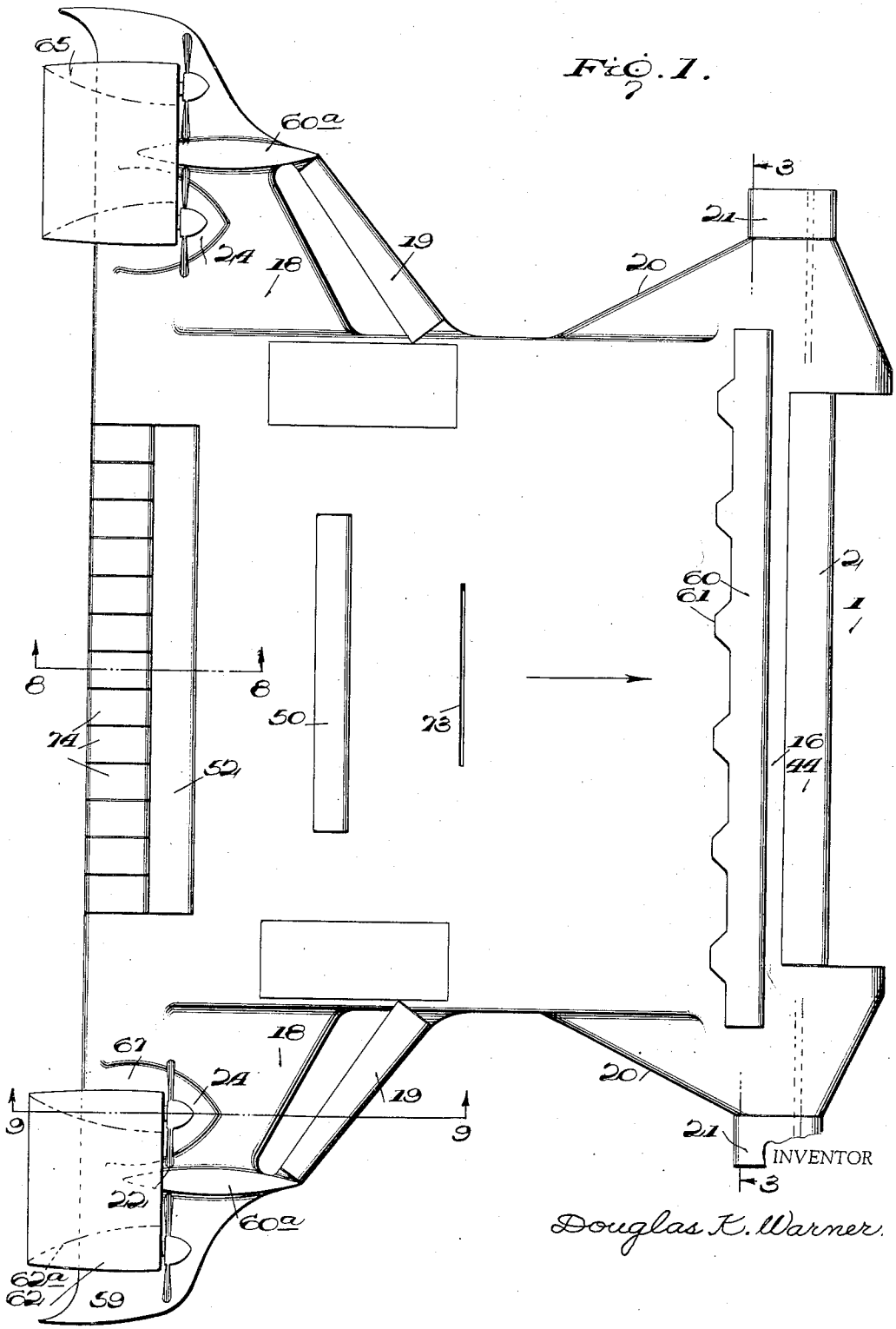
July 3, 1951 D. K. WARNER 2,559,036

STABILIZER FOR WIDE PRESSURE PLANES

Filed June 26, 1947 3 Sheets-Sheet 1

FIG. 1.



