United States Patent

Davenport

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[54] WORKING CHAMBER

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 791,630, Jan. 16, 1969, abandoned.

[52] **U.S. Cl.** .....**220/1 R**, 229/22, 220/6
[51] **Int. Cl.**.....**B65d 7/02**
[58] **Field of Search** .....220/1 R, 1 B, 6, 7, 5 A; 150/0.5, 1; 229/22

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[57] **ABSTRACT**

A variable configuration and volume chamber which, in its most basic form, consists of a plurality of first substantially rigid panels the marginal edges of which form a substantially rectilinear acute triangle and a plurality of second substantially rigid panels, the marginal edges of which form a substantially rectilinear obtuse triangle. The chamber is formed by hinge-joining marginal edges of respective panels in a particular arrangement such that the jointure of the second rectilinear obtuse triangle panels together with the obtuse vertices of the joined second panels intersect at the longitudinal axis of the chamber whereby rectilinear movement of the intersection is maintained in a plane of symmetry of the chamber throughout actuation of the chamber.

4 Claims, 5 Drawing Figures

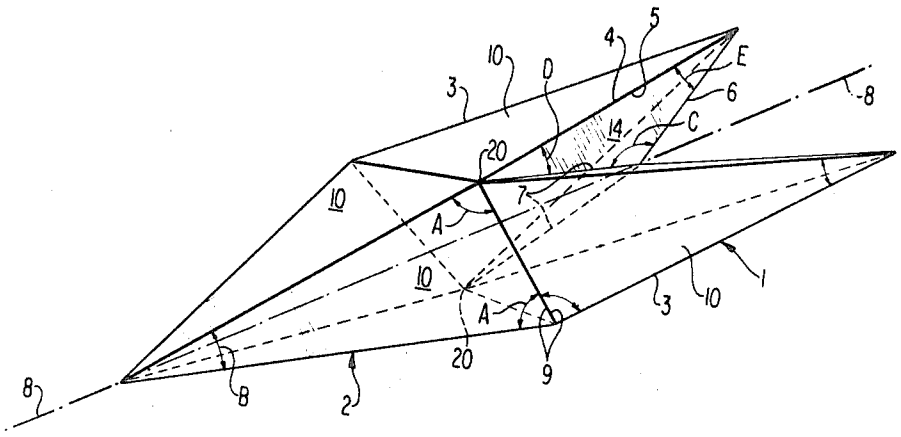


FIG. 1

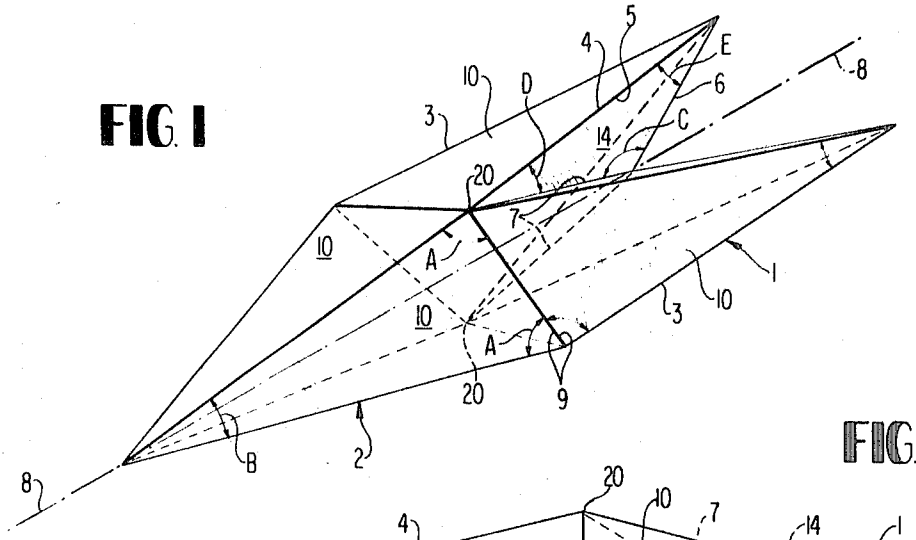


FIG. 2

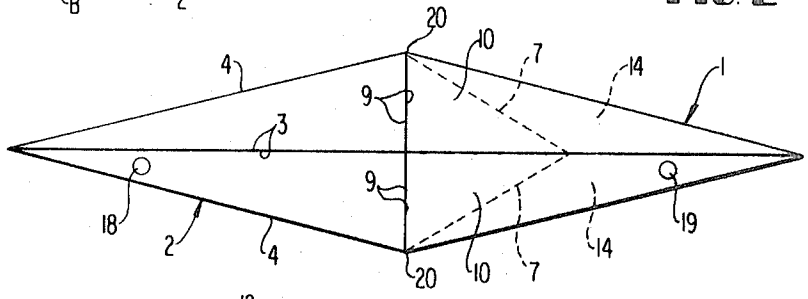


FIG. 3

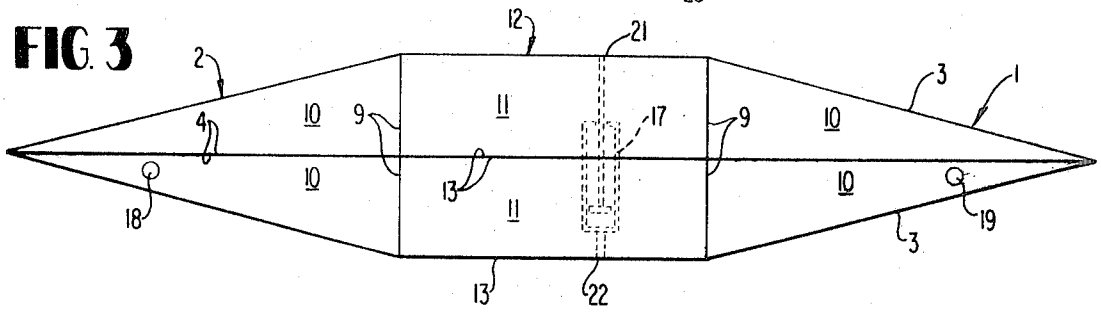


FIG. 4

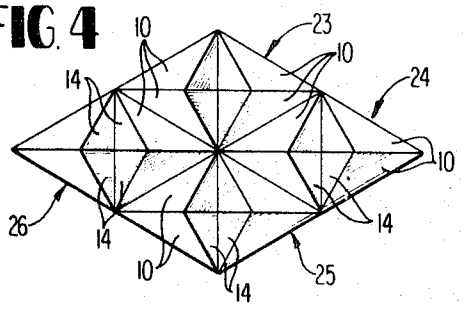
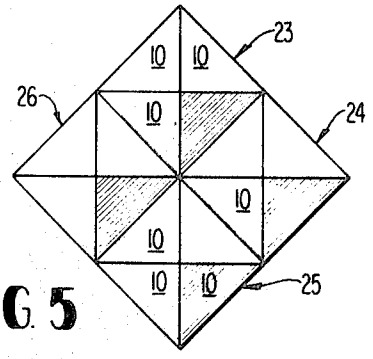


FIG. 5



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WORKING CHAMBER

This is a continuation in part of application Ser. No. 791,630 entitled WORKING CHAMBERS, filed Jan. 16, 1969, now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to working chambers and more particularly, to a working chamber which varies both in configuration and volume and which is constructed of relatively rigid triangular panels which are hinge-joined along rectilinear edges thereof.

2. Description of the Prior Art

