March 11, 1930. R: H. UPSON 1,750,141

AIRSHIP FINS AND STABILIZATION

Filed Sept. 10, 1926

FIG. I.

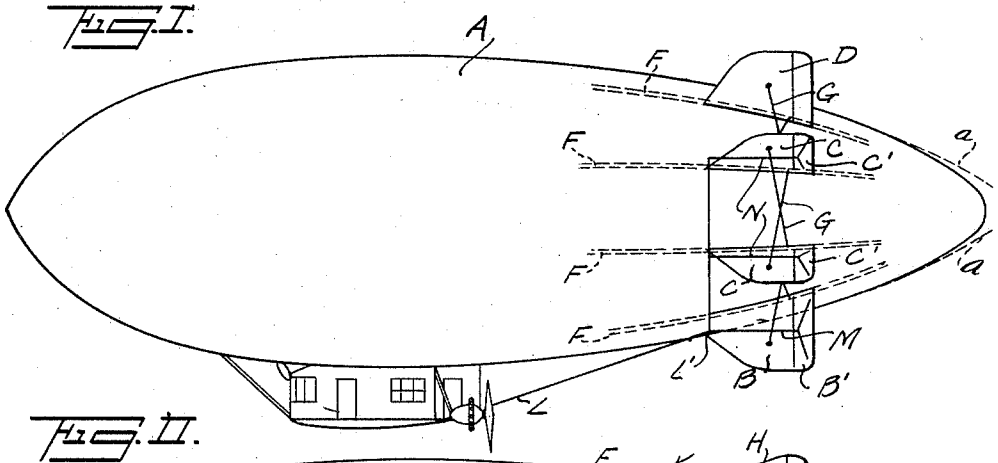


FIG. II.

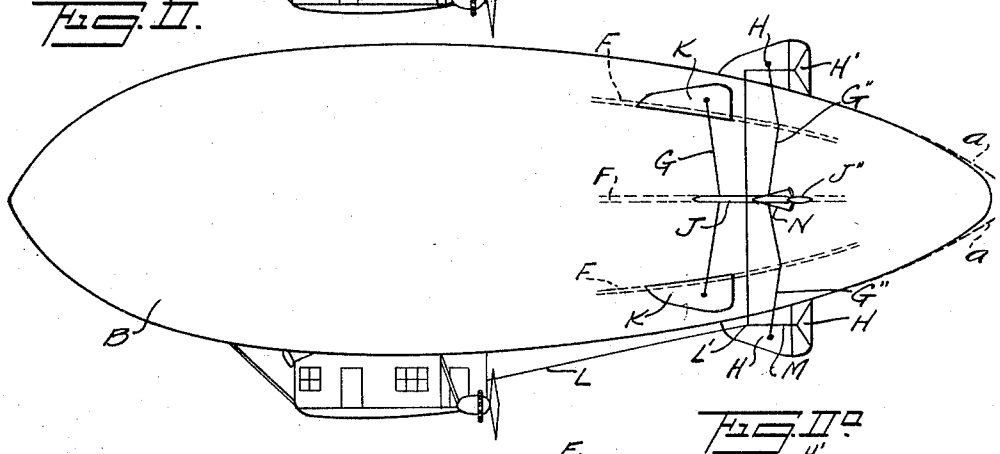


FIG. I a

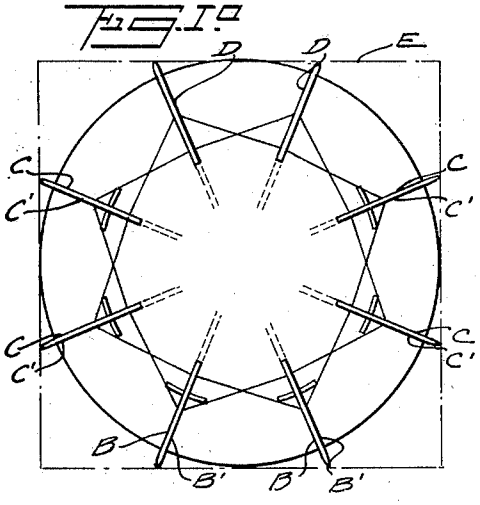
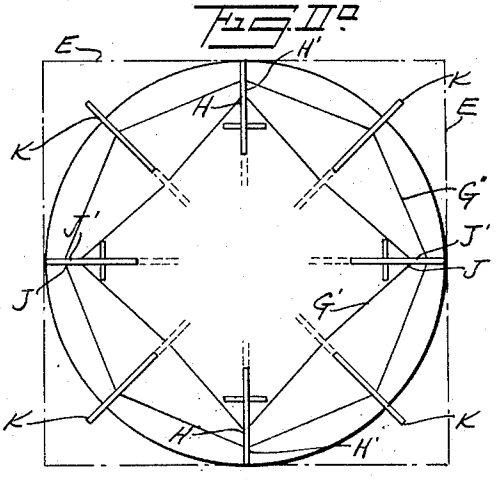


