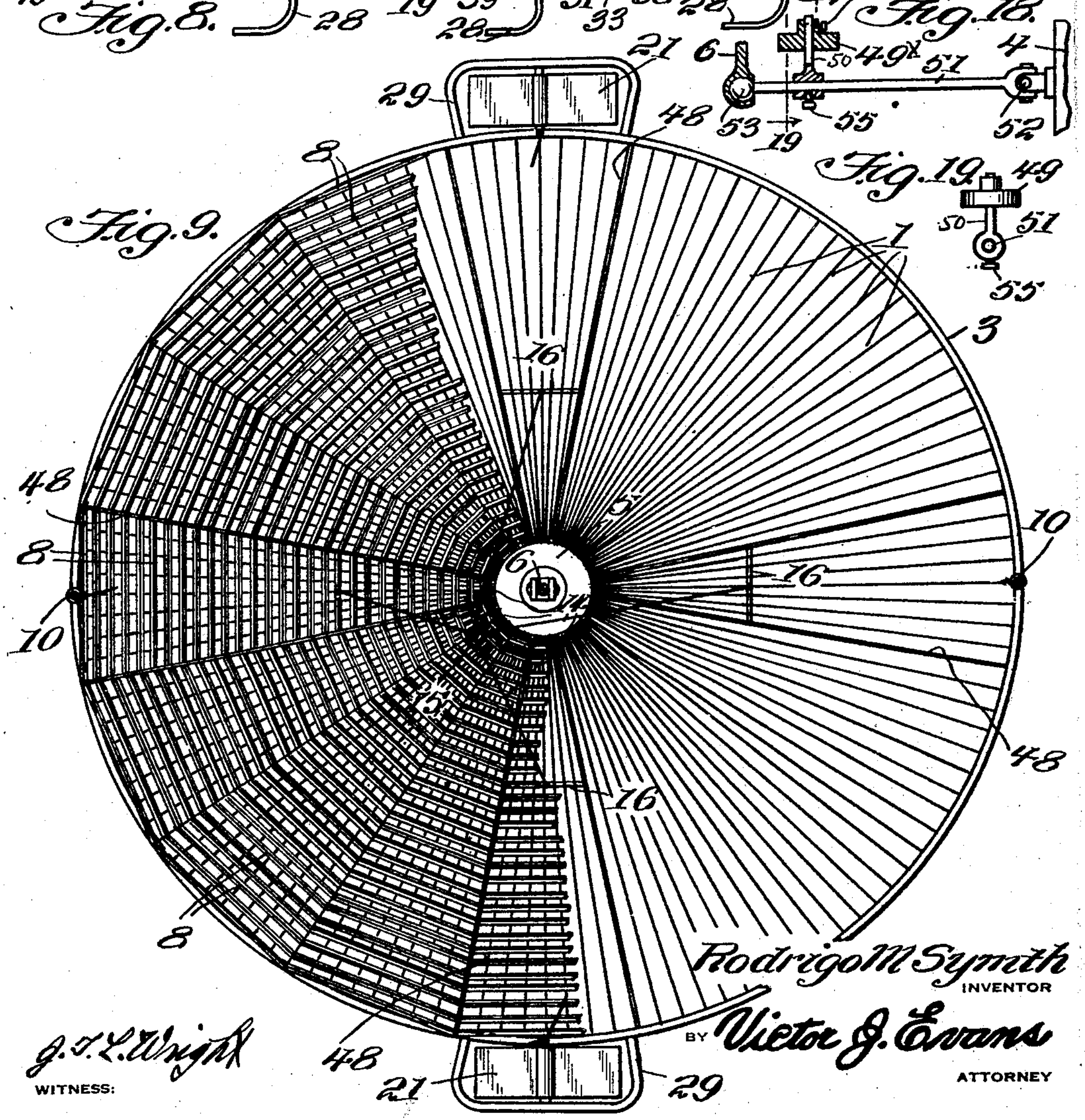

Fig. 18.

