

Jan. 1, 1935.

J. J. LERAY

1,986,064

AMPHIBIAN AIRSHIP

Filed May 15, 1934

5 Sheets-Sheet 1

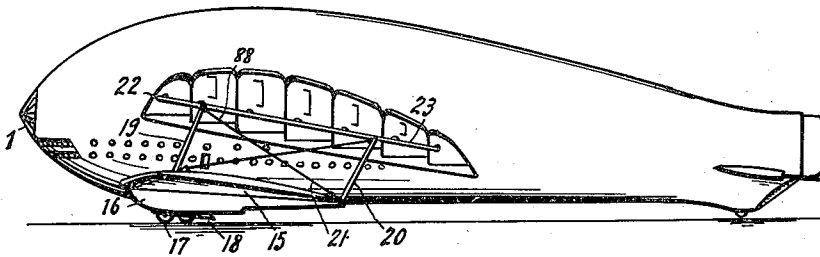


Fig. 1

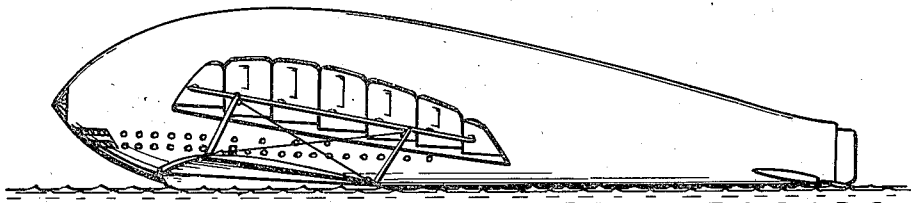


Fig. 2

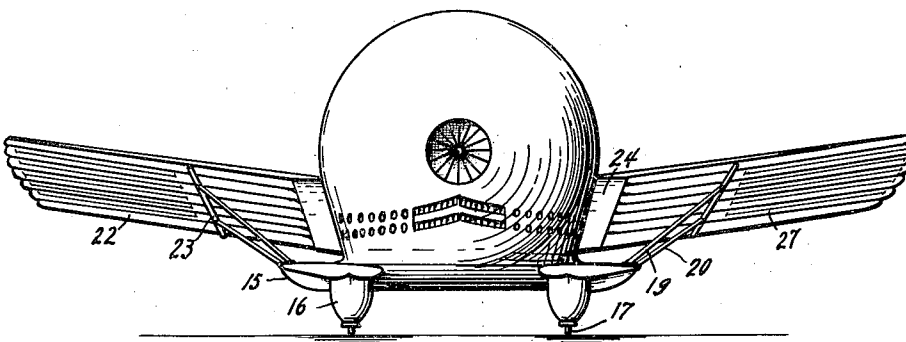


Fig. 3

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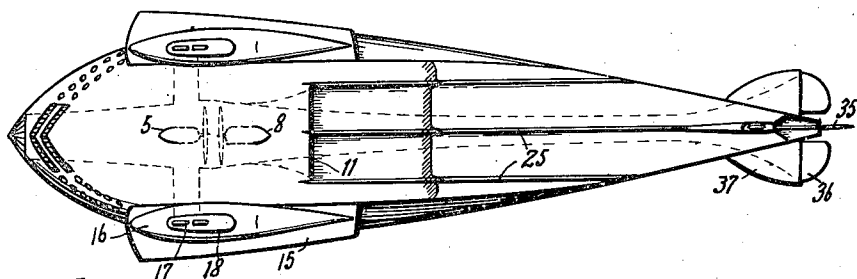