In the normal transport and storage of fluids in large quantities, large fixed configuration and volume structures such as barges, tanks and hulls are used. Prior known conveyances used for this purpose are inefficient as they occupy the same space when empty as they do when full, and, when less than full and in motion, generate resistance to their motion within the environment through which they are moving which is greatly out of proportion to their content. A prime example of this inefficiency is in rigid airship construction where the hull is usually constructed of a lightweight rigid framework covered with fabric. The basic purpose of this hull is to provide a substantially rigid shell to house a plurality of cells made of flexible-type material. These cells are partially filled at sea level with a lighter than air gas such as helium. Since this gas expands and contracts with variations in temperature and pressure, the amount of gas placed in the cells at sea level is that quantity which will ensure that the cells are full only when the airship is at its maximum design pressure altitude. Therefore, these gas cells, in an airship designed to operate up to 18,000 feet where the atmospheric pressure on a standard day is 14.94 inches of mercury are approximately half full when the airship is operating at sea level where the pressure is 29.92 inches of mercury. This type of construction results in a structure which, due to its inflexible lightweight framework, is highly susceptible to damage and which, due to its fixed configuration, is inefficient aerodynamically as its frontal area, for drag considerations, remains a fixed value even though the gas cells may occupy only a fraction of the internal volume of the hull. Additional deficiencies found in prior art airship operations are requirements for ballasting and valving off a part of the lifting gas to maintain or vary the altitude of equilibrium. This ballasting and valving off of gas is a wasteful method of varying the density of the airship. Another disadvantage of prior art airships is that their usual prolate spheroid configuration does not lend itself readily to clustering with other airships for greater capability.