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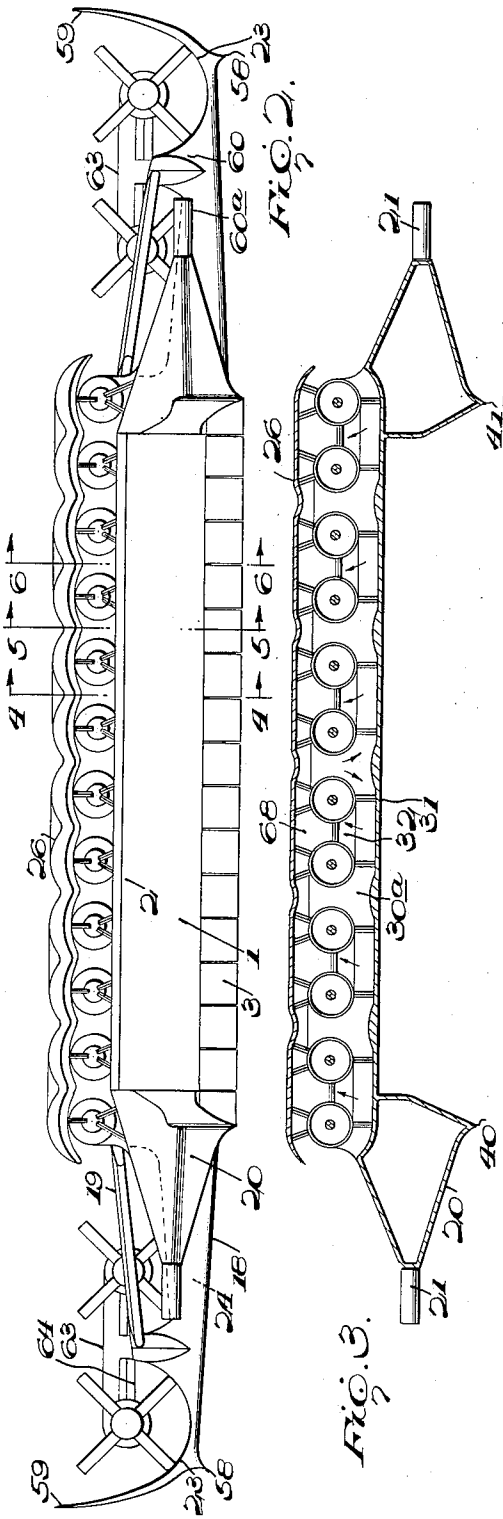


FIG. 2.

FIG. 3.

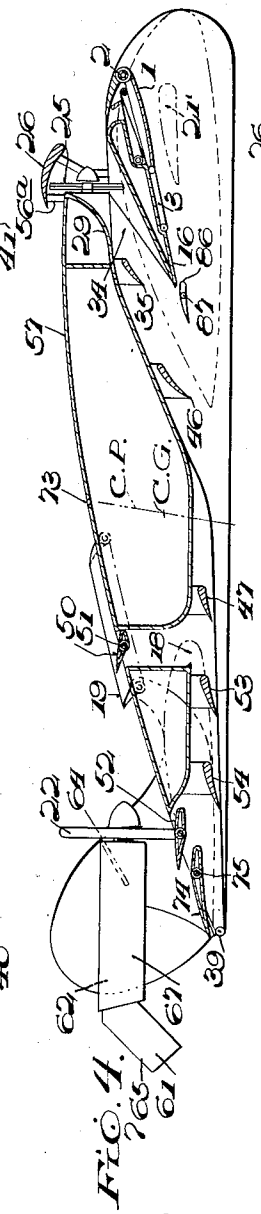


FIG. 4.

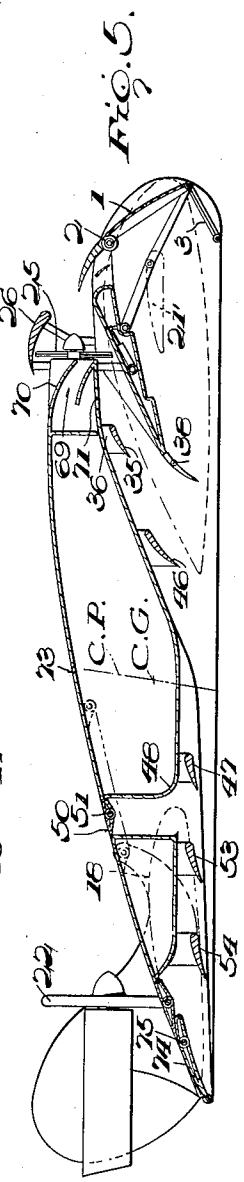


FIG. 5.