Fig. 4

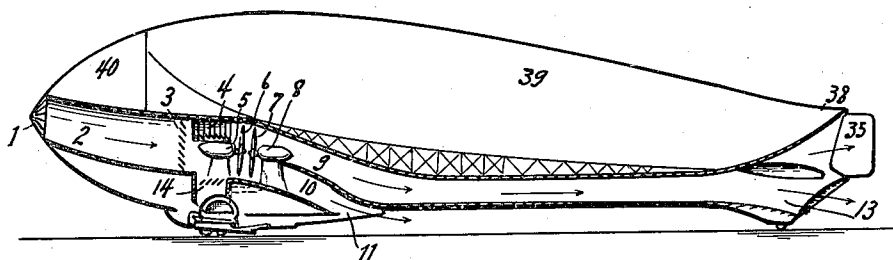


Fig. 5

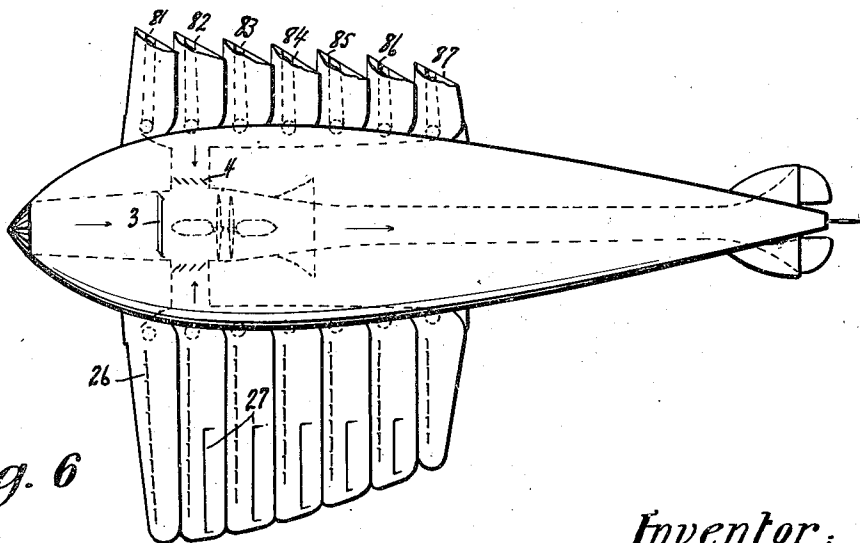


Fig. 6

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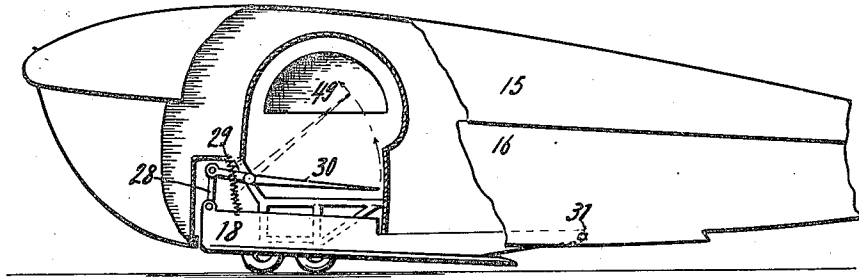


Fig. 7

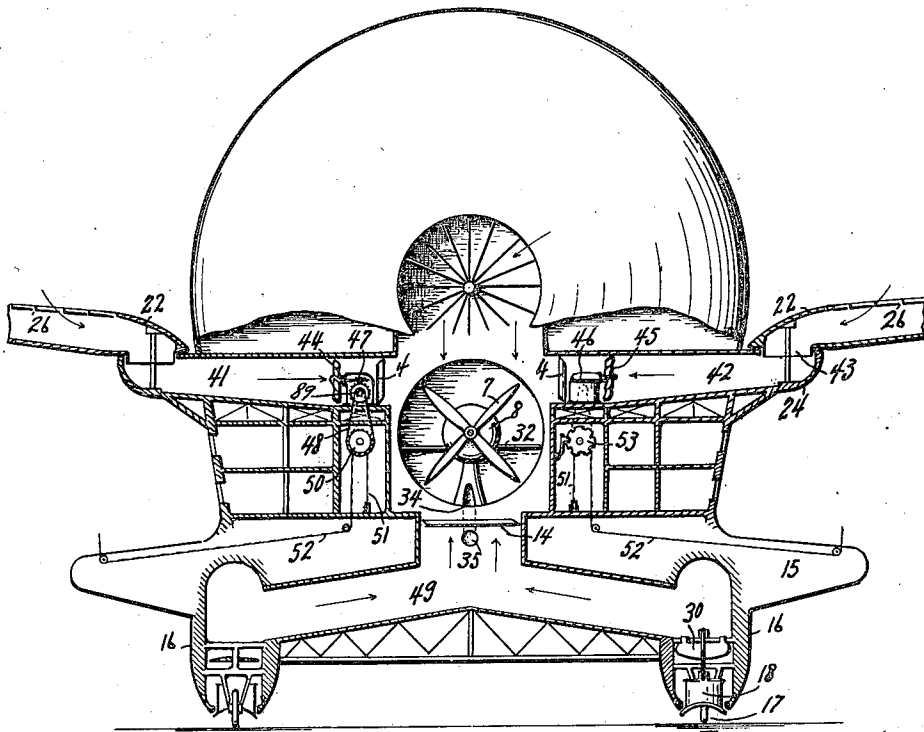


Fig. 8

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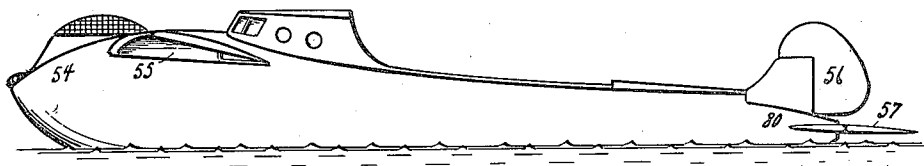


