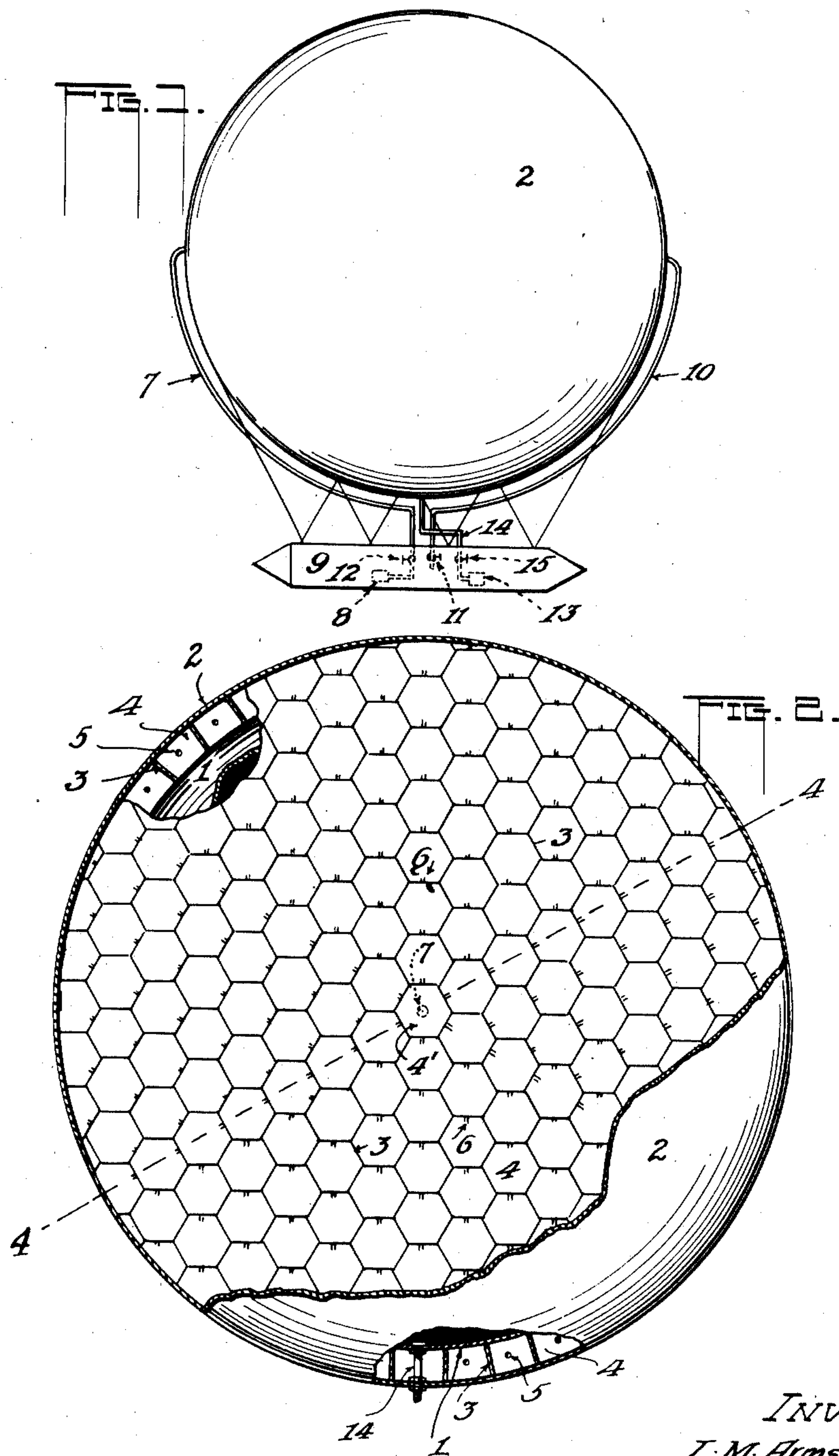


L. M. ARMSTRONG.
AIRCRAFT OF THE LIGHTER-THAN-AIR TYPE.
APPLICATION FILED NOV. 24, 1919.

1,390,745.

Patented Sept. 13, 1921.
3 SHEETS—SHEET 1.