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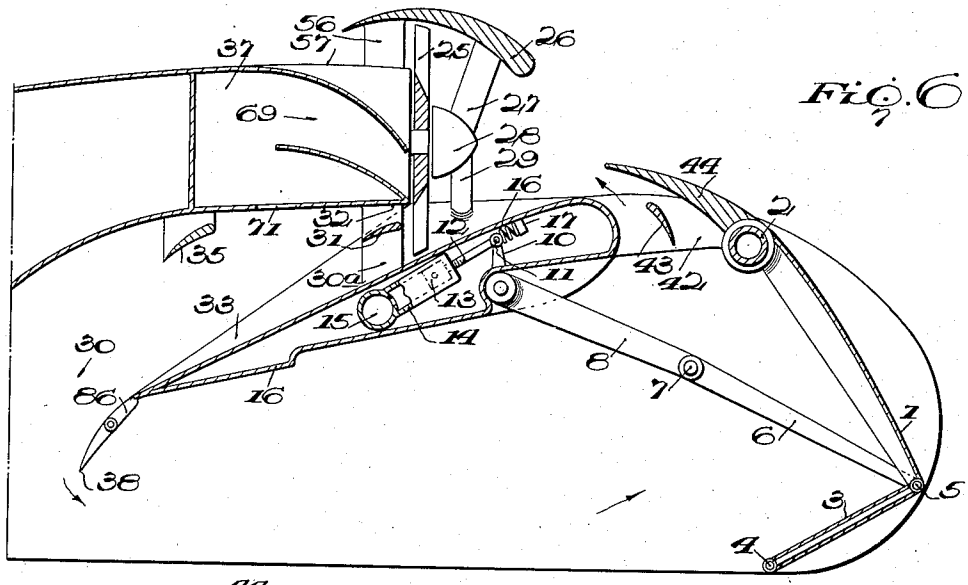


FIG. 6.

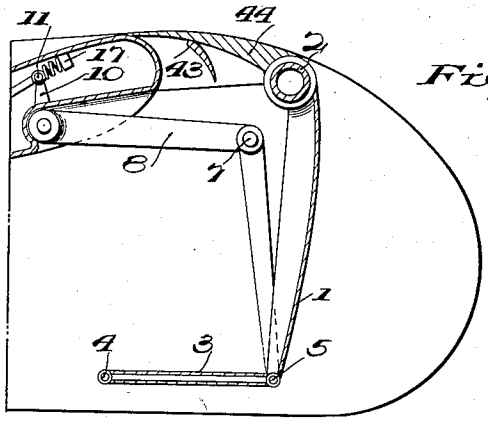


FIG. 7.

FIG. 9.

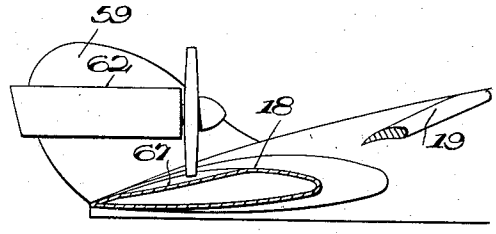
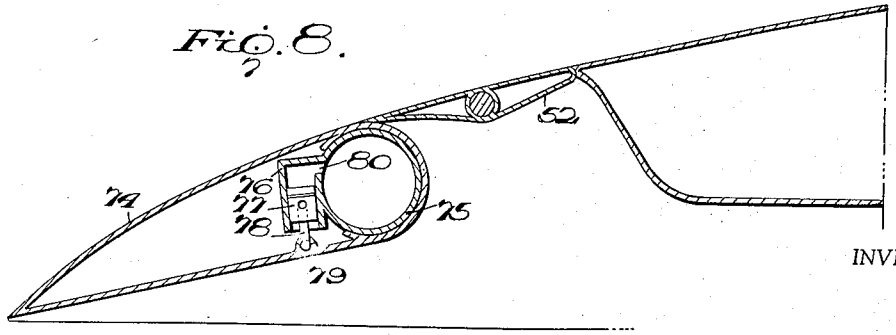


FIG. 8.



