Oct. 23, 1945. D. K. WARNER 2,387,627

AIR ENTRAINMENT PROPULSION METHOD IN CRAFT SUPPORTED CHIEFLY BY AIR PRESSURE

Filed Dec. 3, 1941 4 Sheets-Sheet 1

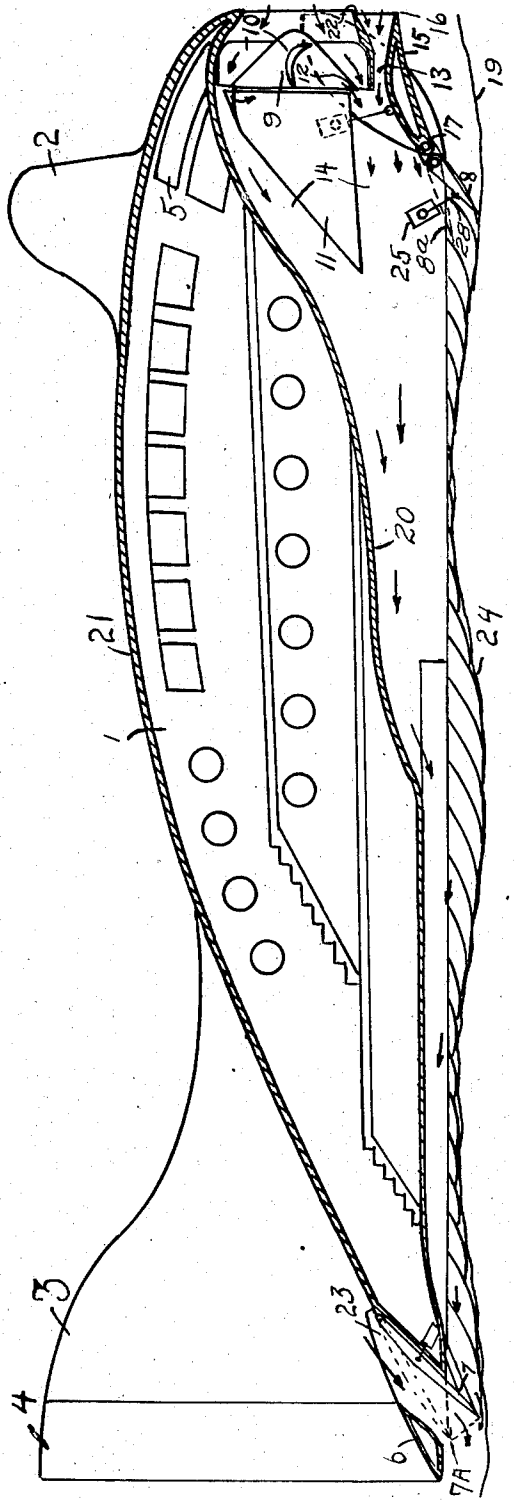


Fig. 1.

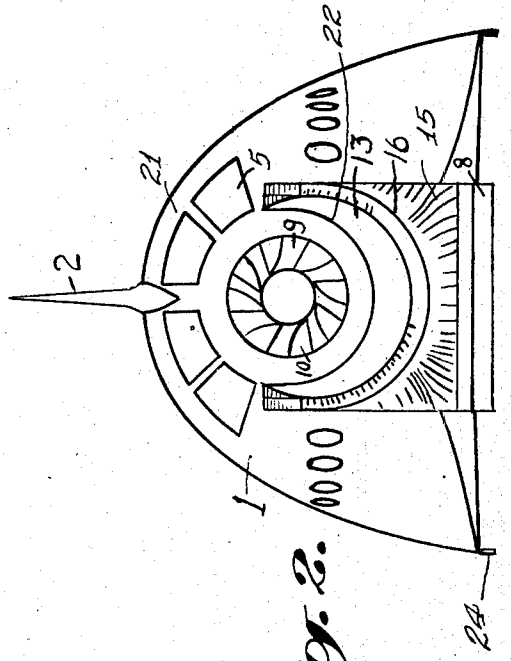


Fig. 2.

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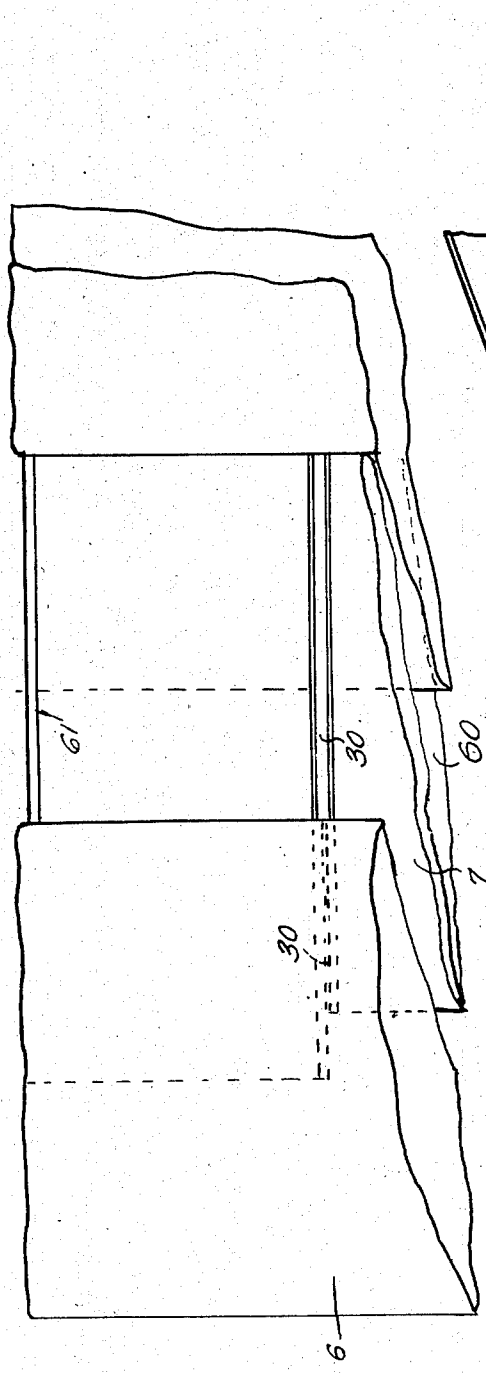


Fig. 4.