The present invention is not only applicable to air ship construction and configuration but also to marine vehicles which have an even greater difficulty in moving through the denser water and especially surface vessels which, in an unloaded condition, are additionally subjected to the destabilizing effect of crosswinds.

SUMMARY OF THE INVENTION

The present invention is directed broadly to a variable configuration and volume chamber, constituting a working chamber for a pump, a working chamber for an aneroid barometer, or a variable configuration and volume chamber, for instance, which may constitute the hull of either an aircraft or a marine vessel wherein the actuation causing the change in configuration and volume of the chamber may be mechanically achieved, under positive operation or, automatically achieved, by variance in the relationship between the density of the environment internally and externally of the chamber, to produce beneficial changes in the chamber's dynamic characteristics when operating in a fluid environment. Further, the chamber of the present invention has sufficient surface rigidity and structural integrity throughout its operable range of configurations and volumes to serve as a vehicle operable in various fluid environments, either gaseous or liquid.

In another form, the variable configuration and volume chamber of the present invention may constitute an enclosed sealed chamber carrying fluids having varying volumetric requirements caused by normal environmental temperature and pressure changes with the chamber retaining substantial surface rigidity and integrity while responding to these varying requirements. A practical use for such a chamber resides in an aneroid barometer.

In the aircraft and marine field, the present invention may take the form of a variable configuration chamber which assumes smaller volume configuration while progressively assuming a more dynamically efficient configuration by reducing its frontal area and increasing its lift producing area. The enclosed working chamber has the inherent ability to absorb momentary shock loads imposable by and normal to the operational environment without sustaining immediate or latent structural damage, since such shock loads are taken up by a change in chamber configuration. By intentionally actuating the means for varying the configuration of the working chamber and therefore its volume, some degree of control of the density of the chamber within the structural limits of the material and design used in the construction of the particular chamber is achieved. The working chamber is readily modified so that a plurality of chambers similarly produced may be joined together to increase the capability for storage in transport, etc. The working chamber in all embodiments comprises simple plane surfaces for ease in manufacture and assembly.

In a specific form, the variable configuration and volume chamber consists of at least one first chamber section comprising a plurality of first substantially rigid panels with the marginal edges of each forming a substantially rectilinear acute triangle and a plurality of second substantially rigid panels, the marginal edges of each forming a substantially rectilinear obtuse triangle. The chamber is formed by at least two pairs of first panels having corresponding marginal edges of respective panels hinge-joined together and other marginal edges of respective panels of each pair of first panels hinge-joined to corresponding marginal edges of respective panels of at least two pairs of second panels. Each of the two pairs of second panels further having other corresponding marginal edges of both panels hinge-joined together and each panel of each of said second pairs of panels further has a third marginal edge joined to a similar marginal edge of a corresponding panel of the other pair of second panels. The jointure of these panels of the respective pairs of second panels is such that the obtuse vertices of the abutting second panels intersect in a plane including the central axis of the chamber. The hinge-joined attachment of the panels along said marginal edges allows the chamber to follow a predetermined correlated pattern of change in both configuration and volume when acted upon with the chamber distinguished by the movement of the line of intersection of said abutting panels of both pairs of second panels being maintained along a plane including the central axis of the chamber throughout the actuation of the same, with retention of symmetry of all panels about said central axis.

For aerodynamic and marine use, a second chamber section may be formed of four substantially rectilinear acute triangles, which are hinged-joined to each other and to similar marginal edges of the rectilinear acute triangle panels of said first chamber section, to define, when fully expanded, two abutting chambers which are pyramidal in form and base connected together.

Another chamber section may be hinge-joined between the first chamber section and the second chamber section and comprise at least four generally rectangular, substantially rigid panels which are hinge-joined to each other along rectilinear edges with ends hinge-joined to corresponding ends of the first and second chamber section. Further, a plurality of such chambers may comprise a clustered array, with the rectangular panels of third chamber sections joined in aligned, planar abutment.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a basic working chamber consisting of two chamber sections defining an aerodynamically useful variable configuration and volume chamber in a partially expanded condition.

FIG. 2 is a side view of the working chamber of FIG. 1 fully expanded to define working chamber sections constituting abutting pyramids.

FIG. 3 is a top plan view of an alternate embodiment of the variable configuration and volume chamber of the present invention constituting three chamber sections joined axially.

FIG. 4 is an end view of a multiple array of variable configuration and volume chambers constituting an integrated cluster of four chambers in a partially expanded configuration.