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2,559,036

UNITED STATES PATENT OFFICE

2,559,036

STABILIZER FOR WIDE PRESSURE PLANES

Douglas K. Warner, Sarasota, Fla.

Application June 26, 1947, Serial No. 757,081

8 Claims. (Cl. 244—15)

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The object of this invention is to provide means for establishing aerodynamic balance in pressure planes of any aspect ratio and to improve starting efficiency by reusing the velocity energy derived from expanding compressed air from beneath a plane, to not only give propulsion and suction lift over the top surface thereof after it has lifted the plane by pressure beneath the wing, but also to expend all the energy in the exhaust jet in aiding the plane's propulsion fans in compressing more air to higher pressures.

Heretofore the rear wing of the pressure plane has been relied upon to take enough load as a plane leaves a surface to balance the forward shift of center of pressure of the pressure supported central section of the plane as that CP moves from 59% of chord to 25% of chord.

As in a wide pressure plane the lift of the central, or pressure supported, portion of the plane is the major lift in high flight as well as while skimming, means such as are described herewith are essential to keep the center of pressure back at 59% of chord in high flight. This invention by giving as high air velocities over the rear portion of the wing as over the forward portion and by giving as low velocities and as high pressures under the rear portion of the wing as under the fore portion and by extending the wing area forwardly in skimming flight and by giving that forwardly located area a high lift from air pressure under the wing the center of pressure away from ground effect remains the same as when skimming and advantage can then be taken of the ability of the pressure plane to take off from any beach or shallow or deep bay with ten or more times conventional wing loading. It is therefore unnecessary to use a narrow central section with low induced drag efficiency in order to make it possible for the rear wings to stabilize the plane in flight.

The conventional propulsion jet during the average takeoff run has a propulsion efficiency of 5% if the average plane speed during that run is 50 M. P. H. and the jet speed 1000 M. P. H. When that jet is delivered over the leading edge of the plane at less than sonic speed and when it goes back into the fans which created it practically all of that usually lost 95% is recovered in addition to giving the plane during the entire takeoff run a pressure lift below the wing and a suction lift above it of more than ten times the lift that the conventional plane has at the end of the takeoff run.

Referring to the drawings:

Fig. 1 is a plan view of the top of the plane.

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Fig. 2 is a front view of plane. Fig. 3 is a cross section of plane through 3—3 of Fig. 1.

Fig. 4 is a side sectional view of plane thru 4—4 Fig. 2 as the plane appears in high flight, and Fig. 5 is a section on the opposite side of one of the propulsion fans of Fig. 2 at 5—5 showing the structure of craft behind upwardly moving fan blades. It will be noted that Fig. 5 is taken thru a section where the blades of the pressure fan are moving upwardly while Fig. 4 is a section where the blades are moving downwardly and where the flow correcting airfoil 31 of Fig. 5 is not required and a swept back passage 29 is provided instead. Fig. 6 is a sectional view thru 6—6 of Fig. 2. Fig. 7 shows the forward portion of Fig. 6 with front flap 1 in the act of folding back.

Fig. 8 is a side sectional view of rear central portion of plane thru 8—8 Fig. 1 showing rear flaps and adjustable slots. Fig. 9 is a cross sectional view at 9—9 of Fig. 1.

The fundamental principle of the pressure plane has been described in Patents 2,362,578, 2,387,627, 2,364,676, 2,364,677, 2,390,859 as a means of continued flight close to the sea supported principally by air compressed beneath the plane or as a means of take off with loads which could never be carried on landing gears or flying boat hulls. Flight is preferably started from a field or beach or shallow water swamp and, for added length of run, finished over a bay or lake at a speed which makes depth of water unimportant. If start must be made from deep water the loading is restricted primarily because of the wave action set up by blowing the water down and plane up.

Because the pressure plane can take off safely with wing loadings of 1000 pounds per sq. ft. it can fly economically near sea level at 600 miles per hr. or 78% the speed of sound while other planes which must take off at 100 M. P. H have their maximum flight efficiency at 150 M. P. H. and at 600 M. P. H. near sea level must operate with a higher profile drag than if they carried sixteen times the gross load which means that they must have more than 16 times the power they would have needed had they been able to take off as the pressure plane does. The wide pressure plane does not have the disadvantageous hump characteristic of the earlier narrow pressure planes and conventional flying boat hulls, this being due primarily to greater width and to the reduction in the induced drag coefficient to 1½% that of conventional high flying airfoils.