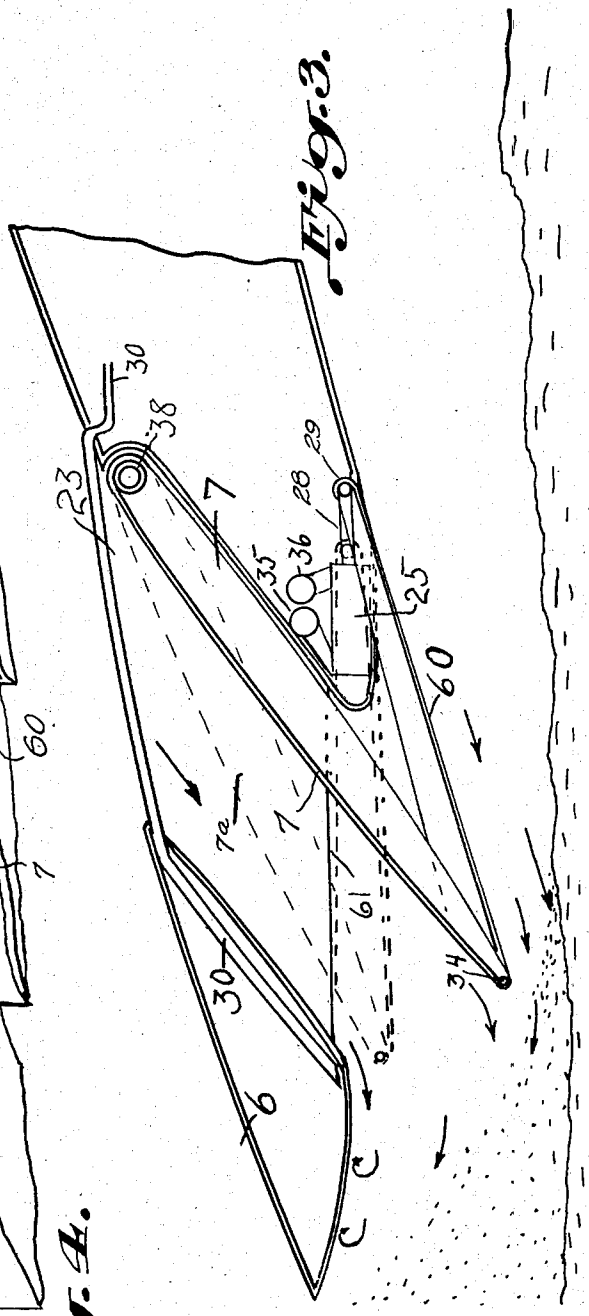


Fig. 3.

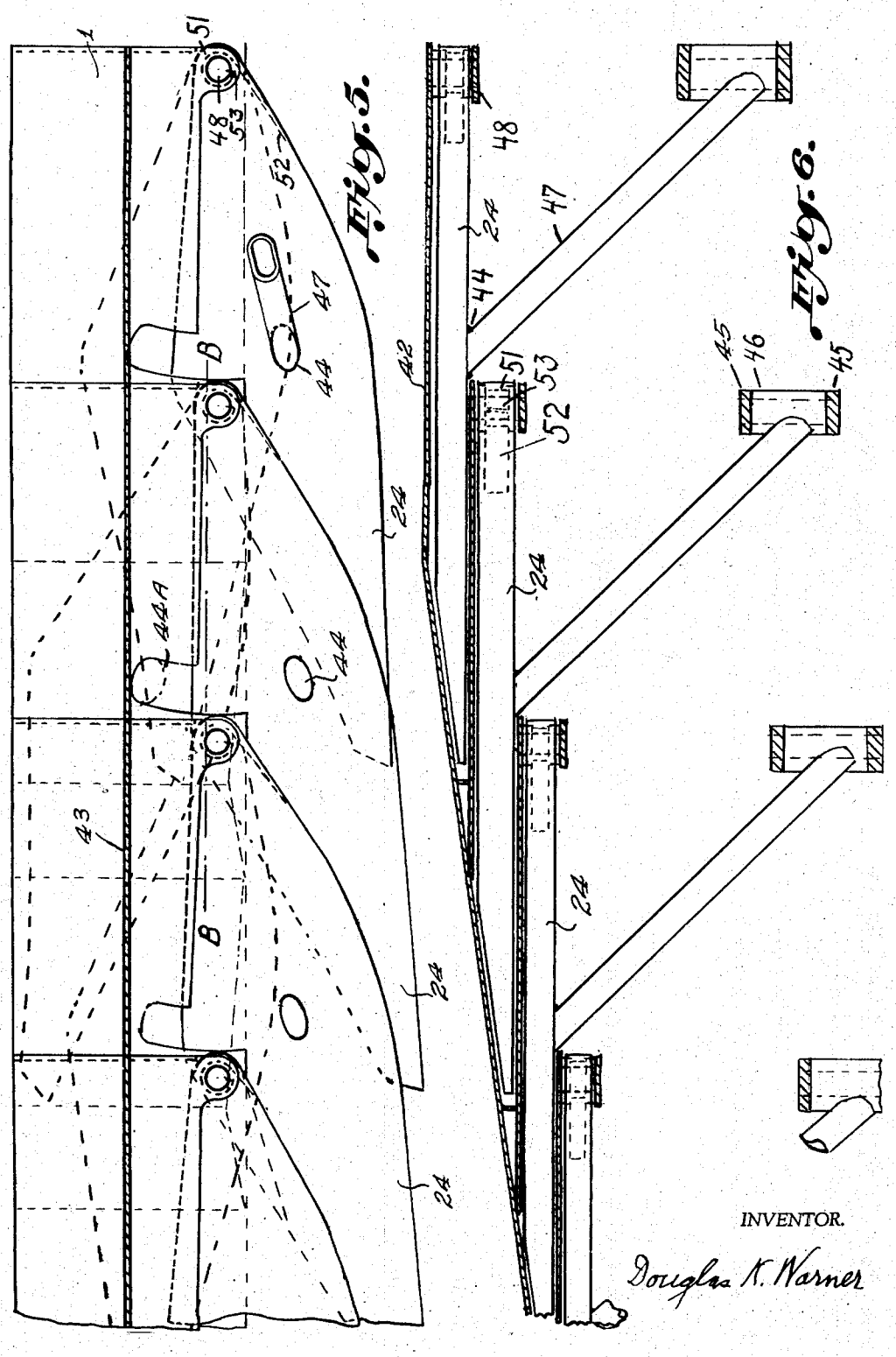
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AIR ENTRAINMENT PROPULSION METHOD IN CRAFT SUPPORTED CHIEFLY BY AIR PRESSURE

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Filed Dec. 3, 1941 4 Sheets-Sheet 4

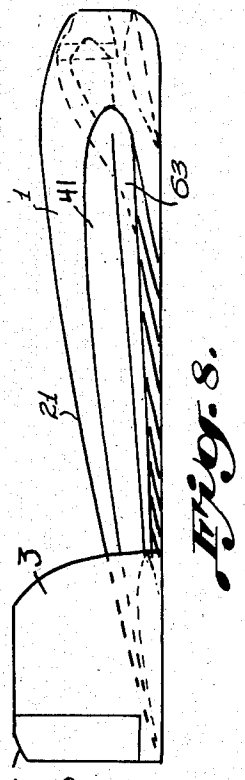


Fig. 8.