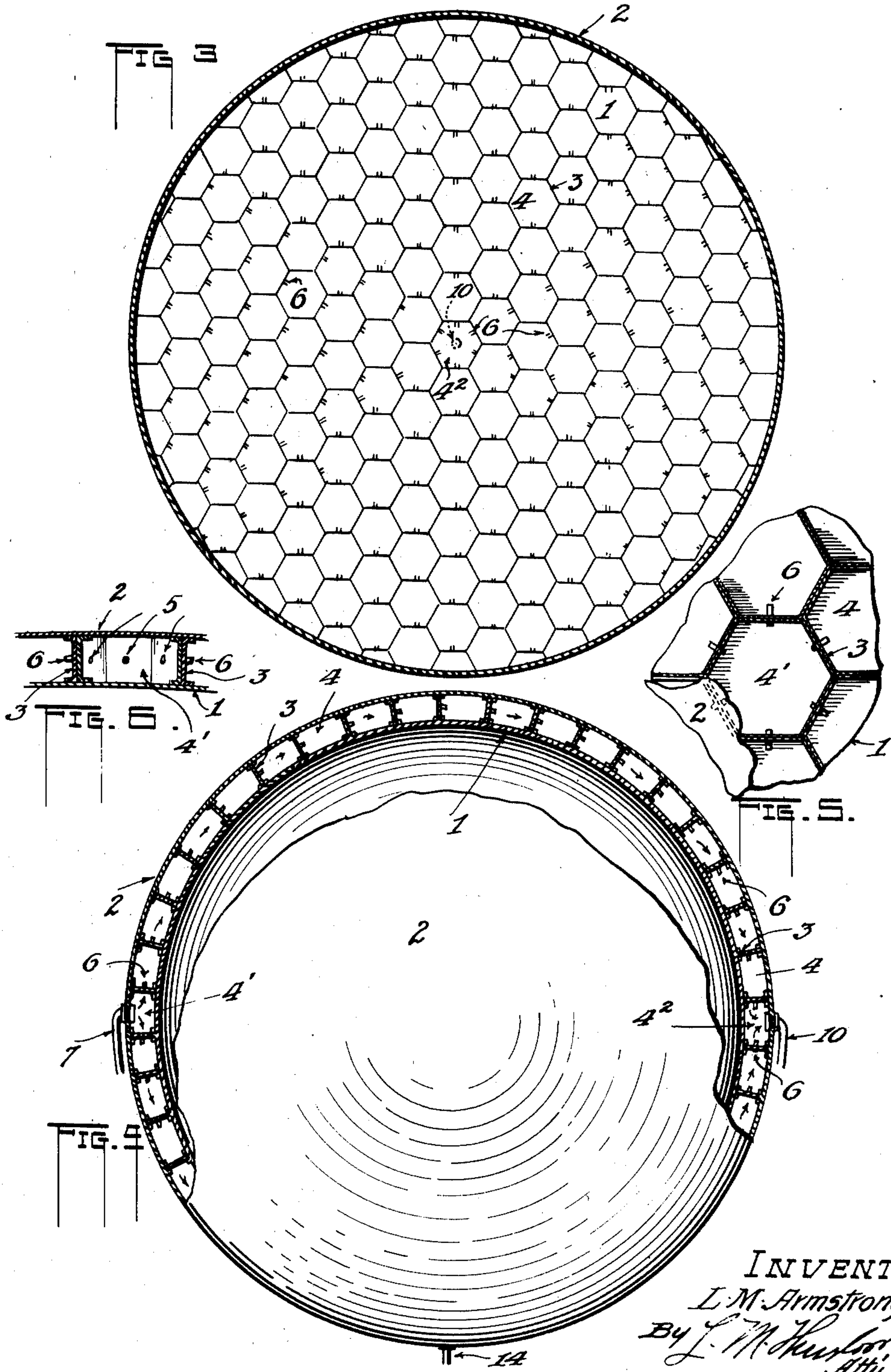
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Att'y.