FIG. 5 is the same chambers of FIG. 4 shown in the fully expanded configuration.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. 1 and 2 of the invention, in one embodiments, the variable configuration and volume working chamber of the present invention as applied to an aerodynamically useful chamber, consists of two chamber sections 1 and 2, chamber section 1 constituted by four substantially rigid panels 10 the marginal edges of each forming a substantially rigid rectilinear acute triangle and four substantially rigid panels 14, the marginal edges of each forming a substantially rectilinear obtuse triangle. In this case, panels 10 are all identical and panels 14 are all identical. The panels 10 and 14 are made from any substantially rigid sheet material, such as duraluminum, compatible with an adhesive sealant type of bonding material, such as a high strength silicone rubber, to effect hinge-joining of the same to each other, that is, to other panels 10 or to the panels 14. The panels 10 contain equal angles, A, of approximately 80° and a vertex angle B of approximately 20°. The four panels 14 have an obtuse angle, C, of approximately 143° and an intermediate angle, D, of approximately 22°, and a third angle, E, of approximately 15°. The panels so formed are positioned and supported by means commonly known to one skilled in the art, so that the panels form a chamber section which may readily vary both in volume and configuration. The adjacent marginal edges of adjacent panels are bonded to each other by the aforesaid adhesive sealant material and maintained in a fixed position until the bonding material has cured. When the chamber so formed is removed from the holding fixture, it is serviceable and biased, by the entrapped air, to preferably an intermediate volume configuration and responsive to normal variations of temperature and pressure to which it may be subjected. The dimensions of a working chamber suitable for actuating a valve, for example, in response to pressure changes, could be one in which the length of the base of the panels, 10, is approximately 3 inches and the length of the longer side of the panels, 14, is approximately 7¾ inches. An appropriate thickness of substantially rigid sheet material for this size chamber would be approximately one-sixteenth of an inch. In this case, while the overall chamber has aerodynamic capabilities due to its specific configuration, it may readily act as a variable configuration and volume working chamber for actuating a valve and be of relatively small size as identified above. In the illustrated embodiment of FIGS. 1 and 2, it is noted that the first chamber section 1 comprises specifically four rectilinear acute triangle panels 10 with two pairs of the first panels 10 defining the outer walls thereof and having corresponding marginal edges 3 hinge-joined together and other marginal edges 4 of the same panels 10 of each pair hinge-joined to corresponding marginal edges 5 of respective panels 14 of two pairs of second panels 14. Further, each of the two pairs of second panels 14 further have other corresponding marginal edges 6 of both panels hinge-joined together defining free edges at the rear of the chamber and each panel 14 of the second pairs of panels 14 further having a third marginal edge 7 hinge-joined to a similar marginal edge 7 of a corresponding panel of the other pair. The jointure of the second panels 14 together about marginal edges 7 is such that the obtuse vertices of the second panels intersect at a central axis, in this case the longitudinal axis of the chamber as defined by dotted line 8. By reference to FIG. 2, the hinge-joined attachment of the panels along the marginal edges as previously described allows the chamber to follow a predetermined correlated pattern of change in both configuration and volume when acted upon, with the pattern of change being characterized by the movement of the line of intersection defined by marginal edges 7 of panels 14 along a common plane including the longitudinal axis of the chamber throughout actuation or change in the volume. Further, there is retention of symmetry of all panels about this central axis throughout actuation of the chamber. In this illustrated embodiment, of FIGS. 1 and 2, the forward chamber section 2 is defined by four hinge-joined substantially rigid panels 10 identical to the rigid panels 10 of the first chamber section and each, of course, forming an identical substantially rectilinear acute triangle as do the first rigid panels 10 of the first chamber section. In this respect, the marginal edges 4 of panels 10 of the second chamber section are hinge-joined together as are marginal edges 3 for respective pairs of panels and, further, marginal edges 9 of the pairs of panels for the first and second chamber sections are hinge-joined together to complete the variable configuration and volume chamber. It is apparent that the working chamber may be fully deflated with the pairs of panels lying flat and in contact with each other or, when fully expanded, only the first substantially rigid panels defining substantially rectilinear acute triangles are visible and produce a chamber whose configuration comprises two base-abutting pyramids.

Reference to FIG. 3 illustrates another embodiment of the present invention in which the first and second chamber sections are identical to those of the embodiment of FIGS. 1 and 2, but the third chamber section 12 comprises four substantially rigid rectangular panels 11 of the proper size and configuration to match the bases 9 of the acute-angle panels 10 of the first and second chamber sections. The third chamber section 12, has the longitudinal marginal edges 13 of respective panels 11 hinge-joined in the same manner as described previously.