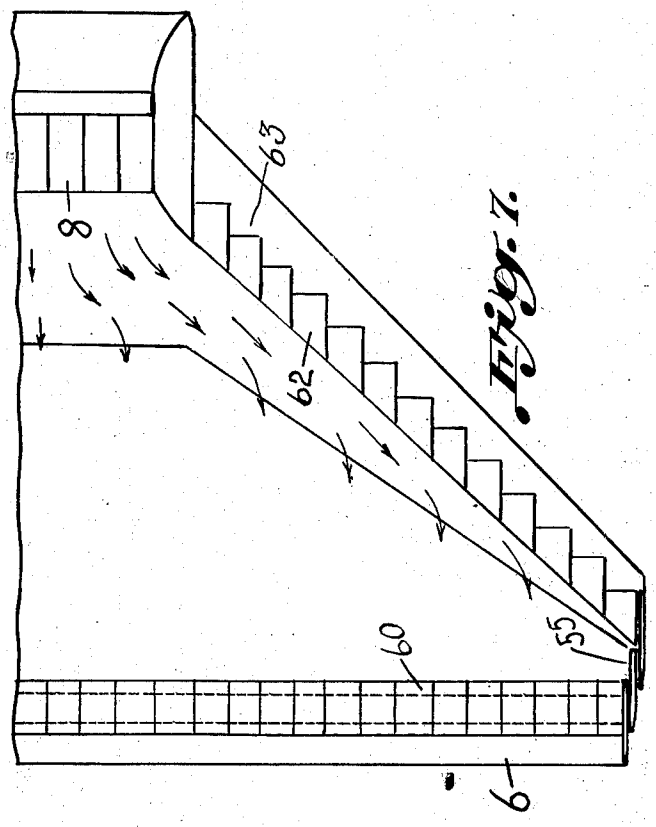


Fig. 7.

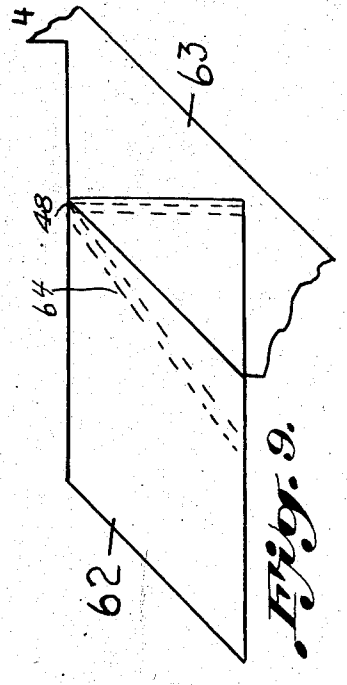


Fig. 9.



Fig. 10.

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Patented Oct. 23, 1945

2,387,627

UNITED STATES PATENT OFFICE

2,387,627

AIR ENTRAINMENT PROPULSION METHOD IN CRAFT SUPPORTED CHIEFLY BY AIR PRESSURE

Douglas K. Warner, Sarasota, Fla.

Application December 3, 1941, Serial No. 421,457

20 Claims. (Cl. 244—15)

This invention relates to skimming and flying craft, and to certain entrainment and other methods of propulsion of such vessels, with especial reference to jet propulsion. It is a development of the inventions described in my co-pending applications for patents, Serial Numbers 252,476 (since issued as Patent No. 2,277,620, 336,545, 365,446, and 337,448.

The primary objects of the present invention are to increase the power and efficiency of the craft by improved means and method both in the production by the engines and fans of pressure-lift and thrust, and in the indraught and entrainment of air at the leading edge, as well as in the conservation of the pressure and power and its employment in a rearward jet, with further entrainment of air in conjunction therewith; to provide means for removing the water spray-laden air at the nose of the craft, avoiding its contacting the propeller-fans; to provide means for effectively maintaining an air-cushion beneath the craft and sealing it from escape of air; to provide means for varying the amount of air-intake as the craft progresses; to produce a propeller fan or compressor which will more efficiently work to entrain and compress air at the nose both directly and supplementarily, with a smaller diameter of fan, yet increasing the volume of air compressed thereby, with concomitantly lighter weight and better vision; to govern the sealing mechanism effectively over a rough surface and reducing the drag thereof in air, when higher speeds render sealing temporarily unnecessary; and in general to improve the working, the strength, simplicity and efficiency of all the elements of the invention and of the craft.

With these and other objects in view, the present invention consists first in a form of craft constructed at the nose in such manner as to cooperate with its engines and fans in the intake of a large volume of air compressed and discharged in high velocity and high pressure behind the fan; second, in a propeller and compressor fan with novel blades, and an engine or engines mounted in connection with the same, having a casing or housing rearward thereof, of a size to permit the fan circumference to extend beyond the same, and both discharge and initially diffuse the air in an annular area around the engine housing, where it is further diffused and its velocity largely transformed into higher pressure; third, in a pressure chamber beneath the floor of the craft from nose to tail in which the air is accumulated; fourth, in directing the engine exhaust rearwardly behind the fan hub, so that it is compressed with the air; fifth, in an entrained-air inlet below the fan-casing, and a movable airfoil helping to form an entrainment nozzle whose throat and exit areas increase with the speed of the plane, whereby much more air is entrained by the fan-blast at high speed, whereby also water spray may be removed through a passage beneath the fan-blades and be separated therefrom in order that the said spray may not injure the fan-blades; sixth, in directing and forcing all this gaseous volume through the pressure chamber to the tail, and ejecting it in a jet at the trailing edge of the craft; seventh, in providing such flaps at the tail-jet as will help re-transform the high-pressure energy again into velocity and entrain matter from the surface beneath to increase the propulsion thrust energy; eighth, in forming the top surface of the craft and its tail into a stream-lined deflector of the outer air down said tail and arranging channels at the bottom thereof, making a rear entrainment passage connecting said outer air with the propulsion jet from within, for added propulsive power by entrainment of additional air from above the plane in said tail-jet to increase its propulsive thrust and efficiency during operation of the craft, according to the varying conditions and consequent requirements of the flight or voyage; ninth, in a series of depending flaps at front as well as rear, and along each side of the craft especially devised to seal said front and rear and sides of the vessel and the air-cushion under the boat, to work in unison when any uniform condition so causes, and independently under other conditions such as waves or rough water; lastly it consists in various other factors and details of construction operating in conjunction with the herein-stated features to accomplish the objects hereinbefore recited.