Fig. 19.

Fig. 9.

Rodrigo M. Symth
INVENTOR

BY Victor J. Evans
ATTORNEY

J. T. L. Wright
WITNESS:

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UNITED STATES PATENT OFFICE

RODRIGO M. SMYTH, OF SAN JOSE, COSTA RICA

FLYING MACHINE

Application filed February 24, 1928. Serial No. 256,735.

This invention relates to a flying machine, the general object of the invention being to provide a body or diaphragm formed of inner and outer members and radially arranged flexible members connecting the inner and outer members together, with flaps forming valves connected to the radial members and means for vibrating the inner member to produce vertical waves in the radial members to cause the valves to open on the upward movement of the radial members and to close on the downward movement thereof so as to produce air currents which will act to lift the body and the flying machine to which the body is attached.

Another object of the invention is to provide mechanical means, preferably arranged in the fuselage of the craft, and connected with the central member, for vibrating the same.

Another object of the invention is to provide means for reducing the strength of the vibrations of certain portions of the diaphragm or body, thus reducing the lifting force on this part of the body so as to provide means for stabilizing the device and changing its direction of movement.

Another object of the invention is to arrange some of the radial members in sets, the members of each set being connected together transversely so as to provide control segments in the body or diaphragm, with means for lowering any desired set or a number of sets to form radial apertures in the diaphragm which will reduce the lifting force on that side of the diaphragm to some extent, to provide additional means for stabilizing the device and changing its direction of movement. If the engine should fail to function or the craft should begin to descend for any reason, the diaphragm would act as a parachute as the valves would close under the pressure of the air and in this event the craft could be guided in its descent by the control segments, for by lowering certain of these segments, apertures would be formed for the escape of air through certain parts of the body. This will reduce the pressure of the air on this part of the body so that the body will tilt downwardly on the side where the pressure is reduced so that the craft can be stabilized and guided in its downward movement.

A further object of the invention is to provide means for shifting the center of gravity of the device, which also acts as means for stabilizing the device and changing its direction of movement.

This invention also consists in certain other features of construction and in the combination and arrangement of the several parts, to be hereinafter fully described, illustrated in the accompanying drawings and specifically pointed out in the appended claims.

In describing my invention, in detail, reference will be had to the accompanying drawings wherein like characters denote like or corresponding parts throughout the several views, and in which:—

Figure 1 is a face view of a solid surface used to explain the theory of the invention.

Figure 2 is an edge view of Figure 1.

Figures 3, 4 and 5 are diagrammatic views used to explain the operation of the valves.

Figure 6 is a view showing the position of the wires or radial members when at rest.

Figure 7 is a view showing the wave formation of the wires when the device is in operation.

Figure 8 is a sectional view showing the complete device associated with a flying machine.

Figure 9 is a plan view of Figure 8.

Figure 10 is a diagrammatic view showing the wave action in the wires produced by the reciprocatory movement of the center member and also showing how a section composed of a number of the wires can be held against movement.

Figure 11 is a section on line 11—11 of Figure 10.

Figure 12 is a detail view showing the means for transmitting the movement of the crank shaft of the motor to the rod which is connected with the inner member of the diaphragm.

Figure 13 is a section on line 13—13 of Figure 12.

Figure 14 is a detail sectional view through a portion of the diaphragm, showing the valves in open position in full lines and in closed position in dotted lines.

Figure 15 is a similar view but showing double valves connected with the radial members.

Figure 16 is a fragmentary perspective view of Figure 15.

Figure 17 is a plan view showing the diaphragm divided into three parts, with means for vibrating the radial members of each part.

Figure 18 is a detail view showing a modified form of means for reciprocating the rod which is connected with the central member.

Figure 19 is a section on line 19—19 of Figure 18.

If I apply an oscillatory motion to a solid surface such as that shown in Figs. 1 and 2 (front and side view respectively) in a direction normal to its plane, said motion will be transmitted to the adjacent layers of air which thus will move in unison with the surface.