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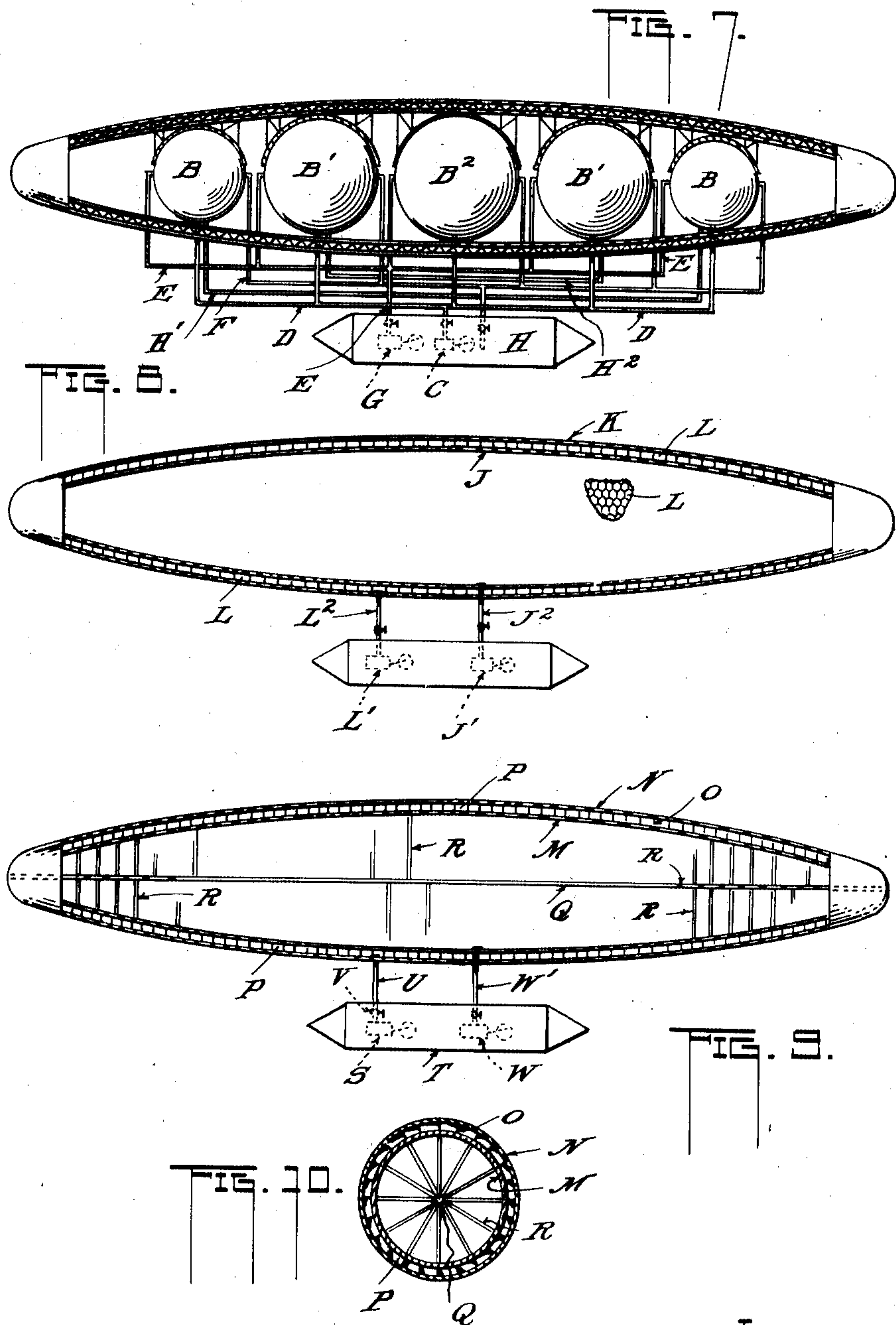
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UNITED STATES PATENT OFFICE.

LAVANDA M. ARMSTRONG, OF PEORIA, ILLINOIS.

AIRCRAFT OF THE LIGHTER-THAN-AIR TYPE.

1,390,745.

Specification of Letters Patent. Patented Sept. 13, 1921.

Application filed November 24, 1919. Serial No. 340,328.

To all whom it may concern:

Be it known that I, LAVANDA M. ARMSTRONG, a citizen of the United States, residing at Peoria, in the county of Peoria and State of Illinois, have invented certain new and useful Improvements in Aircraft of the Lighter-Than-Air Type; and I do hereby declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to an air craft rendered buoyant and capable of ascending by the employment of a vacuum, or near vacuum.

The prime object of my invention is to furnish a type of craft for air navigation in which a compartment can be used from which air is to be exhausted whereby to create a vacuum, or near vacuum, for lifting purposes.

Another object in that of furnishing a type of lighter-than-air craft wherein no dangerous or explosive gases, or gases of any nature in fact, except air, need be used, air being employed merely for ballasting.