In the accompanying drawings, forming part of this specification, in which the like reference numerals designate like parts in the several views;

Figure 1 is a longitudinal central section of a compression plane embodying my invention;

Figure 2 is a front elevation of the same, without the wings, thus in the form of a skimming plane;

Figure 3 is an enlarged vertical section of the tail of the plane, showing the tail-flap, its operating mechanism, the tail gas-tank, the method of entraining air and water at this point;

Figure 4 is a plan view of a portion of the tail;

Figure 5 is a detail sectional elevation of certain of the sealing plates forming part of my invention, greatly enlarged relatively to the other figures;

Figure 6 is a section of the same, substantially on the line B—B;

Figure 7 is a reverse or bottom plan view of one half of a flying or flyable compression plane embodying this invention, showing the several sealing means hereinbefore mentioned;

Figure 8 is a side elevation thereof;

Figure 9 is an enlarged plan of the wing leading edge sealing flap;

Figure 10 is a side view of the same.

In the form of my invention in which I have so far begun to construct it, the body 1 is made in the shape and general proportions illustrated in Figure 1, though the invention is not limited thereto. The roof 21 of the plane or craft is cambered and streamlined so that it slopes down practically to the water or the floor of the craft at the trailing edge not only for reduction of resistance but for direction and deflection of all air, rearwardly and down to the point specified, where such air, as I shall indicate hereafter, is drawn and entrained down that sloping inclined stern to an entraining jet and source of propulsive power.

Upon the top of the craft, just back of its nose, is mounted a front fin 2. At rear, beginning at a point quite well forward of the tail, is a rear fin 3, projecting upwardly from the inclined roof of the tail to a height above the roof of the craft at its peak, and seen in profile, as in Figure 1, rises on an ogee curve from its forward fixation to the trailing edge. At its rear, this fin carries a rudder 4. At the extreme end of the tail, are set the fuel tanks 6, extending across the craft, held by braces 61, and having pipes 30 leading therefrom forward to any desired point.

The body of the craft is a hollow metallic, plastic, plywood or other shell, in the form shown, its floor commencing up near the roof, and in junction therewith, and lowering rearwardly on an ogee curve. The forward portion of this curved floor being concaved upwardly, and the joined roof convexed, they form the upper leading edge and upper sector of the nose of the craft. Within said nose, under the floor of the body, I mount one or more internal combustion engines, not shown, being within the engine housing or encasement 11. The fan 9 has a conical hub, with blades 10 of deep camber much longer at their leading than at their trailing edges. The fan casing 22, continuous at top with the roof-floor junction, and depending therefrom, forms the remainder of the nose.

The engine housing 11 is projected rearwardly in nearly the shape of a right-angled triangle, as shown in Figure 1, of such dimensions that the fan blades 10 project beyond the same circumferentially, and thus there is formed an annular passage 14 above and below the housing 11, beneath the floor. An exhaust passage 12 leads behind the fan rearwardly under the housing 11. By examination of Figure 1, it will be seen that there are intentionally formed at the front of the plane, within its nose, two distinct and efficient diffusing instrumentalities, or pressure creators, expressly designed to transform velocity energy into pressure. First, there is indraught of air through the nose formed flaring rearwardly, and said air is forced through between the fan blades 10, where the conical hub of the fan and the walls of the nose form an annular exit of increasing area rearwardly which ejects said air compressed and at both high pressure and reduced velocity into the pressure chamber which lies beneath the floor 20. Second, as the passage 14 is, by the shape of the engine housing 11 and of the floor 20, formed flaring rearwardly, there is a diffusion of the air there, which reduces part of the velocity energy into pressure energy. The engine exhaust through the fan passage 12, mingles with the air and heats the same, and increases the energy. The passage 14 is continuous all around the engine housing 11, and thus may be considered as a unitary annular chamber or forward part of the pressure chamber beneath the floor; which pressure chamber continues rearwardly under said floor to the trailing edge.

Immediately below the fan casing 22 I pivot an air-foil 15, which is substantially semi-circular in front view, as seen in Figure 2. This being hung at a certain short distance under the fan-casing, leaves a similarly semi-circular orifice 13 between them. The air-foil 15 is pivoted upon a pipe 17, at rear, is held by double-acting air-cylinder 25, and is controlled also by the pilot. It has a cambered upper surface, by means whereof the orifice 13 is contracted at rear to form this orifice also into a narrowed nozzle, directed into the passage 14.

Back of and beneath the air-foil 15 is a series of depending flaps 8, pivoted at top, and normally lying closed rearwardly by a double acting cylinder 25, having a piston connecting-rod 28 pivoted thereto, being elevated to a position shown in dotted lines as 8^a. The orifice 13 receives air and water-spray thereinto in progress of the craft, which it discharges in a jet out of its rear narrowed nozzle end, under the entrainment effect of the jet hub 9 of the compressor fan.

Along the entire length of the craft from the flaps 8 to the tail, I mount a series of depending side-sealing flaps 24, on both port and starboard sides of the vessel, which are shown in Figure 1, lying on the surface of the water, with said sealing flaps touching the surface. These side sealing flaps 24 are shown in enlarged detail in Figures 5 and 6, and in Figure 7 are shown in bottom plan, where they are attached to one of the wings. These flaps are stepped or overlapped (Figures 5, 6 and 7) to effect complete sealing. The wing-flaps 62 (7, 8, 9 and 10) hang from pivots 48, beneath the leading edge 63 of the wing, 41, to swing on a perpendicular arc and braced, as indicated in Figure 9 in dotted line 64. The wings 41 are preferably stub-wings. Where the flaps are placed direct on the hull, then on the inside of the outer wall 42 of the craft, at each side, I hang on pivots 48, set in bearings 51, the sealing flaps 24, which are thin, light, buoyant plates of any desired material, but necessarily rustless and non-corrosible. The plates being pivoted at their upper front corners, tend to drop into operative position by gravity, but this being slow of action, I attach helical springs 52 around the pivot pins 48, one end of said springs bearing against the plate 24. In constructing these plates, I may build them up in much the same way as shown in my Patent No. 1,855,076, wherein the bottom of the ship is of a cellular form to include sufficient air-spaces to afford buoyancy. These flaps 24 are provided with lateral braces 44, diagonally disposed, having their inner ends set in bearings 45, fixed to the bottom of the hull, and said braces being formed of light hollow rods of rustless and non-corrosive alloy steel. These flaps are free to rise and fall, the upper position being indicated in dotted lines in Figure 5. Slots 44^a are notched in the hull to receive the brace-rods 44 therein.