If the surface instead of being solid throughout its whole area, is provided with as many valves as is possible to construct on same, as shown in Figures 3, 4 and 5, the valves will close when the surface moves in one direction (down, as in Figure 5), and will open when moving in the opposite direction (up, as in Figure 4). This is caused both by the inertia of the valves themselves and by the reaction of the adjacent layers of air which are being forced to move by the motion of the surface.

The result of this action of the valves is that the air will be pushed and will move with the surface when the valves are closed, while when the surface reverses its motion, the valves will open and the air will pass through them more or less freely and will thus continue its motion in the direction in which it was pushed when the valves were closed. In other words, an air current of more or less variable speed will be produced, the air receiving an impulse each time the surface moves with the valves closed. The alternating motions which are imparted to the air when the surface is a solid one, are rectified by the valves and a unidirectional air current results, wherefore, I call them "rectifying valves", and in general, any means capable of accomplishing the same results, "rectifying means". If the frequency of the oscillations is sufficiently high, the resultant air current will have an almost constant speed.

It will be obvious that to set the air in motion and produce the above mentioned air current, it is necessary to overcome the inertia of the air, and consequently an intermittent reaction upon the surface will result in a direction opposite to that of the air current. This is a result which would be obtained with any other kind of air impeller, whatever its form, such as an ordinary propeller, centrifugal blower, etc.

If I make the valved surface of sufficient size and the frequency and amplitude of the vibrations of sufficient magnitude, such a device could be utilized as a vertically rising flying machine, provided, of course, that the surface be placed in a horizontal position (as in Figure 8) so that the air current be directed downwards. Such a craft would be a flying machine of the flapping wing type.

To construct a valved surface sufficiently large and strong for flying purposes would require a more or less heavy structure and it will be apparent that to vibrate such a structure at more than a very moderate frequency would be almost impracticable; and it must be taken into consideration that the frequency and amplitude should be somewhat high if it is desired to obtain a reaction of sufficient magnitude for practical purposes.

In order to solve this difficulty, I have devised a special diaphragm provided with valves which can be made to vibrate without vibrating the frame on which it is mounted. Its mode of operation is as follows:

If a wire is suspended between two points (Figure 6) and one of its ends is given a rapid to and fro motion in any direction normal to the wire (Figure 7), the motions will be propagated along the wires in the form of transverse waves in a well known manner until they reach the other end of the wire where they will be reflected backwards, forming standing waves (as shown by the dotted lines in Figure 7), and after reaching again the starting end will be reflected anew and so forth until the energy of the waves has been dissipated. If the frequency of the vibrations and consequently the length of the waves is properly related to the length of the wire, a state of resonance can be created by which the strength of the vibrations will acquire a much higher value.

If instead of a single wire, a set of radial wires is arranged, as shown in Figure 9, all of them fixed to a common center 5 and to a common annular frame 3, and the center 5 is given a vibratory motion in a direction normal to the plane formed by the whole set of wires, the vibrations will be propagated radially along the wires as in the case of the single wire. The system will in fact constitute a vibrating diaphragm. The speed of propagation of the waves along the wires will depend on the working tension of the wires and on their distributed mass. The working tension of the wires depends on the slack allowed to them when at rest, on the frequency of the vibrations and on their amplitude. Due to these facts, the resultant speed of propagation is such that when the vibrating system is in resonance with a given frequency, it will be in resonance with any other frequency, provided the slack of the wires when at rest and the amplitude of the vibrations remain constant.

If the wires are placed sufficiently close together, it is possible to build the valves 8 directly on them (covering totally or partially the area of the diaphragm) without any additional frames nor any other kind of extra weight. These valves should be of special construction as shown in Figures 14, 15 and 16. The wires 1 are the radial wires which constitute the vibrating diaphragm, and the valves 8 are made of thin and light material, such as rubberized fabric (preferably silk), plain silk, thin metal or any other suitable material, in the form of narrow strips placed crosswise to the wires or in any other convenient form and fastened to the latter either along the middle portion of the strips, as shown in Figures 15 and 16, or along one of their edges as shown in Figure 14.