In Fig. 1 it may be seen that the central section of the plane shown is substantially square in plan form and has rear stabilizing wings 18 preceded by auxiliary airfoils 19 above and ahead of 18 to prevent the latter wings from stalling at 45 degree attack angles. The front stabilizers 20 are fitted with pivoted elevons 21 for climb or bank.

Fig. 2 shows the high dihedral angle of the front stabilizers 20 and the elevons 21 high enough to be away from wave contact at start of take-off run, and it also shows the main rear wings, 18, far behind the front stabilizers and set at an attack angle of only about 1° as compared with the much higher angle of the front stabilizers as explained in Patent 2,462,578 of Feb. 22, 1949 and in my Patent 2,418,380.

Fig. 3 is a thin cross section at 3—3 of Fig. 1 showing the front stabilizers and the air passage arrangements back of the propulsion fans. Behind the down moving fan blades of Fig. 4 is the enlarging air passage 29 shown by dotted lines in Fig. 6, and behind the upmoving blades in Figs. 5 and 6 is seen cambered airfoil 31 deflecting the air (which those blades have thrown upwardly) back down again, and there also is seen the diffusing passage 69 taking part of that upmoving air and compressing it in the engine compartment 37 by diffusion in 69. In Fig. 6 also we can se the diffusion that takes place in passage 30 which creates a high air pressure beneath the airplane and since this air can not escape under runners 40 and 41 or under front double hinged flaps 1 and 3 or rear flaps 74 it must be all directed rearwardly at the leading edge of the plane in passage 42 under deflector 44 as seen in Fig. 6 because at that time the airfoils 59 and 52 are closed blocking passage of air out of the 4 rear slots which they create when opened as in the flight positions of Fig. 4. This air leaving passage 42 at extreme velocity over airfoil 16 gives a high suction lift over this front part of the wing before the craft starts to move and this air with still high residual velocity enters fan 25 and part of the air is then blown (without any loss in that energy but instead with a gain in fan efficiency by preventing stall of fan blades) under the plane again, and part is blown out slot 56*a* to create more lift over the top of the plane further rearward, and to give forward thrust. Since part of the air which would normally go up out of slot 56 is caught and deflected down by airfoil 31 and since more is entrapped in diffuser 69, for use in the engine which as shown in previous patents exhausts into the compressed air below the plane, most of the air goes into the pressure chamber below after being compressed by diffusing in passages 89 and 39, and then is returned with very little energy loss to the propulsion fans again.

The main front flap 1 is hinged or swung on leading edge tube 2 and the several flaps 3 shown divided in many small units in Fig. 2 are hinged at lower end 5 of flap 1 in a trailing position. A light tubular rubber covered roller 4 is mounted in the lower end of each of flaps 3 to reduce wear while moving over pavement.

These flaps 1 and 3 are held from being blown forward by arm 6 which at one end is hinged at hinge 5, connecting flaps 1 and 3, and at its opposite end 7 is hinged at the end of arm 8 whose opposite end is keyed to or locked on shaft 9 which is turned by arm 10 mounted thereon.

Crank arm 10 is pivoted to connecting rod 12 at bearing 11 which is pushed forward by piston 13 by compressed air in cylinders 14 fed by transverse pipe 15 which extends inside airfoil 16 the full span of the pressure chamber.

The spring 17 stops crank arm 10 from turning enough to permit arms 6 and 8 from forming a straight line to hinge 5 so that in the event that a wave hit flap 1 it would be free to push back and compress the air in pipe 15. If the rear flaps 74 are raised and the rear slots opened at 50 and 52 and the pressure released from pipe 15 flap 1 will be blown back by the air velocity due to plane speed reacting against the front thereof after the air pressure below the plane has been diminished by the escape of air under flap 74 and out the 4 rear slots.

Fig. 7 shows flap 1 being blown back as arms 6 and 8 fold at 7 and when they are blown fully back flaps 1 and 3 form part of the lower surface of the airfoil 16, as shown in Fig. 4, a recess having been left in the lower portion of 16 to house these flaps. At the same time deflector 44 is closed by conventional means not shown. Now the air speed over 16 is maintained by the forward motion of the plane with the blunt leading edge 2 displacing air and by the suction created by fans 25. With flaps down, in the early part of the take-off run, the baffle 43 helps turn the air rearwardly keeping it close to the top of 16.