The compressed air under the floor of the craft is ejected in a wide jet at the tail. Here I pivot a series of flaps 7, hinged at top, and operating in channels 23 formed between the main body at the tail, and the fuel tanks 6 which project beyond. The raised position of these flaps 7 is shown at 7^a in dotted lines, Figure 3. They are depending from pivots 38, and have pivoted to them at their outer ends, flaps 60, the forward

ends whereof are pivotally supported in bearings **29** beneath the tail. A double-acting cylinder **25** is connected to this flap **60**, and so to the flap **7**, to swing the same, its piston connecting-rod **28** being pivoted thereto at said bearing **29**. Above the cylinder **25** are mounted reservoirs **35** and **36** as shown in Figure 3, which are filled with compressed air, and control the cylinders **25** through pipes thereto and any usual means of adjusting pressure either before flight, depending upon the load carried, or by any suitable means under control of the pilot. All of the cylinders **25** are similarly air-filled, of course, and by similar reservoirs.

Windows **5** are located in the nose and body of the craft as desired. I have not shown any controls or instruments since these form no part of my invention.

Where enough power is built into the craft to enable it to take off and fly over a storm, the design shown in my copending application Serial No. 365,446 hereinbefore mentioned may be employed satisfactorily. Figure 7 shows half of a plane such as that. In this case, the sealing flaps **62** combine somewhat the functions of the bow flaps **8** and the side sealing flaps **24**. And in general, the flaps **62** close off the sides of the plane much as do the flaps **24**.

It is essential that the wing flaps **62** operate without mutual friction; they are made as wide as possible with the least possible clearance between them. Their leading edges are perpendicular to the centre line of the vessel, and where the wing tapers its lower leading edge is cut with indentations or cover plates **65** which enclose the forward portion of the flaps near the pivot. As may be seen, each pivot shaft is located rearwardly and downwardly from that of the adjoining flap nearer the ship's centre line. Since these flaps function in part like the bow flaps **8**, as will hereinafter more fully be explained, they may require cylinders **25** under air-pressure and also the helical springs **52** on each flap as before described.

When this vessel shown in the present drawings is made in large size, for use as a skimming aircraft carrier, it will, if constructed in the shape shown in Figure 7, have a flat upper surface adapted to receive planes thereon and to take off therefrom; and if in the form shown in Figure 1, its top will of course similarly be made flat enough to cover this feature. Such a carrier will be capable of carrying loads far beyond aircraft of today of comparative size, as is also the case with all types of craft and smaller planes made according to my invention.

In the operation of my improved skimming and flying vessel, the gunning of the engines will at once start compression by the compressor-fan or fans, which will draw in air through the open flared nose, compress it and force it out on all the circumference of the fan, both above and below the engine housing **11**. The conical hub **9** of the fan, its form of cambered blades longer at the leading edges, and the form of the entrance, will combine in action so that the fans will discharge compressed air at both high velocity and high pressure into the passage **14** behind, and into the diffusion-chamber or pressure chamber which is formed beneath the floor of the craft. There, by the diffusive effect of the said chamber, by the ejection from the annular exit formed by the conical fan-hub and the nose, into this widened chamber, most of the velocity energy of the air will be converted to pressure energy. All of it will be utilized as a high pressure air and exhaust cushion in the pressure chamber, and said high pressure gaseous volume thereafter will be forced along and under the floor to the tail of the craft, where it will be ejected, with effects I shall outline shortly. Meanwhile, at the leading edge or bow, air is being entrained through the orifice **13** in the nose, formed by the fan-casing **12** and the air-foil **15**. Most of the water will be deflected downwardly by said airfoil with added lift, and any spray sent ahead will be drawn through the orifice below the fan. The air discharged at the throat of the nozzle constituted by the air-foil and fan-casing, will lie right in the path of the air-stream from the fan, and this exhaust and heated air stream will entrain and by suction draw out the said air through said orifice **13**, and draw it both rearwardly and downwardly in its swift paths down and back shown by the arrows in Figure 1. In the progress of the craft, the quantity of air brought in, to the nose will be increased, and also the quantity of said air coming through the orifice, as this orifice is enlarged at higher speeds, under pilot control, and since also the pressure differential under and ahead of the plane is reduced.

By reason of the bottom of the hull being formed with the pressure chamber beneath it, and such chamber being enclosed on all sides by the front and rear and side flaps, the effective power of both lift and propulsive thrust will be conserved and fully utilized in a manner hitherto not accomplished. At the tail of the craft, there will be discharged from this pressure chamber so formed open at the bottom to the water, and sealed on all sides by the several series of flaps, a powerful jet which will force rearwardly water, air, sand, any mixture of matter it contacts, with the result of giving the craft a high propulsive efficiency with capacity to carry at unusually high speeds most unusually high loads due to increasing the amount and thus the weight of material in the jet. This compressed-air and exhaust stream, which being a heated mixture of exhaust gases and air, is more effective than plain air. The orifice **13**, as seen in Figure 2, is only at the lower sector of the fan casing. When the air-foil **15** is lowered at the mouth, against the action of its cylinder **25**, the mouth widens far more than its throat, because of the pivoting thereof being at the rear, and not only is more air admitted, but the widening of the nozzle formed by the air-foil and the base of the fan-casing **22** leaves the said nozzle more proportionately flared relatively to its exit, and therefore the entrained air is drawn in at higher velocity as well as in greater quantity.

All water spray is kept by the air-foil from contact with the propeller fan, with the aid of this orifice and the entraining action of the fan stream within. As speed of the craft increases, the suction lift over the top of the plane-body and wing increases, and the ram effect below does likewise. The point is soon reached where no fan pressure is required to support the craft but a very considerable weight of air must be forced rearward. Many times the amount of air handled directly by the fan is now entrained at the lower sector of its circumference, and the vessel rising, permits more air to enter under the bow flaps **8** and be entrained by that already in active rearward propulsive motion. Gradually the craft rises to a height where the ground has no further effect upon the manner of operation de-

scribed, and altitude becomes limited only by the air density and the jet power of the plane. At the leading edge, the flaps **8** are and should be held against the inner pressure by the cylinders **25**, the pressure of which is maintained by the reservoirs **35**, and by adjusting the same from time to time as required through the valves leading to said reservoirs. One reservoir can supply all near cylinders. In passing over a wave, the flaps **8** will be drawn into the position **8a** shown in dotted lines.

The mixture of compressed air, and gas exhaust, in the pressure chamber below the floor, which has been by the diffusion effect of said chamber brought to a very high degree of pressure, greatly beyond atmospheric, has first created air cushion and pressure lift under the floor of the craft, maintaining it not only on and at the water surface or immediately above the same, but also, to a varied extent, in any desired altitude, depending upon speed. The said compressed air mixture also is impelled rearwardly in the pressure chamber under the craft to the tail thereof, where it leaves the trailing edge in a wide jet. At this point it encounters the tail-flaps **7**, or the flaps **60** attached at the under surface thereof, and the high pressure of the air-mixture within the pressure chamber is transferred to a high velocity jet, leaving the tail at a high speed as well as with considerable force, as a powerful jet, of great propulsive force, with such entrainment effects, hereinafter described, as will be sufficient to advance the craft at speeds far above any hitherto produced in such vessels. Such vessels may, in full flight, approach the speed of sound, with load carrying capacity greatly in excess of any planes of comparable size and engines, known thus far.