It is clear that such a vibrating diaphragm provided with valves will be the equivalent of the vibrating surface previously described and shown in Figures 3, 4 and 5. It is true that the surface is not made to vibrate all at a time, but in a progressive manner as a result of the wave motion imparted to the radial wires or vibrating diaphragm and thus it cannot properly be considered as a flapping wing, but as every portion of the diaphragm makes a complete vibration for every passing wave, the results will be practically the same, both in form and magnitude, viz:—the production of a current of air and its consequent reaction.

Valves of the type shown in Figures 14, 15 and 16 are exceedingly light and will not add any appreciable weight to the vibrating diaphragm. However, even if some extra mass be added, provided the same to be properly distributed, as is the case with the valves, would not affect the general operation of the device, since the whole set of wires is a vibrating system and the added distributed mass would only affect the speed at which the waves propagate along the wires or the resultant working tension of said wires. In fact the vibrating system should have sufficient mass to be capable of transmitting the necessary energy to the periphery ends of the radial wires in the nearabouts of which obviously most of the valves are located and where consequently most of the energy is spent. But since the valves are so light, practically the whole mass will be represented by the wires.

The diaphragm may be divided into segments separated from each other preferably by a very small distance. Each segment may thus be considered as an independent unit, but since all vibrate simultaneously, no separation will result and the whole diaphragm will function as a single unit during normal operation. The purpose of this subdivision of the diaphragm will be explained later.

Since the vibrating or wave energy of the wires is being progressively spent throughout their whole length by the reaction of the air which is being set in motion, only a small portion of the waves will reach to and be reflected at the periphery ends of the wires, and for this reason it is not essential that the frequency of the vibrations be in resonance with the system.

The power source may be any ordinary aviation motor (preferably a high speed type) mounted in any suitable manner in the middle of the diaphragm or in any other convenient place. The frame on which the motor is mounted as well as the compartment which must be provided for the pilot should in turn be supported preferably on the annular frame surrounding the diaphragm. The illustrations show the pilot, motor, etc., all housed within the hull 2.

One of the numerous forms that can be given to a flying machine of this kind and various details of its construction are illustrated in Figures 8, 9, 10, 11, 12, 13 and 14.

The engine 4 is mounted within the hull 2. The crank shaft 9 is provided with a crank 7 which is connected with the diaphragm at its center 5 by means of the lever 33 and the connecting rod 6; 5 is the vibrating center plate from which all the wires forming the diaphragm radiate; the radial wires 1 are supported by the common center 5 and the annular periphery frame 3. As shown, these wires are not stretched between the parts 3 and 5, but have sufficient slack to produce waves when they are vibrated through the vibrations of the part 5. The valves 8 are constructed in concentric circles around the center 5. The propeller 13 is coupled, through clutch 25, directly to the engine 4. 26 indicates a bearing supporting the shaft 27. 30 indicates a gasoline tank.

The engine 4 is mounted on the base 44. This base is supported on the hull through the means of springs 45 in order to absorb any vibrations of the engine which otherwise would be transmitted to the hull.

49 and 49′ indicate the wires which actuate the elevator and rudder respectively. The wires (not shown), which actuate the ailerons 21 run first within the hull in the rear part of which they turn upwards alongside the supporting rods 10 and then run horizontally either inside or alongside the tubular frame 3 of the diaphragm.

The hull 2 is suspended by its two extreme ends from the annular peripheral frame 3 of the diaphragm by means of rods 10 hinged at 11 and 12 by universal joints. 28 indicates four skates capable of turning in any direction and serve to support the machine on the floor and when landing. The protective frames for the ailerons are indicated at 29.