FIG. II a



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UNITED STATES PATENT OFFICE

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AIRSHIP FINS AND STABILIZATION

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This invention relates to airships, and more particularly to their directional control in flight and stabilization heading into the wind. While my development has in recent years shown the advantages of a Metalclad, that is a hull with sheet metal sheathing supported in accordance with my inventions, which is admirably suited for the embodiment of the inventions set forth in this application, these particular inventions are applicable also to other forms of rigid airships and non-rigids.

More particularly certain of the advantages of my present invention reside in greatly improved stabilization, that is steadying the ship on its course in flight as well as steadying it when moored with a head wind or generally pointing into the wind. This improved stabilization I have discovered can be attained in various ways, particular features of which are a multiplicity of fins, such as six, or a larger number which may be in moderate size ships eight, or in larger ships as many as twelve. The even number of fins being preferable owing to matters of designing of the hull and support of the fins. Another feature is the positioning of the fins with respect to the length of the ship, and I have conceived and proven by tests the advantages gained by locating generally the transverse plane through the average centre of areas of fins, a far greater distance forward of the stern of the ship than the heretofore presumed proper position. This also depends upon the fineness of the ship and the longitudinal lines. For example, in the case of a ship with a particular fineness, that is ratio of length to maximum diameter, the fin system average centre of areas may be as much as one-quarter of the total length of the ship distant from the stern, and in other cases of ships with different lines it may be further forward or slightly further to the rear. Each ship design calls for definite determination and also with consideration to the area of vertical and horizontal planes, usually referred to as elevators and rudders extending from or constituting the rear articulated portion of the fins. Reference to fin system may be understood in this case to mean the series of fins distributed circumferentially about the hull inclusive of their articulated rear section, while some in the case of eight or twelve fins may have no rear articulated portion, although a majority would have either elevators in the vicinity of the sides of the ship and rudders on the trailing edge of the fins near the bottom, and sometimes also near the top.

I have found that by reducing the fineness, such as a ratio of length five times the maximum diameter, or even in the case of small ships in the order of three times the maximum diameter, and when a longitudinal curvature of lines is rightly provided I bring the centre of resistance back of the nose of the ship for all head winds slightly off the bow, which is a very advantageous factor in stabilization, and with a proper continuously convex curvature of the hull on lines which I have developed as a combination of ellipse and hyperbola, I get a reduced aerodynamic resistance in spite of the increased ratio of diameter to length compared with rigid ships heretofore built. With this I realize an air flow adjacent the hull which makes the positioning of fins well forward of the stern very advantageous both as to the effect in steadying the flight and for quick response.

In the heretofore prevailing type of rigid airship, the customary four fins are so concentrated in their reactions that it is very desirable, and in fact necessary in most cases to interconnect the fins through internal structure of the hull for their proper support. Usually each fin is connected to the opposite fin by a pair of crossed internal girders, commonly called a "cruciform", and is a typical feature of all present airships. By multiplying the number of fins and cutting down the aerodynamic load which each one has to carry it becomes possible to eliminate the internal girders or cruciform, and to distribute the fin loads around a rigid circular frame.