Fig. 9

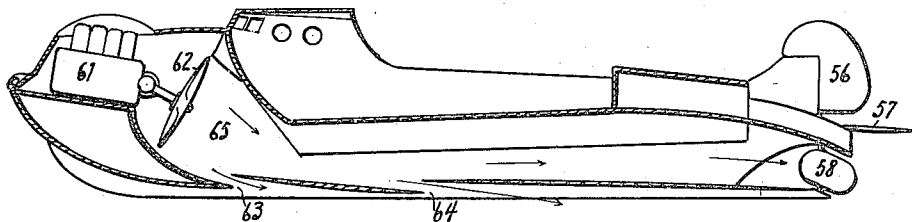


Fig. 10

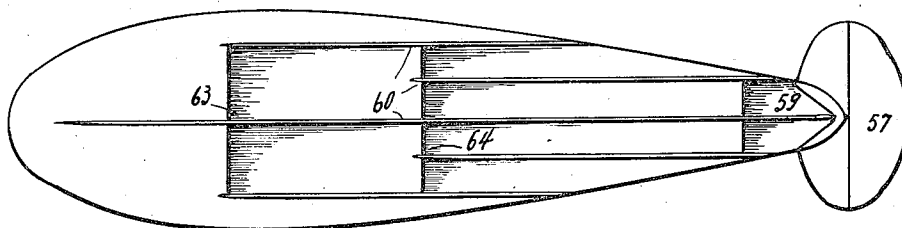


Fig. 11

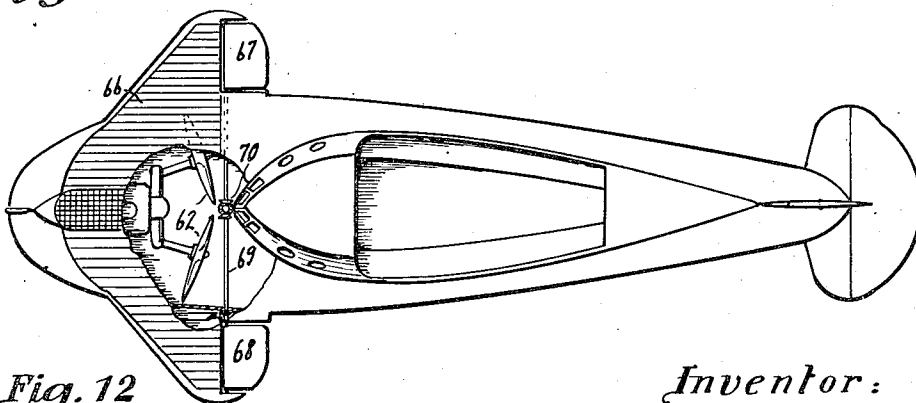


Fig. 12

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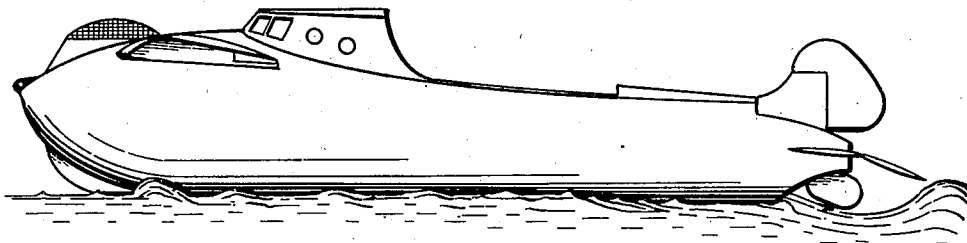