The strong propulsive rearward current set up under the tail by suction draws down the air over the said tail, and forces it rearwardly in addition to said initial current, entraining this air down the upper surface of the body and inclined tail through the channels **23** between the trailing edge of the flaps **7** and the fuel tanks **6**. The entire propulsive current passes under said fuel tanks, and the under surface thereof being upwardly curved, this, with the water's surface beneath, produces a diffusing effect in which the air pressure rises to propel the craft and lift the tank, and the air from over the tanks is entrained by the blast beneath and reduces the pressure above the tanks. The tail end of the pressure chamber is curved downwardly and rearwardly which materially assists in the change of pressure to velocity.

The tail jet passing close to the surface especially acts upon and picks up the water, sand, or other surface matter and entrains the same with and into said jet, or rearward current, materially augmenting the weight of this rearward air current by such addition of matter, thereby increasing the efficiency of the jet propulsion. The rear flaps **7** have the pressure upon their under sides, that is, against the flaps **60**, which is opposite to the pressure-condition of the flaps **8**, and thus the cylinders **25** at rear are set so as to hold said flaps against rearward pressure normally. When a wave-trough reduces the pressure against the flap **60**, the cylinder piston is pushed out thus dropping the flap, diminishing the pressure in the cylinder at rear, so as not to exert as much pressure upon the flap, thereby keeping the tip **34** thereof higher above the wave trough than at its crest.

The air pressure in the reservoir **35** feeding the rear of the cylinder **25** governing the flap **7**, is adjusted in accordance with the speed and load of the craft in order that the tip **34** of said flap may remain at an average correct height above the surface beneath by said adjustment. When the said flap tip **34** is down in the wave trough, and the piston of the cylinder **25** is so pushed out, and the pressure in the cylinder is so reduced, the pressure in the pressure chamber beneath said flap being as yet undisturbed, said pressure is therefore in excess of the reduced cylinder pressure required to hold the flap down, and the space between said flap tip **34** and the surface beneath is accordingly increased, thereby increasing the flow of air leaving the pressure chamber until the decrease of pressure under said flap due to such outflow, balances the pressure decrease in the cylinder.

The drop of the flap **7** in said trough has also increased accordingly the width of the channels **23** in the tail, correspondingly increasing the volume of air entrained down said tail through said channels, to an extent proportional to the increase in outflow beneath the flap. The said flaps **7** and the cylinders controlling the same, therefore also operate in this manner to maintain efficiency of entrainment through said channels independently of change of position of said flaps due to wave-troughs and wave-crests.

The under surface of the pressure chamber at the tail being curved downwardly and rearwardly, and that of the fuel tanks being curved upwardly and rearwardly, there is primarily the effect of retaining the pressure within until the flap tips **34** are approximately reached, whereat the pressure energy is transformed to velocity energy, and the described entrainment through the channels **23** and from the surface beneath, is effected; and secondarily, there is a final stage of diffusion caused by said curved under surface of the tanks **6**, in which the curved widening of the space between the water or other surface and the fuel tanks, again by diffusion transforms velocity energy into pressure energy, and greatly increases the power of the entire propulsive stream, as well as entraining air over the top of said tanks as stated, to add a new lift to said tank-top surface.

While the flaps **7** must be spaced so as not to contact the rear braces **61**, the lower flaps do approximately contact one another and so prevent loss of air between them, thus giving maximum lift and air velocity under the flap tip for maximum entrainment of water and air. When the pressure beneath the ship operates against the flaps **60** and **7**, to force said flaps rearwardly, they obviously reduce the width of the channels **23** in the tail between the fuel tanks **6** and the remainder of the tail of the craft.

It is also important that the side sealing flaps **24** overlap as stated, to prevent leakage as far as possible. The axis of all bearings on each flap or plate **24** must lie in one common straight line, passing through the pivot point of the plate, and the other bearings must be attached to the underside or bottom of the hull nearer its centre line with braces extending to the points on the flaps requiring support. By the mounting of these flaps as shown, any leakage between them will not pass out laterally as waste or loss, but will be directed rearwards as part of the pressure flow, with advantage to propulsion instead.

In the use of the invention as an aircraft

carrier, to which it is admirably fitted, and so planned, if the tip of flaps **60** is on the waves, the cylinders holding the flaps **7** and **60** close to the surface of the wave crests, levels said crests and makes smoother water conditions for planes approaching from the rear for a landing or re-embarkation aboard; the leveling of the water at rear makes the air-pockets above of smaller magnitude, and the blast of air at the tail lifts a plane slightly when it is about to make too low a landing, thereby placing it safely upon the carrier deck. In the form shown in Figure 7, with the wings, it is adapted for either plane or carrier, skimming or flight.

I have shown sufficient means for assuring lateral and longitudinal stability with these wings, the front fin, the large rear fin **3** and rudder **4**, said fins being made of any size desired and supplemented by as many more as found useful; and the fuel tanks **6** being at the rear, may also be used for stabilization, as fully described in my co-pending application Serial No. 336,545, previously referred to. These fuel tanks, having pipes **30** therein, leading forward, can be emptied partially into any portion of the front of the craft to which in practice such pipes may have been led, thus distributing and transferring the weight of the fuel as described in my said application. Any other additional measures of stabilization in my several applications specified, or any other commonly known in the art, may be employed; and many other modifications, additions or alterations in details may also be made without departing from the essence of my invention.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent is:

1. An aircraft formed with a pressure chamber beneath its floor, an engine and a compressor fan mounted in the nose of the craft, a diffusion passage or portion in said chamber shaped to reduce or transform the velocity energy of the fan into high pressure energy, an entrainment nozzle at the leading edge directed into the path of the fan-air stream, opening into the pressure chamber, whereby the said entrained air will be mixed with the said fan-air stream, and power added to it by the compressor, means for sealing the front, sides and rear of the pressure chamber, and the said pressure chamber discharging in a propulsion jet at the tail of the craft ejecting the compressed air of the pressure chamber, and discharging under the rear sealing means to re-transform the high pressure energy into high velocity energy, to entrain the air from over the roof and tail down into the said tail-jet, and to entrain water, sand or other surface matter into the rearward propulsive current.