Figure 12 shows a device for regulating the amplitude and consequently the strength of the vibrations of the whole diaphragm. This is accomplished by shifting the member 31 to the right or left of the figure by means of rod 39 which is actuated by hand lever 40, (Figure 8). Member 31 is provided with a special universal bearing 32 which permits the transmission member 33 to oscillate in any direction with the bearings 32 as a fulcrum, allowing at the same time the member 31 to be shifted from one side to the other, thus changing the amplitude of movement of the end 36. The numeral 38 indicates a guide rail along which the member 31 slides and 35 indicates spherical bearings at the end of the crank 7 and connecting rod 6, respectively.

Instead of the crank 7 to produce the vibrations from the rotary motion of the engine, it would be possible to produce them by a rotating eccentric weight, as shown in Figure 18 in which 49× is the eccentric weight slidably fixed on an extension 50 of the shaft 51. This extension is in turn slidable on shaft 51, which is coupled to the engine 4 by the universal coupling 52. Both the weight 49 and the extension 50 are rigidly fixed in any chosen position by means of screws 54 and 55 respectively. The resultant vibrations are transmitted to the connecting rod 6 by means of the spherical bearing 53 similar to the spherical bearing 35 previously referred to. Their strength and amplitude is regulated by varying the relative position of either the weight 49 or the extension 50. The advantage of this system of producing the vibrations is that the engine will be kept practically free from vibrating. The particular form which has been illustrated has been selected just for simplicity, but it will be clear that there are many other forms which may be utilized with the same results.

When the engine is running, the connecting rod 6 will make a rapid up and down motion which will be communicated to the center 5, and hence to the radial wires 1 forming the diaphragm where the vibrations will be propagated in the form of waves, as described.

Cables 56 connect the hull with the member 3 so as to prevent the valve frame from falling over when the aeroplane is at rest upon the ground.

The propulsion in a horizontal direction may be obtained by simply tilting the machine, wherefrom a horizontal component will result that will propel the craft in the desired direction. In other words, it will glide its way forwardly, but without losing altitude since its lifting force constantly compensates for the downward component resulting from the gliding of the machine. Obviously, the power should be increased when moving horizontally since by tilting the machine, the vertical or lifting component is somewhat reduced and must be compensated by an increase in power. Whenever it should prove desirable, any other known propulsion system may be utilized. Figure 8 shows the device equipped with an ordinary propeller 13, coupled through clutch 25, directly to the same engine that drives the vibrating system. The clutch 25 is operated by hand lever 41 through rod 42.

The stability of the machine may be secured in several ways, four of which are described below.

One of the most effective is by regulating the strength of the vibrations (and consequently the magnitude of the air current produced) at different portions of the diaphragm. For instance, if the machine is tilted to one side, the vibrations on the lower side should be strengthened or those on the raised side weakened, or both operations might be performed simultaneously, any of which would obviously bring the craft to an even keel.

This regulation of the strength of the vibrations in different portions of the diaphragm (which hereinafter will be called "vibratory control") can be accomplished in several ways. One of the simplest is, perhaps, to either partially or totally prevent the wires radiating towards the raised side of the craft from vibrating. This can easily be done by attaching at some distance from the center, one or more wires (which hereinafter will be called controlling wires) to each portion of the diaphragm whose vibrations it is desired to regulate, and connecting the other ends of said wires to a common central control lever at a point somewhat lower than the diaphragm, as shown in Figures 8, 9 and 10, and in which 14 indicates the controlling wires and 15 the central control lever. Under normal conditions, the controlling wires should hang loose so that they would permit the diaphragm to vibrate freely, but if it is desired to diminish the intensity of the vibrations of, say the left hand portions of the diaphragm, the control lever is pushed to the right so as to tighten the left hand controlling wire (see Figure 10), thus preventing the portion of the diaphragm to which said wire is attached from vibrating freely, which obviously will decrease the strength of its vibrations. If the lever is pushed with sufficient force, the vibrations of the affected portion of the diaphragm may be entirely stopped.