Fig. 13

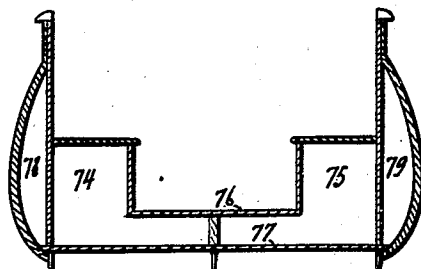


Fig. 14

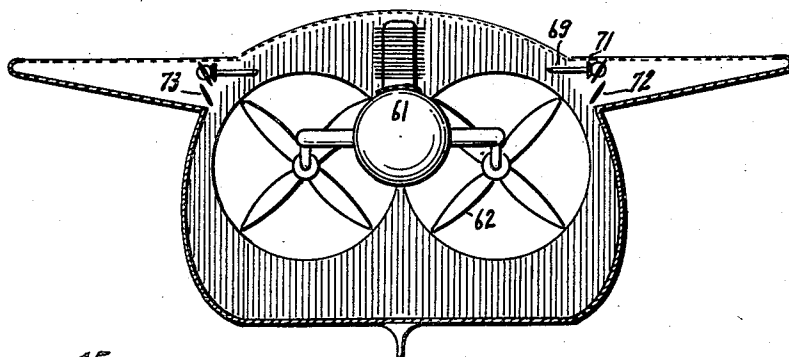


Fig. 15

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UNITED STATES PATENT OFFICE

1,986,064

AMPHIBIAN AIRSHIP

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Application May 15, 1934, Serial No. 725,757

3 Claims. (Cl. 244—5)

The invention relates to improvements and developments in amphibian airships, which have also application in racing boats,

First,—by providing means to drive airships or boats with air propellers completely enclosed inside the craft.

Second,—by using slipstream pressure against water resistance, in lieu of water propellers to drive the airship or boat.

Third,—by eliminating water friction on the craft, by interposing an airstream between the bottom and the water.

Fourth,—By improving the stability and controllability, by locating the propellers and motors at about the center of gravity, and having said propellers positioned in close tandem rotating in opposite direction one to the other.

Fifth,—by making the propellers accomplish a double function: being the usual driving means and being besides a pumping device in the production of internal suction.

Sixth,—by improved vacuum cups working automatically in braking and anchoring airships on land.

Seventh,—by increasing the force and reliability of the control with the slipstream of the propellers.

Eighth,—by improving a folding wing of the multi-airfoil type having internal suction applied.

Ninth,—by improving the working conditions of the propellers by maintaining a nearly constant velocity of the relative wind coming to the blades, whatever is the speed of the airship or boat.

Tenth,—by an automatic system to fold and vary the setting of the wing to better the flight conditions of an airship.

The purpose of the present invention is chiefly to develop high speed airships combining and condensing in one aircraft most of the special features found in zeppelins, blimps, and airplanes, with added new features, also partly applicable to water crafts, like racing boats.

Those new features consist in removing the propulsing means, air propellers and power plants, from the exterior and locating them interiorly at about the center of gravity. The center location is far more convenient, requires a great deal less structural parts and removes nearly all undesirable reactions from the power, like the torque. The power plant and propellers are installed in a tunnel formed by the structure of the airship, extending longitudinally from the nose to the tail, said tunnel being of sufficient size

to bring the necessary air to the propellers to produce a strong slipstream.

The airship is designed to land itself on the ground and water, new means are provided from the slipstream to propel the airship on the water surface with little power; new automatic vacuum cups will efficiently brake and anchor the airship on land.

To afford the airship to cruise efficiently on water surface, the slipstream is discharged partly from the tunnel under the bottom of the airship into the water, and partly discharged at the tail some above and some under the water surface, the rudder and elevators being inside the slipstream, thus it is obvious that the water resistance is used to harness the energy of the slipstream, not only the air column will bear on a greater surface of water than the usual water propeller, but will maintain an efficient pressure at a far greater speed, which is particularly valuable for racing boats; of course at high speed the airship will not remain on the water surface, it will fly.

The absence of exterior propellers rotating under the airship or boat makes a marked advantage to ride on shallow water or over seaweed or other marine vegetation.

The discharged slipstream into the water builds an up pressure which raises the craft from the water, and maintains a continuous air layer between the bottom and the water, whereof at high speed the craft rides mostly on air instead of water; as the air resistance is small compared to the water resistance, the craft if a boat could easily attain a speed comparable to aircrafts in the range approximating 100 miles an hour.

Internal suction is applied to the airship on a large scale and is obtained from the propellers without other special pumping device, the indraught making the suction while the normal thrust is obtained in the usual manner by the imparted sternward momentum given to the air by the propellers. It is to be noted that the aerodynamic conditions in which the propellers work are different from those working in free air. From theory confirmed by experiments we know that for a propeller operating in free air, static condition, the velocity of the indraught is only half the velocity of the corresponding slipstream, or if the velocity of the slipstream is represented by v , the corresponding velocity of the indraught will be $v/2$; however the volume or quantity of air entering the propeller disk remains equal at all times to the volume discharged through the slipstream, if the velocity differs it is neces-

sarily because the sectional area on which they move differs. It is obvious that the indraught moves toward the propeller by pressure reaction from the air environing and that said reaction comes from all directions not affected by the slipstream or the displacement of the aircraft, while the air discharged by the propeller or slipstream moves in a compact column of a sectional area approximately 0.9 the propeller disk retaining a uniform velocity till it expends. In other words the distance in front of the propeller where the measured velocity is $v/2$ represents a column of air approaching the propeller having an area twice the area of the corresponding slipstream or nearly so, without being rigorous this statement is sufficiently accurate for the explanation given here.