To maintain high yaw stability even before the plane starts to move ahead, the tips 59 of the rear wings 18 are bent up around the path of the tips of propeller blades 22 forming a trough 23 with the outer wall of wing cabin 60, and the inner wall of wing cabin, 60*a*, forms an arc about inner propellers 22*a* thus providing 3 upright surfaces at the rear outermost extremities of the plane over which air moves with the speed at which it leaves the propeller tips and, since these propellers are chordwise central of the trough in which they turn, they give twice the lift of trough type wings where the propellers are at the rear of the trough as shown by Matta in 1915 and tested by the Air Forces in 1948.

The propellers are driven by engines not shown, mounted in depended wing tip nacelles 62 below the tips of stub wings 63 which in turn are mounted atop of housings 60. The blades turn upwardly in front of these stub wings increasing the lift thereof because they are close to it as they could not efficiently be close if the down moving blades also passed in front of the wing.

Behind the upmoving propeller blades and below stub wings 63 are cambered airfoils 64 set at higher attack angle than 63 and extending between nacelles 62 and cabin walls 60. These deflect some of the upwardly moving air from the propeller blades back down over the wing below to help increase the velocity there, but by diffusion also decrease the air velocity below the stub wings 63 to give high pressure beneath them and this pressure is further increased by the outwardly sloping wall 62*a* of nacelle 62 and the oppositely sloping wall 61 of cabin 60 thus entirely enclosing the air passing between 63 and 64 with 4 walls all tapered to diffuse the air and increase its pressure under wing 63.

Tests at Langley Field tow basin showed that thus increasing the pressure under an airfoil behind upmoving propeller blades greatly increased plane efficiency.

Under the rear of stub wing 63 is flap 65 having end plates 66 extending down as low as the bottom of nacelles 62. Slots are formed in the nacelles' rear portion to receive flap 65 and its end plate. If an engine stops or if additional rear lift is needed these flaps 65 are moved back and down

by conventional means not shown as taught by Fowler. This gives a very great lift half the plane length rearward of the center of gravity. When the plane is landing at a 45° attack angle with the propellers turning at maximum speed these lowered flaps make the propeller blast go straight down as in a helicopter after first giving a high wing lift and increasing the drag to slow the plane.

The pilot wings 19 are also swivelled with the leading edge down 30° when the plane is landing at this high attack angle. The air in front of wings 18 unable because of the ground to go under those wings is caught by pilot wing 19 and deflected down over the top of 18 so that with the aid of the propellers 18 does not stall but gives enormous lift and drag to make the landing safer when the trailing edge hits the water. On the other hand the front stabilizers 20 now stall even tho the elevons at their tips may be turned down enough to prevent their stalling and to let them still be effective. The stall of the front stabilizer prevents the wing from flopping back over. The conventional flying wing as it lands finds the CP moved suddenly back due to ground effect and is apt to nose into the ground but that can not happen here as the C. G. is way back.

Referring to Fig. 6 we see how air enters fan 25 over stationary spinner 28 under cowling 26 and past vanes 29 connecting 28 with locations in the top surface of 16 at each side of each trough formed therein to let air smoothly approach the fan tip circles. In the NACA model one fan was placed forward of its neighbor so that the blades could overlap and thereby get more power in a given space. Air from downwardly moving fan blades pass thru passages 69 under dotted line in Fig. 6 said passages having a gradually increasing cross-sectional area rearwardly. Air from upwardly moving fan blades passes vertical vanes 30*a* and horizontal vanes 31 therebetween and continues thru diffusing passage 30 under floor 32 of engine room 37. Vanes 31 and vanes 35 further back in passage 40 are cambered and set at high attack angles so that air below them will be deflected at higher velocity below to increase the lift over 16 and to increase the pressure by reducing the velocity under surface 32 and similar action is found at diffusers 46, 47, 53 and 54.

When starting the plane, diffusing passage 30 is lengthened by airfoil 87 with its leading portion 86 tipped up and trailing edge down to form a continuation of 16. Compressed air then passes forwardly under 38 to slot passage 42 to return the air to the fans.