In order to control the vibrations not only of a single radial wire, but of a whole section of wires, there is provided a cross bar 16 (Figure 9) corresponding to each controlling wire which rigidly connects the whole set of radial wires together, permitting their free vibration as a whole, but not to move independently of each other. The controlling wires are directly connected to the cross bars themselves, thus making each controlling wire to act on a whole set of radial wires. There can be as many controlling wires as desired, and all of them connected to a common control lever. Of course, not less than three should be provided if it is desired to control the stability of the craft in all directions.

It is convenient to point out that in case the diaphragm is vibrating at any of its resonance frequencies, the above described controlling system will become much more sensitive because when the controlling wire of a certain portion of the diaphragm is tightened it will make the strength of the vibrations to decrease not merely by its direct forced action, but also by throwing said portion of the diaphragm more or less out of resonance, due to the fact that the tension of the vibrating wires, as well as their distributed mass are varied, and, as I have previously stated, the speed of propagation of the waves along the diaphragm radial wires, and consequently their resonance frequencies, is a function of their tension as well as of their distributed mass. There are many other arrangements by which this vibratory control (either the direct forced vibratory control or the resonance control) may be accomplished, but I will not describe them as they all work on the same general lines of the one that has been described.

When the machine is moving in a horizontal direction, it is possible to secure its stability and general control by the ordinary means used in airplanes, viz:—an elevator plane 20 (Figure 8) or the like for the longitudinal stability, ailerons 21 or the like for the lateral stability, and a rudder 22 for controlling its direction. A stabilizer plane 23 and fin 24 are also provided. It is obvious, of course, that the method of regulating the strength of the vibrations is equally effective whether the craft is stationary or in motion.

Another method (which hereinafter will be called "gravity control") for stabilizing the machine, is by shifting its center of gravity to one side or the other according to the inclination assumed by the machine or which it is desired to give same. This method is of special importance when the engine fails and it is desired to make a vertical descent, although it can be used advantageously during a normal flight. A simple way of accomplishing this gravity control is shown in Figure 8. The hull 2 where the engine, pilot compartment, etc., are located, is suspended by its two extreme ends from the annular peripheral frame of the diaphragm by means of rods 10, hinged at 11 and 12 by universal joints. The operation of shifting the center of gravity is performed by means of the same control lever 15 previously referred to. In pushing said lever to any side, the pilot is taking support upon the hull and since the upper end of the lever is connected to the diaphragm wires through the controlling wires 14, said upper end of the lever will thus have a fixed supporting point and as a result the hull will swing in the opposite direction of that in which the lever is pushed. Obviously, the center of gravity of the whole system is also shifted in the same direction and the heavier side of the machine will descend. It will be noticed that the control lever 15 actuates simultaneously the gravity control and the vibration control, as well as the elevator or the ailerons, only that the vibration control as well as the elevator or the ailerons begin to be effective after a comparatively small movement of the control lever and require but a slight effort on the part of the pilot, while to produce a stabilizing force of equal magnitude with the gravity control, the movement of the lever must be continued still further by pushing it with a force which will depend on the distance to which the center of gravity is shifted, but since the three systems of control can work simultaneously without interfering with each other, it is convenient to actuate them by means of the same lever.

The rudder may be operated by means of the hand steering wheel 17 fixed at any convenient height on the control lever 15, or by means of the foot lever (not shown) fixed crosswise near the lower end of the control lever, which control lever is fixed to the bottom of the hull by means of the spherical bearing 19 which permits the control lever to swing in any direction.

In the case of the diaphragm being divided into segments, it will be apparent that those segments which are connected to the control lever through the controlling wires or rods (which hereinafter will be called controlling segments) will be pulled down to a certain extent and will thus be separated from those which are not connected to the control lever (see Figure 10). This action will create radial apertures between the controlling segments and their neighbors which will obviously reduce the lifting force on that side of the diaphragm to a considerable extent, in addition to the reduction produced by the diminished strength of the vibrations.