In the present invention the propellers are not fed in free air, the area in front is restricted and limited by the tunnel and if the sectional area of the inlet approaches the sectional area of the outlet, the velocity of the indraught will approach the velocity of the slipstream and the ratio maintained independently of the speed of the aircraft; in such conditions the propeller or propellers could be designed to give the maximum efficiency whatever is the speed of advance, then variation in the pitch of the propeller becomes unnecessary, which is an improvement over the normal condition of propellers operating in free air which requires the use of variable pitch propellers for fair efficiency at low speed.

The invention is illustrated in the accompanying drawings in which

Fig. 1 is a profile view of an amphibian airship at rest on land.

Fig. 2 is the same airship at rest on water.

Fig. 3 is a front view of the same amphibian airship with the tail raised a little to decrease the profile view of the wing on the drawing.

Fig. 4 is a plan view of the bottom of the same airship.

Fig. 5 is a longitudinal view in section showing the inside tunnel.

Fig. 6 is a view from above, part of the wing being omitted.

Fig. 7 is a detailed view of the float, showing the construction of the vacuum cup.

Fig. 8 is a cross section at the center of the airship.

Fig. 9 is a profile view of a racing boat at rest.

Fig. 10 is a longitudinal section of the same racing boat shown on Fig. 9.

Fig. 11 is a bottom view of the same boat.

Fig. 12 is a plan view of the same boat, with a cut showing the location of the motor and propellers.

Fig. 13 is another profile view of the same boat raised from the water when racing.

Fig. 14 is a sectional view across the center.

Fig. 15 is a cross sectional view of the racing boat at the motor location.

The invention is fully illustrated by an amphibian airship shown on Figs. 1 to 8. The lower part is of a rigid structure type and forms a large tunnel beginning at the nose, 1, and ending at the tail, 38, Fig. 5. The upper part is mostly of fabric forming a bag or gas container, 39, protected at the nose by a rigid bustle, 40, which maintains a proper streamlined contour under the strain imposed by the drag at high speed. The tunnel is enlarged some in front of the propellers where connections are made with the several conduits, 41, 42, 49, Fig. 8, communicating respectively with the wing, 22, and the floats, 16.

The power plant, 5 and 8, Fig. 5, and propellers, 6 and 7, are installed inside the tunnel at about the center of gravity, the power plant being in two units, 5 and 8, each composed of several motors geared to a common shaft. The front unit, 5, drives a pusher propeller, 6, and the rear unit, 8, drives a tractor propeller, 7; the two propellers being placed in close tandem and rotating in opposite direction one to the other. Beginning at a short distance past the propellers the tunnel is divided in two; one branch, 10, leading out a part of the slipstream under the airship thru a large slot-like opening, 11, made in the bottom, the other branch, 9, of the tunnel extending up to the tail, releasing thereout the remaining part of the slipstream thru large slots made in the trailing edge of the vertical fin, 38, and the horizontal fins, 37, and an orifice, 13, ending the tunnel below the control surfaces, all and each in suitable dimensions sufficient to exhaust properly the slipstream.

The rudders, 35, and elevators, 36, are mounted respectively in the slots of the vertical and horizontal fins lying inside the slipstream in a balanced manner.

The tunnel is connected from the sides to air conduits, 41, and 42, Fig. 8, communicating interiorly to each airfoil of the wing, 22, and having suitable registers, 4, one on each side operating with the normal control in lieu of ailerons to assist the airship to bank in making turns, by unbalancing the lift on the wing shifting the suction from one side to the other. The tunnel is also connected at the bottom to another conduit, 49, built-in with the structure which branches to each float, 16, and establishes communication with sucking cups, 18, installed strongly at the bottom of said floats with hinges at the rear, 31, Fig. 7, and a strong articulated joint, 28, at the front having a large baffle-surface, 30, laid across the air conduit which is enlarged and elongated in section at that particular point inside the floats; said baffle-surfaces, 30, obstructing the conduits above the cups in their normal position when no suction is applied. The weight of the cup is supported by suitable springs, 29, Fig. 7. If the register, 14, Fig. 8, installed in the float conduit becomes open when the propellers are running, the indraught of said propellers extends thru the conduit, 49, down to the floats, 16, raises the baffle-surfaces, 30, articulated with the cups, 18, sinking said cups to the ground and opening the conduit, 49, above the cups; the contact of the cups with the ground cuts off the indraught again which develops a vacuum inside the conduits and inside the cups, whereof a strong adherence or grip is maintained with the ground, resulting in a very efficient means to brake and anchor the airship safely without the assistance of a land crew.