In Fig. 8 the trailing flap 74 is enlarged together with airfoil 52. Flap 74 swivels on compressed air tube 75 and is pressed down by pin 79 mounted in the lower end of connecting rod 78 which is pinned in piston 77 in cylinder 76 to which compressed air is delivered thru port 80 in tube 75.

As in the case of flaps 3 the rear flap 74 is divided in many units as shown in Fig. 1 in order that each may ride separately over the wave beneath.

Airfoil 52 like 50 is swiveled down in high flight as shown in Fig. 8 to form two slots directing air rearwardly at high velocity over the top surface. To reach the slots formed by vane 50 when it is swiveled clockwise at 51 air passes up the passage behind diffuser 49.

The cambered airfoils 53 and 54 are approximately at the lower surface of wing 18 where the spars are located. These air-foils carry the tension in the bottom surface over to that in the opposite wing while the compressive stress is carried across thru the body of the plane.

The laterally disposed rear wings 18 have little lift compared to that of the pressure chamber while skimming but considerable in flight compared therewith and since its attack angle is less than that of the central portion as in all previous pressure planes its lift becomes proportionally larger as attack angle increases stabilizing the plane in pitching moment.

Behind the top of fan blades 25 are airflow straightening vanes 56 tieing fan cowling 26 to top surface 57 of plane. Over the upward moving fan blades the cowling 26 is extended further rearward as shown at 61 Fig. 1 in order to deflect down and rearwardly the up driving air. The blast rearward is relatively more intense at slow speeds and since the blast is mostly over the fore part of the top surface it helps in keeping the C. P. forward at that time.

The down curved runners 40 and 41 cause the air to move downwardly as it rushes sidewise to escape under the runners but the lateral air velocity is insignificant compared to that under a wing without runners so the induced drag is much lower as was indicated in the NACA tests.

After takeoff part of the air compressed in diffuser 69 is jetted out of slot 73 to increase rear lift on top surface.

Exhaust from the engines is delivered from nozzles 71 beneath the plane to augment the energy of air compressed there. In high flight it may be carried in pipes not shown back to slot 73 to augment the blast above the top surface.

Such large craft as are made possible by wing loadings of 1000 pounds per sq. ft. must have large concentrations of power even though the power required per pound carried is only 1% that normally required. Fans permit this power concentration when spread across the full span and the power may be even greater by overlapping fans with every other one ahead of its neighbor and of course turning oppositely to its neighbor to prevent sonic disturbances where blades overlap. To gain the full advantage of pressure principle loads of 50,000 tons should be flown.

I claim:

1. In an airplane, a main airfoil extending the approximate full length of said plane and runners depended from the sides thereof, and flaps flexibly depended from approximately the leading and trailing edges thereof, a rearwardly directed slot at the leading edge of said plane communicating with the space directly behind said front flap and all space beneath said plane, fans rearward of said slot and spaced therefrom and top lifting surface located therebetween, a passage of rearwardly increasing cross-sectional area communicating between said fans and the space beneath said airplane, rearwardly directed slots in the top rear surface of said plane communicating with the space beneath and airfoils pivotally mounted and independently operated in the top surface of said plane forming said slots to close the front and open the rear slots as the plane lifts away from a surface, thereby releasing the pressure of air previously trapped therebeneath, and rearwardly located wings extended from the runners of said plane, outwardly, upwardly to form a dihedral angle for lateral stability, pilot wings pivotally mounted forwardly and above said rear wings of approximately 18%

the main lateral wing's chord, and a like distance above and ahead of said wings, and smaller airfoil stabilizers extended from the forward portions of said runners set at higher attack angles than said rear wings and designed to stall before the main wing and rear wing can stall.

2. In an airplane as described in claim 1, airfoils pivoted at their approximate ¼ chord point from the leading edge at the tips of said forwardly located stabilizer airfoils, said first airfoils normally held at zero attack angle but deflected downward on one side to tip that side down and drag it back for the purpose of bank and turn, and operated together upwards or downwards to climb or descend, and pairs of propellers mounted above each rear wing, and housing erected on said rear wings between said propellers with sides conforming to the lower arc of the tip circle of said propellers, stub wings above said housing with downturned tips, rear wing tips bent up around the outer propeller circle and continued upwardly outwardly to the approximate height of the propeller circle, nacelles extending rearwardly straight in a gradually flattening vertical side on the side furthest from said housing and sloping rearwardly outwardly on the sides next the housing and the housing itself converging rapidly to a trailing, vertical, backwardly, downwardly sloping edge, an extendible and downwardly, rearwardly, sloping flap having endplates extended down from its tips.