2. An aircraft formed with a pressure chamber beneath the same, an engine and a compressor fan mounted in said craft and delivering into the pressure chamber, means for transforming the velocity energy of the compressed air into high pressure energy, an entrainment nozzle beneath the fan, opening at rear into the pressure chamber, in the path of the fan stream, whereby air and water spray are entrained by said fan stream through the said entrainment nozzle and mixed with the same, the said pressure chamber discharging in a tail-jet at its rear, means at the tail for re-transforming the high pressure energy of the discharge into velocity energy, and also entrain the air from above the craft down the tail to said tail-jet, and to entrain water, sand or other surface matter into the rearward propulsive current.

3. In an aircraft the combination with an engine located in the nose of the craft, and a diffusively constructed pressure chamber, of a compressor fan mounted in relation to the engine to discharge compressed air over and around the exterior of said engine, having a conical hub and a circle of blades of which the tips extend in an annular discharge area beyond the housing of said engine, the said blades being separate and circumferentially parallel, with uniform projection at said circumference, and each blade being separately cambered, and longer at its leading edge than at its trailing edge; and the said pressure chamber discharging the compressed air therein, in a propulsive jet at the tail of the craft.

4. In an aircraft, the combination with an engine and compressor fan mounted beneath the leading edge of the craft, and a diffusively constructed pressure chamber into which said fan discharges, whereby velocity energy of the compressed air is measurably transformed into high pressure energy, of an air-foil pivotally mounted below the nose of the craft, of a shape and in a position to deflect downwardly and forwardly all water spray and head-on air, and also to form with the fan-casing an entrainment nozzle, of which the mouth is wide and forwardly flared, the throat contracted rearwardly, the pivoting of the air-foil being such that depression of its leading edge will widen its mouth, the exit of said entrainment nozzle lying in contact with the path of the fan-stream, to be entrained thereby through said nozzle into the pressure chamber and rearwardly to the tail, the said pressure chamber discharging the compressed air therein, in a propulsive jet at the tail of the craft.

5. An aircraft provided with a pressure chamber beneath the floor of the same, an engine and compressor fan in the nose thereof, means for transforming the velocity energy of the entering air measurably into high pressure energy in the pressure chamber, an entrainment orifice and nozzle below the engine to receive head-on air and water spray, to mingle with the air from the fan, said nozzle lying in the path of said fan stream whereby the blast from said fan entrains said air and water spray through the nozzle into the said fan-stream, the said pressure chamber discharging in a propulsive jet at the tail of the craft, and means whereby said tail-jet entrains the air from over the tail to said tail-jet, the roof of the craft and its tail being cambered and inclined, and provided with channels through which said air is entrained by the force of said tail-jet to a junction therewith, said tail-jet also entraining water, sand or other surface matter into the rear propulsive current.

6. In an aircraft, the combination with power-means for drawing air under the craft and retaining the same in sufficient constant volume and pressure to support the craft upon or above a surface, and at a greater air pressure than surrounding atmospheric pressure, and means for transforming measurably the velocity energy of the indrawn air to pressure energy, of means for re-transforming pressure energy to velocity energy at the tail of the craft, means for directing the overhead air to the location below the craft where the conversion of pressure to velocity energy has taken place, means for entraining said overhead air with the higher velocity converted air from the underneath propulsive stream, whereby simultaneously the entrainment of said

upper air will increase the lift upon the top surface of the craft, and add the mass of such entrained air to the weight of the propulsive air beneath by which it is entrained.

7. In an aircraft, the combination with power-means for drawing in air through the entrance nose, a pressure chamber for holding said air under the craft, said chamber being forced to diffuse the air and transform its velocity energy into pressure energy, and means for sealing said pressure chamber on all four sides against egress of said air while the craft is on a surface; of two sources of entrainment of air at front and rear of said craft respectively, the first source being means under entrainment by the leading edge power-means, whereby air and water spray are drawn into the pressure chamber with energy and velocity added to the same by such entrainment, the said pressure chamber discharging its compressed air in a propulsive jet at the tail of the craft, and the rear source being under entrainment by the said compressed air discharge or exit jet of the pressure chamber, and comprising means for drawing air down the tail from over the roof of the craft, and adding the same at a high velocity to the propulsive tail-exit jet.

8. In an aircraft provided with a pressure chamber beneath its floor, and an engine and compressor fan discharging air thereinto, the said pressure chamber discharging said air at its rear in an exit propulsive jet; means for sealing the sides of the craft and the said chamber, consisting of two series of plates or flaps hung from the hull, depending vertically to contact a surface beneath, pivoted to move upwardly on a perpendicular arc, and normally contacting the surface below, the sides of the said plates or flaps being opposed against the exit of pressure-air laterally from said pressure chamber, each series of said plates or flaps being mutually closely adjacent to form a complete lateral seal, and all being independently movable whereby various of said plates or flaps will rise with the crest of waves and fall into wave-troughs.

9. In an aircraft provided with a pressure chamber beneath its floor, and an engine and compressor fan both located at the front of the craft discharging air thereinto, the said pressure chamber discharging said air at its rear in an exit propulsive jet; means for sealing the sides of the pressure chamber against lateral egress of air therefrom, consisting of a series of depending flaps on each side of the hull hanging from pivots and dropping into contact with the water beneath, and rising and falling therewith to maintain a lateral enclosure of said pressure chamber, means for sealing the front of the pressure chamber consisting of flaps pivoted at top beneath the bow of the craft and depending therefrom, and normally closed to seal the said pressure chamber at front; and a flap or flaps at the rear end of said pressure chamber within the longitudinal dimensions of the craft, combining with the side sealing flaps to form a complete enclosure of the entire pressure chamber from the forward portion of the craft to said rear end of the pressure chamber, the said tail flaps being pivoted to swing upwardly within the said longitudinal dimensions of the craft, and downwardly, with the waves, and being normally forced out and rearwardly up, by the compressed air entering the pressure chamber at front and passing through the same to its tail.

10. An aircraft provided with a pressure chamber beneath its floor, an engine and compressor fan discharging air thereinto, the said pressure chamber discharging in a propulsive jet at the tail of the craft, means for sealing the sides of the pressure chamber against lateral egress of air therefrom, consisting of a series of depending plates or flaps on each side of the hull, means for sealing the front of the pressure chamber consisting of flaps pivoted at top beneath the bow of the craft and depending therefrom, a tail flap or flaps sealing the rear of the pressure chamber at the point of exit of the propulsive jet; and means connected with the side sealing flaps to hold them normally depressed upon and against the surface below the pressure chamber in addition to gravity, and means connected with both the front and rear flaps respectively, to hold them normally opposed against the pressure of the compressed air within the chamber.