Another object of the invention is that of furnishing an air craft wherein there is a compartment from which air can be exhausted for creating a vacuum more or less perfect, according to needs, a compartment for air to be used for ballast, and means to exhaust air from one of the compartments.

Still another object is that of constructing a craft for air navigation in which a vacuum or partial vacuum can be created in the envelop thereof in place of using a buoyant gas, air being admitted to or withdrawn from said envelop for elevating or lowering the craft according to the rarity or density of the atmosphere encountered.

A still further object is that of constructing an air craft wherein a vacuum is created in the usual gas envelop to act for lifting purposes, while employing a second envelop for containing air of greater or less density for ballasting purposes, whereby any elevation desirable may be reached and maintained.

A further object is to provide an air craft of a spherical form made of a fabric, for example, as an envelop in which to create

a vacuum, or near vacuum, said envelop being covered or surrounded by a second envelop constructed so as to hold air under pressure, the walls of the envelop being spaced from one another and tied together with certain wall structures, inflation of the outer envelop thus constructed being designed to form a resistant to the collapsing tendency of the inner structure due to the vacuum within the latter.

Still another and extremely important object is that of providing in an air craft a lifting envelop comprising two non-communicating compartments, preferably one within the other, each for the reception of a gas of greater or less density.

With these and other objects in view the invention consists of certain details of construction that will yield the desired results as will be understood from the drawings herewith submitted forming part of this application, it being understood that changes may be made without sacrificing the spirit or intent of the invention or departing from the scope of the appended claims.

Figure 1 is an elevation of one type of air craft, or one of spherical form, involving my invention.

Fig. 2 is an elevation of the same type on a large scale, with an outer skin or wall thereof partially broken away to show a cellular structure, parts of these being broken away to better illustrate the manner of arrangement.

Fig. 3 is a view similar to Fig. 2 but showing the side of the sphere opposite that seen in that figure.

Fig. 4 shows the outer surface of the sphere with parts broken away to show the cellular structure and an arrangement of valves in the walls thereof, taken on line 4-4, Fig. 2.

Fig. 5 is an enlarged detail of construction and arrangement of cells.

Fig. 6 is a cross section of part of what is shown in Fig. 5.

Fig. 7 is a longitudinal section of a craft of an elongated or dirigible type of craft which includes my invention.

Fig. 8 is a similar view of a slightly altered form of the invention.

Fig. 9 is a like view of still another form of the invention, and

Fig. 10 is a transverse section of Fig. 9.

As intimated in the objects, my invention seeks to adopt an envelop within which to create a vacuum, or near vacuum, for lifting purposes to the exclusion of gases lighter than air as the lifting medium usually employed, the term vacuum being a relative one only, as will be understood.

In adopting an envelop for vacuum purposes there is required, especially in the lighter forms of craft, such as may be made of fabric, for example, a peculiar construction of great strength or one that will resist the tendency to collapse or to be drawn inwardly into the created vacuum.

In the type of craft shown in the first seven figures, and in Fig. 8 as a modified type thereof, there is illustrated a sphere consisting of an inner and an outer skin or wall, 1 and 2 respectively, of fabric, such as may be used in airship construction, both being spheres, the inner one creating an envelop from which air is to be exhausted to create a vacuum as nearly as is practicable. The outer skin or wall is spaced some distance from the inner one, the two being securely connected at close intervals by walls 3 perpendicular to each. The walls 3 may be arranged so as to create a series of cells 4 of any desired size and shape, or cells may be formed by any other method. For convenience, in the present case, I show cells of hexagonal form in order that the said walls 3 connecting the skins or walls may be regularly disposed as bracing means over the entire sphere for a purpose to be made known.

The said inner and outer skins or walls may be made as thick and strong as desired, as also the said walls 3.

In Figs. 2 and 3 the cells are indicated diagrammatically, merely, and without taking into consideration their thickness, nor the effect of perspective as diminishing the size of the cells in appearance toward the margins of the figures, as they would actually appear upon a sphere, no attempt being made to show the wall structures thereof, but I have shown said walls in Figs. 5 and 6 as of double thickness merely from choice. The cells 4 cover the entire area of the inner wall 1 as already stated, Figs. 2 and 3 showing opposite sides of the sphere so laid out. The cells communicate with one another through openings in their walls, which openings are represented at 5 in some of the figures, and if desired said openings may each be furnished with a valve 6 of any approved type and one that will open or pass air in one direction only.