If it is desired to have several controlling segments near each other, they should not be contiguous segments, if maximum effectiveness is sought. The maximum effect would be obtained when every other segment of the diaphragm is made a controlling segment, and when their width is not large compared to the distance to which they are pulled apart from the intermediary segments, that is, in relation to the size of the resultant apertures. The machine shown in Figures 8 and 9 is provided with four controlling segments 48. This controlling action (which I call "aperture control") produced by creating apertures in the diaphragm, is of special importance when it is desired to make a descent, particularly a vertical one, with the engine stopped, whether because of failure or for any other special reason, since it is very effective and reliable and requires relatively little effort on the part of the pilot. It is, of course, equally effective when moving forward, and in general, in all circumstances whether the engine be working or not.

Instead of actuating the diaphragm from a single central point or vibrating center, it is possible to actuate same simultaneously from different points (Figure 17). This can be accomplished either by transmitting the power to the different vibrating centers from one or more central engines, or, preferably, by placing an engine at each vibrating center.

This multiplicity of vibrating centers is especially convenient for large flying machines as it will eliminate the necessity of very heavy diaphragms capable of transmitting the greater power required at the necessarily greater distances involved, and at the same time providing increased safety if a plurality of power sources is made use of. Figure 17 shows a diaphragm provided with three vibrating centers 5′. 3 indicates the annular frame of the diaphragm; 45, 46 and 47 indicate wires or metal strips to which the ends of the vibrating wires radiating from centers 5′ are fastened. It will be apparent that if the power source of any of the vibrating centers is not working, the vibrations of the wires corresponding to the other vibrating centers will be communicated to those of the non-vibrating center, even if with a diminished intensity.

Respecting the power required by a flying machine of this kind, it will be noticed that there are only relatively small losses in the operation of the device. The main losses are those resulting from the functioning of the valves themselves and arise while they are moving upwards when they should oppose no resistance to the air current passing through them, and, as is obvious, this resistance cannot be entirely eliminated. From actual experiments made, I have roughly estimated that it is possible to reduce said resistance to perhaps much less than 20% of the total useful reaction.

The losses arising from the vibrating system are almost negligible if properly constructed. This is a result of the fact that every movement of the system takes place in a gradual manner and in an entirely natural sequence, there never occurring what we might call forced movements of any kind. The air itself is accelerated in an equally gradual way so that eddies are practically eliminated and a current of air of almost constant speed is obtained.

The load factor of the machine may be varied within wise limits, but for the sake of safety, it is very convenient, and entirely within the practical limits of the invention, not to exceed the load factors used in ordinary parachutes, as in this way the whole machine may come down gently in the event of engine failure or whenever it is desired to descend vertically with the engine dead.

The general advantages of this kind of flying machine, in addition to the main advantage of being capable to rise vertically, may be summarized as follows:—simplicity of construction and operation, great maneuverability, light weight, great translational ability since the main portion of the device is practically flat which permits the machine to attain high speeds, possibility of producing large lifting forces with relatively small powers, and great safety in flight since it becomes a ready open parachute as soon as the engine fails.

What I claim is:—

1. In a fluid impeller, a body, means to impart a vibratory motion to parts of the body, means to transmit said vibrations to other parts of the body in the form of waves, means to communicate the motions of the body to the surrounding fluid to produce a unidirectional current of fluid, means to regulate the strength of the vibrations on the whole body, and means for reducing the vibratory motions of certains parts of the body.

2. In a fluid impeller, a body, means to impart a vibratory motion to parts of the body, means to communicate said motions to the surrounding fluid to produce a unidirectional current of fluid, means for moving certain portions of the vibratory parts of the body away from other of said parts to form apertures in the body, and to reduce the vibratory motions of the portions which are so moved.

3. In a flying machine, a body, inner and outer supporting members, radially arranged flexible members connecting the supporting members together, valves carried by the flexible members and means for vibrating one of the supporting members to vibrate the flexible members to open and close the valves.