11. An aircraft comprising a hollow shell or body formed with a roof having a rearward camber and inclined down at the tail to the surface on which the craft operates, having its floor connected at or near the top thereof to the roof at the leading edge, and formed with a flared nose and a large pressure chamber rearward thereof and connecting therewith, an engine and compressor fan mounted at or near the leading edge, the engine housing contributing to form said pressure chamber into a diffusion passage or portion at front behind the fan, and said fan discharging circumferentially over and around said housing, whereby velocity energy is transformed measurably into pressure energy by and in said diffusion passage and chamber, an exhaust for said engine passaged behind the fan and being compressed and mingled with the discharge from said fan, an orifice and nozzle being formed below the nose to admit air independently of the main air inlet to the fan, said nozzle discharging in the path of the fan-stream whereby air and water spray are entrained at high velocity through said nozzle and mingled with the air and exhaust; the said pressure chamber discharging its compressed air at the tail of the craft in a propulsive jet whereby the ejection of the contents of said chamber will form also a second source of entrainment at said tail, channels in the tail directing the air from over the roof and down the inclined tail surface to unite with and be entrained downwardly and rearwardly by and in the propulsive tail-jet.

12. An aircraft having a pressure chamber, an engine and a compressor fan delivering thereinto, all arranged and constructed to transform the air velocity energy into pressure energy; a source of air inlet to the fan direct; and two entrainment devices, one at front and one at rear, whereby the fan-stream entrains air independent thereof, the first entrainment device comprising a deflecting air-foil mounted at a distance beneath the nose of the plane, a separate inlet orifice and nozzle formed between said air-foil and the fan-casing, and the second entrainment device comprising channels in the tail, an inclined surface on said tail, and the pressure chamber discharging its contents at its rear in a propulsive jet ejected in the path of the air through the channels, to entrain the air coming down the tail from over its roof; all whereby the head-on air at front is utilized at high velocity added to the fan-direct-air, and whereby the tail-jet both adds water, and quantity of air from above to the jet, with increased power and lift and thrust.

13. An aircraft formed with a pressure chamber beneath its floor, commencing at the roof of

the craft, a hollow nose under said floor communicating therewith, and outwardly flared rearwardly, an engine and compressor fan mounted therein, the housing of said engine forming with the nose and floor a diffusion passage or portion in said pressure chamber, the fan being formed with a conical hub and a circle of blades each cambered and longer at the leading edge than at the trailing edge thereof, an entrainment orifice and nozzle formed at the leading edge beneath the main air inlet or nose entrance, a pivoted air-foil contributing to form said nozzle and adapted to widen its mouth, a flap or flaps pivoted below the air-foil, normally retracted, the said air-foil and flap forming a deflector means to direct head-on air and water spray under said flap, the said nozzle ejecting into the fan-stream whereby the fan stream entrains the air therethrough with high velocity and mingles it with the compressed air; the pressure chamber discharging its contents at the tail of the craft in a propulsive jet.

14. An aircraft formed with a pressure chamber beneath its floor, commencing at the roof of the craft, a hollow nose under said floor communicating therewith, said nose being outwardly flared, rearwardly, an engine and compressor fan mounted in said nose, the housing of said engine forming with the nose and the floor an annular diffusion passage around said housing, leading into said pressure chamber, the fan projecting beyond said housing circumferentially, and discharging around the same, whereby the velocity energy of the fan-stream of air is transformed measurably into high pressure energy, an exhaust opening from the engine into the diffusion passage and pressure chamber, an air-foil at the leading edge of the craft, under the nose, pivoted at its rear and top-cambered to form with the oppositely flared fan-casing a wide orifice and nozzle flared forwardly and narrowed rearwardly, and adapted to move down to widen the mouth of the orifice and nozzle, means for holding the air-foil in normally adjusted position, the said nozzle lying in the path of the fan-stream whereby head-on air and water spray are entrained thereby and forced into the pressure chamber, front flaps pivoted rearwardly of the air-foil and normally retracted, perpendicular sealing flaps on each side of the hull and vertically movable to contact the surface below the pressure chamber, and normally held down, rear flaps depending at the tail, and normally held closed, the pressure chamber discharging against the front of said rear flaps, in a propulsive jet transforming high pressure energy inside the chamber back into high velocity and propulsive thrust, and entraining air from over the craft-roof down the tail into said exit jet or current, the tail being formed with an inclined upper surface, and channels therein through which the air is entrained by said tail-jet.

15. An aircraft designed to operate above a land or water surface, comprising a body having a roof cambered at the forward portion and inclined down at the tail, and a bottom portion constructed to maintain an air pressure beneath the same, an opening at the nose, power means to draw air in through said opening, means forming another opening below said leading edge, means for entraining spray filled air through said lower opening by the same power means as at the nose, an adjustable device permitting increase of both entrance and throat of said lower opening, a sealing device below said entrainment opening, the lower part of said sealing device comprising flaps adjusted to move up and down over waves in the surface beneath, means to automatically control the pressure of the flaps on the surface below, adjustable flaps at the tail of the craft, and means to maintain these at a height above the water varying with the speed of the craft.

16. An aircraft provided with an engine and a compressor fan, a pressure chamber beneath said aircraft into which said fan delivers air, which said chamber diffuses said air and transforms its velocity energy into pressure energy, the pressure chamber discharging at the tail of the craft in a propulsive jet, a rear flap thereat, means for governing the rear flap in such manner that the distance between the tip of the flap and the surface below varies according to the depth of any depression in said surface.

17. An aircraft provided with an engine and a compressor fan, a pressure chamber beneath said aircraft into which said fan delivers air, which said chamber diffuses the air and transforms its velocity energy into pressure energy, the pressure chamber discharging at the tail of the craft in a propulsive jet, channels at the tail, a rear flap thereat, the under surface of the craft being downwardly and rearwardly curved to reduce pressure energy again to velocity energy, and fuel tanks at the rear of the craft provided with a rearwardly and upwardly curved under surface to entrain air from over the top of the tanks and also to measurably re-transform velocity energy to pressure energy by diffusion under said curved surface.

18. In an aircraft the combination with an engine located in the nose of the craft, and formed with a diffusively constructed pressure chamber, of a compressor fan mounted in front of said engine and discharging compressed air over and around the exterior of said engine, said fan having a conical hub and a circle of blades of which the tips extend in an annular discharge area beyond the housing of said engine, the said blades being separate and circumferentially parallel, with uniform projection thereof at said circumference, and each blade being separately cambered and each of the same being longer at its leading edge than at its trailing edge; the said pressure chamber being open beneath the bottom of the craft, to the water or other surface.

19. In an aircraft as set forth in claim 8, each said side plates being laterally inwardly located from another more forwardly located plate whereby any air escaping between said plates will escape in a rearward direction and thereby produce thrust forwardly.

20. In an aircraft as set forth in claim 8 the leading edge of each said plate extending downwardly and rearwardly in a gradually decreasing curve to approach a horizontal straight line, whereby as each side plate moves up and down over waves the said lower surfaces may practically conform with the top surface of said waves, whereby no considerable mass of air may escape laterally.

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