The purpose of the space between the skins or walls 1 and 2 is that air may be placed therein under pressure. Inflation of the sphere may be obtained, for example, through a suitable conduit 7 leading into

what may be termed a distributing cell at 4' in Figs. 2, 4, 5 and 6.

Since the cells communicate with one another, as explained, the pressure introduced spreads throughout the entire space between the skins or walls and may be retained therein at any pressure by any suitable means such as the usual check valve (not shown) of an air compressor 8 carried by the car 9 suspended from the sphere, Fig. 1; or other means may be employed having the same end in view, as will be explained.

The pressure of air thus maintained, aided by the said walls of the cells tying the two skins or walls 1 and 2 together, in effect creates a "truss" of spherical form as a shell for withstanding collapsing tendency due to the vacuum created in the envelop or compartment within the skin or wall 1.

If the walls are provided with valves as explained, the arrangement thereof is preferably as shown in Figs. 2 and 3 wherein, as stated, opposite sides of the sphere are shown. That is to say, in Fig. 2 the walls of the distributing cell 4' are each furnished with one of the valves 6, which valves open outwardly under air pressure to permit air to pass into the immediately adjoining cells at all sides. Also said adjoining cells have valves opening toward the cells lying outward therefrom, and while all of the cells of the entire number may communicate in every direction by valves in all of their walls, I preferably so place the valves that a minimum number need be used in the interest of simplicity and economy.

It will be noted that all the cells in Fig. 2 are fed from the center one 4' in an outward direction to the margin of the represented hemisphere, and then by reference to Fig. 4 it will be noted that the valves thereon shown open toward the central relief cell 4². Thus if we follow the surface of the sphere from the cell 4' to said cell 4² the valves are all shown to open from one "pole" of the sphere to the other. This is clearly illustrated in Fig. 4 wherein the part shown in the section is taken on line 4—4, Fig. 2. In this figure also the conduit 7 is shown connected into the outer wall 2 of the central cell 4', there being a conduit 10 connected with the cell 4².

The conduit 7 leads to said air compressor 8 in the car or gondola 9, while the conduit 10 is provided with a valve 11. By this arrangement the air in the sphere between the skins or walls 1 and 2 may be compressed to any desired extent by closing the valve 11 in the conduit 10, for example, the compression being thereby held, the valves 6 preventing back pressure toward said compressor 8, or if the valves 6 are not employed, merely using the holes 5 in the cell walls, the valve 11 and a valve 12 in the conduit 7 when closed will act together to

prevent loss of pressure. The use of the compressor and the provision for permitting air to escape through the conduit 10 is that any desired pressure may be maintained for certain purposes, as may be more fully described herein.

The vacuum is created and maintained through the use of an exhausting apparatus of any approved type. This apparatus, merely for convenience herein, is shown as an exhausting pump 13 connected through a conduit 14 with the envelop through the skins or walls 1 and 2, Fig. 2, said conduit having a valve, for example, at 15. In Fig. 7 is illustrated a craft of the accepted oblong type having a rigidly constructed envelop A, for example, wherein a number of spheres B, B', B² of the type just described are installed, suitable provision being made for securing them relatively and relatively to the envelop, and so also that the lift thereof can be properly distributed over the framing of the craft, it being my purpose merely to show the use of the spheres as applied to a craft of this type; the spheres being exhausted by such means as already described through a vacuum pump "C" for example, connected with all of the spheres by a conduit D.

Also air is supplied through conduits E through the cells thereof and exhausted through conduits F for each sphere, said conduits E leading to an air pump G in the car H. A pipe H' connects the vacuum chambers of the spheres B and a pipe H² connects the chambers of the spheres B' whereby conditions that may exist in the spheres of either pair will be equalized to maintain the proper balance of the craft if found desirable.

Fig. 8 illustrates a semi-rigid form of craft also of the oblong type. It comprises an inner and an outer envelop J, K respectively, of fabric, the space between them being provided with connecting walls creating cells L of any form desired, adapted to be supplied with a gas, the space within the envelop J being supplied with a gas of lesser density, the two spaces or compartments being separated in a gas-tight manner. The apparatus for handling each gas is merely indicated as a pump, for example, that at L' having control of the outer compartment through a pipe L², that at J' controlling the inner space through a pipe J².