4. In a flying machine, a body, inner and outer supporting members, radially arranged flexible members connecting the supporting members together, valves carried by the flexible members, means for vibrating one of the supporting members to vibrate the flexible members, causing the valves to open and close to produce a unidirectional current of air, and means for moving certain sets of the flexible members away from the adjacent flexible members to form apertures in the body and to reduce the vibratory motions of the sets of flexible members which are so moved.

5. In a flying machine, a body, inner and outer supporting members, radially arranged flexible members connecting the supporting members together, valves carried by the flexible members, means for vibrating one of the supporting members to vibrate the flexible

members, causing the valves to open and close to produce a unidirectional current of air, means for moving certain sets of the flexible members away from the adjacent flexible members to form apertures in the body and to reduce the vibratory motions of the sets of flexible members which are so moved, and means for regulating the strength of the vibrations imparted to the supporting member.

6. In a flying machine, a body, inner and outer supporting members, radially arranged flexible members connecting the supporting members together, valves carried by the flexible members, means for vibrating one of the supporting members to vibrate the flexible members, causing the valves to open and close to produce a unidirectional current of air, means for moving certain sets of the flexible members away from the adjacent flexible members to form apertures in the body and to reduce the vibratory motions of the sets of flexible members which are so moved, means for regulating the strength of the vibrations imparted to the supporting member, and means for changing the center of gravity of the body.

7. In a flying machine, a body composed of inner and outer members, radially arranged flexible members connected with the supporting members, valves carried by the radial members, means for vibrating the inner member to produce waves in the radial members causing the valves to open and close, to produce a unidirectional current of air, some of the radial members being arranged in sets to form controlling segments, means for lowering any desired controlling segment or segments to reduce the vibratory motions thereof and to form apertures in the body, means for movably connecting the body with the fuselage of the flying machine and means for changing the center of gravity of the body with respect to the fuselage.

8. In a flying machine, a body, means to impart a vibratory motion to parts of the body, means to transmit said vibrations to other parts of the body in the form of waves, means to communicate the motions of the body to the surrounding fluid to produce a unidirectional current of fluid, means for moving certain portions of the vibratory parts of the body away from other of said parts to form apertures in the body and to reduce the vibratory motions of the portions which are so moved.

9. In a flying machine, a body, substantially inelastic pliable members mounted on said body, means for producing waves in said pliable members and means for communicating the motions of the pliable members to the surrounding air.

10. In a flying machine, a body, substantially inelastic pliable members mounted on said body, means for producing waves in said pliable members and valve means carried by the pliable members opened and closed by the wave motions thereof to produce a unidirectional current of air.

11. In a fluid impeller, a body, substantially inelastic pliable members mounted on said body, means to impart a vibratory motion to parts of said pliable members, means to transmit said vibrations to other parts of the pliable members in the form of waves and means to communicate the motions of the pliable members to the surrounding fluid to produce a unidirectional current of fluid.

12. In a fluid impeller, a body, pliable members mounted on said body, means to impart a vibratory motion to parts of the pliable members, means to transmit said vibrations to other parts of the pliable members in the form of waves, means to communicate the motions of the pliable members to the surrounding fluid to produce a unidirectional current of fluid and means to regulate the strength of the vibrations.

13. In a flying machine, a body, pliable members mounted on said body, means to impart a vibratory motion to parts of the pliable members, means to transmit said vibrations to other parts of the pliable members in the form of waves, means to communicate the motions of the pliable members to the surrounding air to produce a unidirectional current of air and means for moving certain portions of the vibratory parts of the pliable members away from other of said parts to form apertures in the body.

14. In a fluid impeller, a body, substantially inelastic pliable members mounted on said body, valves carried by the pliable members and means for vibrating parts of said pliable members to produce wave motions in them to transmit the vibrations to other parts of the pliable members, causing the valves to open and close to produce a unidirectional current of fluid.

In testimony whereof I affix my signature.

RODRIGO M. SMYTH.