The landing gear, 17, is suitably installed under the floats inside the vacuum cups, 18.

As possibly the air leaking thru the register, 14, when closed, might cause the water to back up into the conduit, 49, during the take-off from the water, an air-bleed, 35, of sufficient size and having a scoop, 34, built-in the base of the rear motor said scoop supplying air from the slipstream to the conduit, 49, below the register, 14; said air-bleed, 35, having a suitable gate articulated with the register, 14, whereof the gate becomes closed when the register is open and becomes open when the register is closed.

A register, 3, Fig. 6, is installed in the tunnel

between the nose and the motors to stop the indraught from the nose when desired, said register is operated independently of the normal control.

Past the underneath slot, 11, Fig. 4, discharging a portion of the slipstream, the bottom of the airship is raised in the center along the length having parallel runners, 25, along the raised part to retain the air-stream under the bottom when cruising over water. Said air-stream interposed between the airship and the water will eliminate a large part of the water friction, will raise the airship from the water by under pressure produced by the slipstream compressed between the bottom and the water surface and provide an efficient means to drive the airship over the water surface.

The wing, 22, is of a multi-airfoil type, the airfoils being placed in steps descending toward the rear and folding simultaneously each over the following one respectively, against the fuselage. Said wing is formed by seven airfoils, 81—87, on each side of the fuselage, pivoted on an air conduit, 24, Fig. 3, imbedded in the side structure, the seat of each airfoil having a circular opening, 43, and revolving and fitting a similar opening in the conduit, 24, whereof interior communication is established between the airfoils, the conduits and the tunnel. The seven airfoils on the same side are supported and held together by a continuous beam, 23, Figs. 1 and 3, pinned on the lower surface to each airfoil and across the width of the wing, turning in their joints to permit folding. The wing, 22, is held by two strong struts, 19 and 20, on each side having their upper end attached to the cross beam, 23, and their lower end attached to the fins, 15, forming part of the floats, and having turning joints at both ends. A pair of strong cables, 21 and 88, attached on each side to the upper ends of the struts bring the wing at the desired position by winding on reels inside the fuselage. The spreading cables, 88, attached to the rear struts pull forward and open the wing, while the folding cables, 21, attached to the front struts pull toward the rear and fold the wing, all cables entering the fuselage by the fins, 15.

A folding wing is designed primarily to afford convenience to house the aircraft in hangar and increase the top speed by cutting down the drag. If the size of the airship, greater structural simplicity or other reasons make the folding wing undesirable or unnecessary, a fixed wing could be used in place.

The slotting of the wing could even be carried further by dividing a portion of each folding airfoil into smaller airfoils, 27, Fig. 6, beginning at the tip and extending inboard as far as construction will make it convenient.

The air enters the wing, 22, by valves, 26, made in the upper surface, one row to each airfoil along the length.

The invention provides also an optional automatic system, shown on Fig. 8, to fold and set the wing to meet the particular needs resulting from the different conditions of the flight. The system is composed of two air turbines, 44 and 45, Fig. 8, installed one on each side of the tunnel inside the air conduits, 41 and 42, communicating with the wing, 22. Said turbines being operated by the indraught coming from the wing, their energy being used to turn the reels on which wind the cables, 51 and 52, to set the wing, said energy being transmitted to a worm-gear, 47, whose housing, 46, makes the mounting of the

turbines. The worm-gear is connected with the reel by a sprocket chain, 48, and wheels, 50 and 89, making another large reduction; thus the turbines being slow-acting, but sensitive and powerful to hold the wing in the proper position in all conditions of flight. Suitable means, 53, manually or pneumatically operated to lock the wing at any setting being also provided.