In Fig. 9 is shown a rigid oblong type of craft wherein the inner and outer envelops M, N, are a light metal spaced apart and connected by walls O creating cells P. The inner wall or envelop M is imperforate so that the cell space cannot communicate with the inner compartment within said envelop M. As in the type first described herein, the said inner compartment is designed to be exhausted of air, creating a vacuum,

while the outer compartment between the envelops is for containing air under more or less pressure.

Q is a rod or tube extending longitudinally through the craft, lending rigidity thereto, and R represents a series of rods or tubes fixed at one of their ends on the rod or tube Q, their other ends being affixed to the inner wall M. Said rods radiate in all directions, Fig. 10, for the purpose of preventing collapse due to the vacuum. It is to be understood that any other means may be employed, however, for preventing collapse.

S is an air compressor within the car T for introduction of air to the cell space through a pipe U, a valve V in the latter being employed for permitting the air pressure to be lowered when desired, it being understood that the cells communicate with one another as in the other forms described.

W is indicative of an apparatus of any approved type for creating a vacuum within the inner envelop. In preparing craft of the type shown in Figs. 1 to 6, Figs. 7 and 9, for flight the inner envelop may be preferably exhausted of air by means of a suitable pump (not shown), upon the ground, and the outer space placed under air pressure by a pump also upon the ground, both of a size or capacity to provide for quick work, the apparatus for these purposes carried in the car being then connected for maintaining the desired conditions during flight. However, the procedure of ground work is mere choice.

After the outer compartment or space has been distended by the pressure found proper for maintaining the sphere in form as against the vacuum to be created, the air may now be exhausted from the inner compartment to the extent found necessary to lift the vessel in the density of air at low levels or at the ground. Upon ascending, as the atmosphere becomes less dense and the partial vacuum is less effective, more air can be withdrawn, or it can be withdrawn in a continuous manner as the craft arises.

It is clear that by the exhaustion of the air to form a vacuum more or less perfect, a desired elevation may be reached where the craft will remain suspended traveling at that level, neither rising nor descending except through increasing or decreasing the vacuum mechanically. This may also be assisted, as rendering the craft more or less buoyant, by placing more or less pressure of air in the outer space between the skins or walls. That is to say, the air can be allowed to escape slightly, while at the same time maintaining a pressure sufficient to protect the outer space against collapse, and by thus releasing such air the weight of the craft is decreased.

A nicety of adjustment of the pressure,

and of the vacuum, thus admits of wide variations in levels attained and maintained, and the ascent and descent of the craft can thereby be perfectly governed, the pressure of air in one compartment and the lack of it in the other furnishing the control.

A lifting-gas as ordinarily employed in lighter-than-air craft when discharged, whether by design or through leakage, must be replaced by a gas which may not always be ready at hand. However, since a vacuum can be created and air can be compressed, mechanical operations only are required with my type of craft.

To descend, air may be admitted slowly or as fast as desired to the vacuum compartment and thereby any desired lower level may be attained where the craft may be sustained, or it may be permitted to come to earth by admitting more air, the outer space for air being meantime placed under proper pressure if any air pressure has been released therefrom.

Suitable means may be made use of to show the pressure prevailing in the said outer space. Likewise a device may be employed to show whether leakage of air into the vacuum compartment is taking place so that the attendant is apprised at all times of the conditions existing or of what is taking place at any moment. Also, knowing his elevation, by means of a barometer the attendant is enabled by experience to change the conditions by means of the apparatus provided, either to maintain his desired elevation or for reaching any other elevation or level.

Whether fabric is employed as the material for constructing the envelopes of an air craft, or whether light, strong metal is used for the envelopes, the vacuum principle of lifting is the object sought. And if fabric is the material used the outer space between the skins or walls serves as the rigid "shell" when distended by air pressure for bracing the envelop against collapse. It is believed to be obvious that since the shell is of a round or spherical form the pull of the vacuum distributed alike over the whole surface is met by said shell whose cells, in abutting upon one another, when under inflation, act as so many keystones.

Furthermore, the atmospheric pressure upon the outer skin or wall bearing equally upon every part of its surface, acting to reduce the size and bulk of the sphere, tends to compress the "shell" from every point in the direction of the center of said sphere, rendering it still more unyielding to the pull of the vacuum within.

Part of my invention is that of providing in a lighter-than-air craft an envelop composed of two separate compartments, preferably one within the other, each of which is employed for a different purpose, one for in-

stance containing air, the other to be placed under a vacuum, or near vacuum, or for containing gases of different densities, changeable by choice, for the purposes outlined above.