3. An aircraft comprising an airfoil having approximately straight leading edge and an approximately rectangular plan form, runners depended from lateral extremities of said airfoil, flaps depended from forward and rearward extremities of said aircraft whereby a chamber is formed beneath said airfoil which is open below except as it may be closed by ground or water surface beneath said airfoil, fans within said airfoil and passages leading forwardly from said fans to above said airfoil and passages leading rearwardly from said fans to beneath said airfoil whereby air is drawn from above and discharged beneath said airfoil, an air deflecting member connected to said forwardly depended flap at its upper extremity and supported on said aircraft with said flap at said forward extremity and between said runners and said deflecting member at its uppermost extremity extended above said leading edge of said airfoil whereby air blown under said airfoil by said fans when said aircraft is on ground or water may move forwardlly beneath said airfoil and upwardly in front of the leading edge thereof and be deflected back over the upper surface of said airfoil by said deflecting member at high velocity to said passages leading forwardly from said fans whereby a lift is derived from the air pressure beneath said airfoil and from a high air velocity over the top surface of said airfoil resulting from the release of said air pressure under the upper extremity of said deflecting member and whereby the residual velocity energy of said air released over said leading edge is recaptured by said fans with resulting increase in fan efficiency.

4. The aircraft of claim 3 including a pivoted airfoil below said main airfoil which when in a steeply inclined position forms an extension of the lower surface of the said passages leading rearwardly from said fans and means for turning said airfoil to horizontal position.

5. An aircraft as claimed in claim 3 including means forming rearwardly directed slots in the

rear top surface of said airfoil, passageways extending downwardly from said slots thru said airfoil and communicating with the space below said airfoil, adjustable means in said slot passageways whereby slots over the rear portion of said airfoil may be closed when close to a surface and when air from beneath is being deflected back over said leading edge, and whereby said rear slots may be opened and said front flaps be retracted to form the lower forward surface of said airfoil and said deflecting member also retracted to form part of the forward surface of said airfoil.

6. The aircraft of claim 3 said front flap pivotally depended adjacent the leading edge of said airfoil, jointed control arms pivotally mounted at the lower extremity of said flap and in said airfoil, a crank arm connected with said control arm and pivotally mounted in said airfoil and means for turning said crank arm whereby one control arm rigidly connected with said crank arm causes said flap to move from a position adjacent to and forming the bottom of said airfoil to a depended position by means of its jointed connection with said other control arm.

7. The aircraft of claim 3, a diffusing, rearwardly expanding passage sloped downwardly, rearwardly comprising said passages leading rearwardly, airfoils positioned in said passages rearward of said fans and spaced adjacent the upper wall surfaces of said passages, said airfoils being cambered and having their leading edges nearer the upper wall of said passages than the trailing edges of said airfoils whereby air moving thru said passages is slowed down adjacent the upper wall thereof and the pressure thereunder thereby increased and wall friction decreased and whereby the air velocity over the lower wall of said passages is increased with further increase in lift for said aircraft.

8. The aircraft of claim 3 said passages leading forwardly from said fans having gradually decreasing cross-sectional area forwardly, air from above said craft entrained in the said high velocity air leaving said deflecting member and said entrained air and the recirculated air both diffused in said passages leading to said fans and the pressure thereof thereby increased before reaching said fans.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,696,404	Kluse	Dec. 25, 1928
1,731,666	Jackson	Oct. 15, 1929
1,801,356	Loveland	Apr. 21, 1931
1,990,308	Phillips	Feb. 5, 1935
2,254,485	Irwin	Sept. 2, 1941
2,364,676	Warner	Dec. 12, 1944
2,364,677	Warner	Dec. 12, 1944
2,375,265	Wagner	May 8, 1945
2,387,627	Warner	Oct. 23, 1945
2,390,859	Warner	Dec. 11, 1945
2,418,380	Warner	Apr. 1, 1947

FOREIGN PATENTS

Number	Country	Date
686,936	France	Apr. 21, 1930
49,917	France	June 6, 1939

(Addition to 796,140)