By using a multiplicity of fins beyond the heretofore standard practice of four tail fins, I require only a fractional area of fin sur-

face for each individual fin in my system, and with the reduced area required for each fin, the distance such fins need project radially from the hull surface, and with the ship's skin converging toward the stern, from the maximum diameter forward of the middle, with a continuous curvature, my positioning of the multiple fins so much further forward than usual, still permits each individual fin to be of a radial extent that will not exceed the maximum width or height of the hull. That is, the lower fins will not be lower than the lowest portion of the ship, and therefore not interfere with ground mooring, and the lateral fins will not project beyond the maximum lateral extent of the hull, and will therefore pass through any hangar door without interference, while the upper fins will likewise pass through any hangar door that will accommodate the maximum height of the ship hull.

If it should be attempted to limit the projection of the customary four-fin surfaces, there is no way to provide adequate total area without abnormally extending each fin in a longitudinal direction and that would result in what is known as "low aspect ratio". While in my system of multiple fins, to the contrary, the overall dimensions of each fin can be kept within proper limits and the fins can be given a very favorable aspect ratio, that is, the length or longitudinal dimension of each fin is not large compared with the dimension normal to the hull surface. Thus providing a construction which results in a much more favorable aspect ratio of the fins I provide greatly improved stabilizing and control efficiency per unit area.

Particular embodiments of my invention are shown in the accompanying drawings, in which:

Fig. I is a side elevation of a ship with a series of eight fins all between the vertical and horizontal diameters of the hull.

Fig. I[a] is a rear view of Fig. I.

Fig. II is an elevation of another ship having eight fins, half of the number being positioned forward of the other half alternately, that is in staggered position.

Fig. II[a] is a rear view of Fig. II.

The ship A has fins B—B with rudder planes B′ forming the trailing edge. Fins C—C are equipped with elevator planes C′—C′ forming the trailing edge, while fins D—D may have in certain cases no articulated trailing edge plane, as, for example, in the case of small ships in which the rigging of manipulating means, as rudder lines, is undesirable owing to general structural conditions and unnecessary in view of the general characteristics of the ship. From Fig. I[a] it will be seen that the fins are each located in a longitudinal plane twenty-two and a half degrees off the horizontal and off the vertical, so that their extreme radial edge may extend beyond the circle of maximum hull diameter and still not exceed the square of the diameter as indicated in dotted lines E—E. In the case of a rigid airship these fins furthermore, are positioned on and extend radially from meridian ribs or trusses F—F, which provide the most advantageous support particularly in the case of a Metal-clad where the hull sheathing, which simultaneously constitutes the envelope, has a suitable stiffening rib or girder directly under the hull skin and thus serves as the rigid support for the base of each fin, while guys G—G extend from the outer portion of each fin to the base of the adjacent fin on either side where the longitudinal meridian members F form a secure anchorage resistance. This arrangement, with the multiple fins, meaning in excess of the heretofore standard arrangement of four, provides a disposition which permits the guys G—G to run straight from the base of one fin to the bracing point on the adjacent fin and at an angle with respect to the fin plane which provides for better strain-resistance, so that each of the multiple fins may in addition be better braced, and in all provide better structural efficiency with respect to their union with the hull.

In Fig. II, the fins H—H at top and bottom have rudder sections H′, while fins J—J on either side and in the plane of the horizontal diameter of the hull support the elevator trailing sections J′. Intermediate fins K—K are located forward of the rudder and elevator fins and have no articulated trailing edge plane. In this case the average position of the centre of area on all of the fin planes is as heretofore noted far forward of the stern of the ship, and in the figure are approximately one-quarter of the total ship's length forward of the stern. The dotted lines *a*—*a* indicate a continuous rearward converging shape of the hull and would meet at the stern with respect to which the above-mentioned relative position of the fin system is located, while the abruptly rounded-off stern shown in full line is arbitrary. The fins may be either staggered or not, depending upon various detailed considerations of the design of the ship as a whole.

In either case rudder and elevator lines are diagrammatically illustrated as L leading to a suitable point L′ where they are linked up with the rudder by lines M, or to the elevators by lines N to the usual horns secured to the rudder or elevator sections near their hinge, and with suitable guys to resist the strains of deflection. It will be understood that the fins may be secured to the hull in any suitable manner, the base of each fin requiring in the case of these multiple fins less strength of attachment because of the effectiveness of the lateral or circumferential guys and the cooperation with the small radial extent of each individual fin. In some

cases, however, the fins may be rigidly attached and braced directly from their base connection with the hull, or may be flexibly attached in accordance with the requirements of other inventions that I have made with respect to fin and rudder construction per se.