The functionment of the automatic system is briefly as follows: at the take-off, after the motors have been started, the wing is unlocked while the nose conduit is kept closed to direct the indraught from the wing only, said indraught of the wing resulting strong in such conditions will set the turbines in motion which will unfold the wing promptly and keep it firmly spread. The nose conduit is open next to bring in the necessary indraught to the propellers to develop their full thrust which will cause the airship to advance and take-off. If the wing is left unlocked during the flight, when the speed becomes high, the nose opening will then be better located for the indraught than the valves on the upper surface of the wing and otherwise at high speed normal vacuum or negative pressure develops on the upper surface of the wing where the valves are located, said normal vacuum opposing the indraught from the wing, thus the inflow furnishing the energy to turn the turbines becoming weak, while the drag on the wing increases and becomes powerful, then the turbines will no longer hold the wing open, then the wing will fold gradually cutting down a part of the drag and thus affording the airship to attain a still higher speed. It should be remembered that at high speed this type of airship does not need the lift of the wing to fly. When nearly folded the wing has little drag and the negative pressure on the upper surface nearly gone, then the indraught from the wing will increase setting again the turbines in action to open the wing. From the combination it could be easily seen that the wing will not fold completely, remaining in varied positions balancing all forces. When preparing to land the indraught is stopped from the nose, cutting down the thrust, reducing the speed and forcing a strong indraught from the wing which will cause the turbines to open the wing even with the motors partly throttled down. As soon as the airship is landed the indraught is turned to the vacuum cups, the other conduits being closed as much as necessary to brake or anchor the airship.

The invention finds also application in racing boats, one is illustrated on Figs. 9 to 15. The power plant is chosen preferably from airplane stock and is formed by one or several motors, 61, according to the size of the boat. Said power plant is installed at the bow, 54, completely enclosed inside a tunnel which extends the whole length of the boat. The motor or motors drive two high speed pusher propellers, 62, Fig. 10, also enclosed inside the tunnel, 65, whose slipstream is discharged from the tunnel under the boat by two slots, 63 and 64, and at the stern where the tunnel ends, 59. The inlet of said tunnel is made by suitable grates, 66, set flush with the deck covering the greater part of the bow and extending on the upper surface of a stub wing, 55; the motor or motors being set under the grates lying in the indraught of the propellers. Said grates being in size amply sufficient to feed the propellers and obtain a strong slipstream. The stub wing has small ailerons, 67, 68, like airplanes; the stub wing has also registers, 72 and

73, on each side to stop alternatively the indraught on one side or the other.

From the bow the tunnel continues under the seats, 74, 75, Fig. 14, and between the bottom, 76, and false bottom, 77. A substantial part of the slipstream is discharged under the boat from the tunnel by two slots, 63, 64, made in the false bottom, 77. The air-stream discharged under the craft into the water is retained underneath by parallel runners or protruding ribs, 60, which serve also to straighten the course of the boat. At the start the slipstream is discharged nearly all under the water surface, but when speeding the boat only skims the water surface and most of the discharge at the stern comes out above the water surface. The contact of the slipstream with the water furnishes the principal means of propulsion. As explained above for the airship, the air-stream discharged under the boat raises the craft from the water and eliminates friction by interposing an air layer between the bottom and the water.

The stub wing will develop an appreciable lift raising the boat and helping the control. The control is composed of a combination air and water rudder, 56, 58, air elevators, 57, and ailerons, 67, 68, said control functioning as normal control in airplanes. The registers, 72, 73, installed at the roots of the wing and operating jointly with their respective adjoining ailerons, 67, 68, afford means to bank the boat sideways when making sharp turns.

Tight compartments or floats, 78, 77, are built low on each side to maintain the craft high on water and prevent undesirable rolling.

Being enclosed the propellers, 62, are relatively small for the power used, and are consequently suitably geared to turn at very high speed and designed specially in view to obtain high compression rather than maximum air thrust, as the efficiency depends mostly from the high velocity of the slipstream resulting in high compression thrown against the water.

From the above description of my invention, I claim:

1. In amphibian airships, an interior tunnel built-in longitudinally with the structure extending from the nose to the tail, a power plant in two units substantially installed inside said tunnel at about the center of gravity, a pusher propeller and a tractor propeller rotating in opposite direction and positioned in close tandem inside the tunnel, between the two power units and being driven independently and respectively by said two power units; a horizontal partition dividing the tunnel in two past the propellers, a slot-like opening in the bottom of the airship ending the lower branch of the tunnel which carries a part of the slipstream under the airship, parallel runners under the bottom to retain said discharged slipstream underneath and straighten the course of the airship on water, propulsive means obtained by the contact of the slipstream with the water, elimination of water friction by interposing air-stream between the airship and the water surface; low orifice ending the tunnel at the tail to discharge the slipstream into the water also for propulsion, vertical and horizontal fins having large slots therein releasing some of the slipstream over the control surfaces which are hinged in a balanced manner; an air register installed in the tunnel between the nose and the propellers to stop or reduce the indraught from the nose, two air conduits connected with the tunnel from the