I claim:

1. An air craft including in its construction an envelop made up of two spaced walls creating two separate compartments, a series of walls connecting the first named walls, arranged to form a series of cells throughout the space between the latter, one of said cells being a distributing cell, another of said cells being a relief cell at substantially the opposite side of the envelop from the distributing cell, and a valve in one of the walls of each of the cells lying between said distributing cell and said relief cell, adapted to open in the direction of and to communicate with said relief cell only, and to close in the direction of the distributing cell for permitting passage of a gas from the latter through all of the cells into said relief cell.

2. An air craft including in its construction an envelop made up of two spaced walls creating two separate compartments, a series of walls connecting the first named walls arranged to form a series of cells throughout the space between the latter, one of said cells being a distributing cell, another of said cells being a relief cell at substantially the opposite side of the envelop from the distributing cell, a valve in one of the walls of each of the cells lying between said distributing cell and said relief cell, adapted to open in the direction of and to communicate with said relief cell only, and to close in the direction of the distributing cell for permitting passage of a gas from the latter through all of the cells into said relief cell, and a gas compressor connected with the distributing cell.

3. An air craft including in its construction an envelop made up of two spaced walls creating two separate compartments, a series of walls connecting the first named walls arranged to form a series of cells throughout the space between the latter, one of said cells being a distributing cell, another of said cells being a relief cell at substantially the opposite side of the envelop from the distributing cell, a valve in one of the walls of each of the cells lying between said distributing cell and said relief cell, adapted to open in the direction of and to communicate with said relief cell only, and to close in the direction of the distributing cell for permitting passage of a gas from the latter through all of the cells into said relief cell, a gas pressure pump connected with the distributing cell, and a relief valve connected through one of the walls of the relief cell.

4. An air craft including in its construction an envelop made up of two spaced walls creating two separate compartments, a series

of walls connecting the first named walls arranged to form a series of cells throughout the space between the latter, one of said cells being a distributing cell, another of said cells being a relief cell at substantially the opposite side of the envelop from the distributing cell; a valve in one of the walls of each of the cells lying between said distributing cell and said relief cell, adapted to open in the direction of and to communicate with said relief cell only, and to close in the direction of the distributing cell for permitting passage of a gas from the latter through all of the cells into said relief cell, a gas pressure pump connected with the distributing cell, a relief valve connected through one of the walls of the relief cell, and an exhaust pump connected with the inner compartment.

5. An air craft including in its construction a body of elongated form made up of an inner and outer envelop, the envelop creating two separate compartments, an inner and an outer one, walls connecting the envelops within the outer compartment whereby to create a series of cells communicating with one another for receiving a gas under pressure, a strut extending centrally through the inner compartment through the longest axis of the body, and radial bracing members radiating from the strut extending between the same and the inner envelop, and an air exhausting pump connected with the inner compartment for creating a vacuum.

6. An air craft including in its construction an elongated envelop, a series of separate bodies inclosed therein, each having a vacuum created therein, and a pipe connecting the vacuum chamber of corresponding pairs of the bodies, or those which lie in corresponding positions at each side of

the middle of the length of said envelop whereby when the vacuum of one of the bodies of a pair is affected the corresponding one will be affected in like degree.

7. An air craft including in its construction an elongated envelop, a series of separate bodies inclosed therein each having a vacuum created therein, a pipe connecting the vacuum chamber of corresponding bodies, or those which lie in corresponding positions at each side of the middle of the length of said envelop whereby when the vacuum of one of said bodies of the pair is affected the corresponding one will be affected in like degree, and an air exhausting pump connected with vacuum chamber of each of the several bodies.

8. An air craft including in its construction an elongated envelop, a series of separate bodies inclosed therein, each including an outer compartment for a gas under pressure and an inner compartment within which to create a vacuum, a pressure delivering pump connected to the outer compartment of each body, an air exhausting pump connected to the inner compartment of each of said bodies, and pipes separately connecting the inner compartments or vacuum chambers of those bodies which lie in corresponding positions at each side of the middle of the length of said envelop whereby when the vacuum of one of the bodies is affected the one corresponding thereto will be affected in like degree the equilibrium of the craft being thus maintained.

In testimony whereof I affix my signature in presence of two witnesses.

LAVANDA M. ARMSTRONG.

Witnesses:

J. M. REYBURN,

L. M. THURLOW.