While reference has been made to the position of the fins embodied in a ship in accordance with my invention, as in the order of a quarter of the distance more or less from the stern, it will be understood that the actual rear-most extermity of the hull may be blunt, that is the converging curvature of the meridian lines beyond a point near the rear need not follow any uniform degree of curvature, but may be drawn in abruptly without causing any undue drag, which my tests have proven. Thus the reference to the approximate position of the fins is subject to some variation with respect to the abruptness with which the curvature of the stern is designed in any particular ship, but in any event wind-tunnel tests on models have proven my very substantial advantages gained in stabilization, by positioning the fins as set forth, while with each specific ship laid down the precise position within a limited zone of variation, can be readily determined with respect to fineness and curvature and desired fin system area.

In general, with the increase of size of ships the number of fins, as six, eight, twelve, or even more will be suitable. As to the staggering of fins, certain designs may lend themselves to the embodiment of control trailing planes on both series in the system, or even in some cases the forward series only may have articulated trailing planes, depending upon conditions of speed, manœuvreability, and in general the kind of service with respect to altitudes and contingent requirements to meet conditions which a ship is liable to encounter on the particular services for which it is intended. As to the position of the fin system with respect to the ship's length, my designs of rigid airships provide continuous convex curvature of the meridian lines of the hull with the maximum cross-section forward of the middle of the ship. With this, the hull back of the maximum section is greater than half the ship's length, and has a continuously rearwardly converging shape except for the abruptly-rounded stern, such as shown, and it is in the approximate middle of this aft converging portion with its theoretical stern indicated where the dotted lines *a*—*a* would meet, or slightly back of the middle thereof irrespective of where the stern is arbitrarily rounded-off, that I position the fin system, thus bringing the reaction of the control planes, elevators or rudders, not only where the air-flow is most advantageous but also in most advantageous relation to the centre of buoyancy and other related factors of design of the ship.

While I have shown and particularly described particular embodiments of my invention, it will be understood many variations may be made in the practice of my invention, and that in each particular ship design dimensions and ratios will vary, the shape of fins may be changed and their attachment to the hull varied, in many ways.

But what I claim and desire to secure by Letters Patent is:

1. A rigid airship of a fineness of one to six or less, having as stabilizing means a fin system comprising five or more fins each individually connected on substantially meridian lines adjacent to longitudinal structural members of the hull, and positioned approximately half way between the maximum section of the hull and the point toward which the main lines of the hull would converge at the stern.

2. In a rigid airship, a fin system comprising a multiplicity of separate fins six or more in number, means of attachment to the hull surface over meridian structural members of the rigid ship at a section of the ship approximately midway between the larger and maximum section and the stern defined by the point toward which the lines of the main hull would converge without modification of the lines in the immediate vicinity of the stern, rudder planes coacting with the trailing edge of each of the fins on the lower hull quarter, elevator planes articulated with the trailing edge of fins on the sides of the ship and means for control of the rudder and elevator articulation.

3. In an airship a system of stabilizing fins comprising two series of fins of circumferentially disposed fins, each series having their centre of pressure in a different transverse plane and in an average plane transverse to the axis of the ship in the order of one-half of the distance between the normal stern apex of curvature of the converging hull lines at the maximum section of the hull.

4. In an airship, a fin system consisting of six or more fins, different adjacent fins having their fixedly attached portions secured to the hull in the zone midway between the maximum hull diameter and the stern at different longitudinal positions of the hull surface, certain fins having articulated voluntary control trailing plane section, and certain of said fins being subject only to effect of the normal stream-line air flow along the ship.

5. A rigid airship having its hull meridian lines of generally convex curvature throughout and with a maximum diameter forward of the middle, providing a rear portion of converging meridian lines more than half the ship's length, and a fin system of six or more units extending radially from the hull surface generally in the zone near the

middle and slightly back of the rear converging hull section.

6. In an airship, a fin system including a plurality of individual fin areas extending longitudinally generally on meridian lines of hull radially from the hull surface, and having one or more of the individual fins positioned in advance of the other individual fin with respect to the ship's length.

In testimony whereof, I have signed my name to this application, this 22d day of May, 1926.

RALPH H. UPSON.