side in front of the propellers communicating with the wing and drawing the air to the propellers from said wing which has series of air valves in the upper surface; one air conduit branching to the floats which is connected with the tunnel in front of the propellers drawing the air to said propellers from the bottom of the floats; an air register installed in the float conduit at the entrance with the tunnel, which is operated by the pilot; two air registers installed in the conduits communicating with the wing, at the entrance with the tunnel, one on each side, operated by the normal control of the airship in lieu of ailerons for lateral control; two floats, each formed by a fin and a hull combined, supporting the airship on water; landing gears carried by said floats underneath partly concealed; sucking cups operated automatically from the suction, enveloping the landing gears and attached to the bottom of said floats with hinges at the rear and a strong articulated joint at the front; baffle-surfaces lying across and obstructing the air conduit, carried by a member of said articulated joint, said baffle-surfaces raising open under the indraught force and causing the cups to sink down and contact with the ground, whereof an automatic system is effected to brake and anchor the airship on land; an air-bleed having a scoop built-in with the base of the rear motors, which carries air from the slipstream to the conduit of the floats and having a gate suitably articulated with the adjoining register of the conduit to close when the register opens and open when the register closes; a wing formed by several airfoils positioned in steps descending toward the rear; air conduits built inside each airfoil drawing the air from the upper surface thru valves and carrying the air drawn to larger conduits built-in with the structure inside the body or fuselage, said larger conduits communicating with the tunnel; a cross beam supporting and maintaining the airfoils of the wing in proper position each relatively to others; suitable struts or braces having their upper end attached to the cross beam of the wing and their lower end attached to the fins of the floats; a substantial rigid structure forming the lower part of the airship, the nose bustle, the interior air conduits, the tunnel, the mounting of the motors, the compartments for passengers, supplies or freight; and a suitable fabric envelope containing the gas cells and forming the upper part of the airship.

2. In amphibian airships having an interior tunnel, enclosed motors and propellers inside said tunnel, floats with attached landing gears and sucking cups, interior conduits carrying internal suction to the floats and the wing, registers regulating said suction, means to drive the airship on water from the slipstream, rudder and elevators hinged in the slipstream, all the above as in claim 1; a multi-airfoil wing folding automatically, said wing having its airfoils pivoted on suitable air conduits along the side of the fuselage; circular opening at the root of each airfoil revolving on a similar opening in said side conduits whereof communication and suction inside the airfoils are maintained when said airfoils revolve on their seat during the folding action; interior conduits in said airfoils having one row of valves along the span on the upper surface; a continuous beam supporting the airfoils of the same side having turning joints; two struts on each side supporting the wing, said struts being attached with turning joints, the upper end being attached to the cross

beam of the wing and the lower end to the fin of the floats; cables attached to the upper end of the rear struts pulling the wing open and cables attached to the upper end of the front struts pulling the wing folded; two reels suitably installed inside the fuselage winding the above mentioned cables folding the wing being operated by air turbines installed in the air conduits communicating with the wing; worm-gear, sprocket wheels and chains driven by said turbines to transmit the turning force of the turbines to operate the above-mentioned reels, the combined system working from the suction or indraught of the propellers passing the air conduits of the wing, whereof the variations in intensity of the indraught during the flight in regard to the force of the drag of the wing determines automatically the attitude taken by the wing to balance the two opposing forces; and a suitable means manually or pneumatically operated to lock the wing at any setting during the flight.

3. In racing boats, an interior tunnel built-in longitudinally with the structure extending from the bow to the stern; a power plant substantially installed inside said tunnel, at the bow; two pusher propellers enclosed inside said tunnel and driven

by said power plant, generating a powerful slipstream carried by the tunnel; two slot-like openings made in the bottom discharging into the water sternwardly from the tunnel a part of the slipstream; an orifice low at the stern ending the tunnel and discharging the remaining part of the slipstream into the water; parallel runners under the bottom to retain the discharged slipstream underneath and straighten the course of the boat; propulsive means obtained by the contact of the slipstream with the water; elimination of water friction by interposing air layers between the boat and the water surface; grates flush with the deck covering the entrance of the tunnel at the bow; stub wing having inside conduits covered above with grates to increase the entrance of the tunnel; air registers at the roots of the stub wing; ailerons appended to the stub wing articulated and working jointly with the registers by the normal control of the boat; normal control formed by a water and air combination rudder, air elevators, ailerons and registers of the stub wing, the whole functioning like airplane controls; and side floats built-in with the side of the boat, keeping the craft high on water and preventing undesirable rolling.

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