By equipping any one of the embodiments with an actuator 17 comprising a conventional extensible fluid power piston or the like and an inlet valve 18 and outlet valve 19 selectively positioned to control the configuration and/or volume of the working chamber, the chamber becomes a variable density or pumping apparatus as desired. The invention is not limited to the specific embodiments shown since it teaches the concept that chambers formed from two generally pyramidic structures having opposed congruent bases become variable in configuration and volume by the division of lateral edges of the structures and the insertion inwardly of appropriate numbers of appropriately shaped obtuse-angled triangular planes into the appropriate lateral edges and connecting the adjacent edges of the adjacent planes in such a way that the adjacent planes are free to vary their angular relationship.

As such, by referring to FIGS. 1 and 2 and in particular FIG. 2, and assuming that the working chamber is at it maximum volume configuration and contains a responsive fluid whose density is in equilibrium with the environmental density and that the environmental density then changes in pressure, under the influence of an increasing pressure, for instance, and due to the surface areas of the working chamber being free to change their relative positions without becoming unsealed, the working chamber will respond, in a manner similar to that of the actuator in an aneroid barometer. The actuation of the working chamber will be as follows: the points of intersection 20 of all panels on each side will move toward the center of the working chamber, decreasing its depth. The intersections of marginal edges 4 and 5 of panels 10 and 14 will move away from the longitudinal axis increasing the width of the working chamber and exposing surface panels 14. Such

concurrent movements will continue until the high pressure trend stops, the internal contents become incompressible or the working chamber reaches its minimum volume configuration. Obviously, reversal of the environmental pressure trend will reverse the actuation of the working chamber.

Further, by reference to FIGS. 4 and 5, a cluster of chambers, 23, 24, 25 and 26, may be readily achieved by the simple expedient of joining panels of intermediate chamber sections in aligned planar abutment so that the rectangular panels 11 of one complete chamber are in flush abutment with a similar panel 11 of another chamber. This may be readily seen where chambers 23, 24, 25 and 26 are so formed by planar abutment between rectangular panels 11 as illustrated in the end views thereof. Expansion and contraction of the individual chambers 23, 24, 25 and 26 of the cluster is transmitted through the abutting panels 11 to the other chambers so that all of the chambers expand and contract in unison and when completely expanded, take the form illustrated in the end view of FIG. 5.

When the working chamber is equipped with an actuator, 17, installed as shown in FIG. 3, having its two working ends, 21 and 22, pivotally coupled to the opposite sides of the working chamber, either expansion or contraction of the ends of the hydraulic actuator, 17, will cause the marginal edges, three of section 1, for instance, to move away from each other or towards each other, depending upon the movement of the fluid motor power piston. If an inlet valve, 18 and an outlet valve, 19, are provided, as shown, and if the actuator, 17, is operated cyclically, obviously the chamber will increase and decrease accordingly. As the chamber continues to enlarge, the inlet valve, 18, opens and the interior of the chamber fills, on the completion of its inward stroke, and reversal in direction, marginal edges, 3, move farther apart thereby decreasing the internal volume of the working chamber and placing the contents under pressure. Outlet valve, 19, then opens under the pressure and the contents of the interior of the working chamber discharge and the piston returns to its starting point. This completes one cycle of pumping action.

What is claimed is:

1. A variable configuration and volume chamber comprising:

at least one first chamber section, said first chamber section comprising a plurality of first substantially rigid panels with the marginal edges of each forming a substantially rectilinear acute triangle, and a plurality of second substantially rigid panels, the marginal edges of each forming a substantially rectilinear obtuse triangle, said chamber being formed by at least two pairs of first panels having corresponding marginal edges of respective panels of each pair hinge-joined together and defining outer chamber walls and other marginal edges of respective panels of each pair of first panels hinge-joined to corresponding marginal edges of respective panels of at least two pairs of second panels, each of said two pairs of second panels further having other corresponding marginal edges of both panels hinge-joined together and each panel of each of said second pairs of panels further having a third marginal edge hinge-joined to a similar marginal edge of a corresponding panel of said other pair of second panels, said jointure of said third marginal edges of said second panels lying in a plane of symmetry of said chamber; whereby the hinge-joined attachment of said panels along said marginal edges allows said chamber to follow a predetermined correlated pattern of change in configuration and volume when acted upon, said pattern being characterized by the movement of the jointure of said third marginal edges of said second panels being maintained in a plane of symmetry of said chamber throughout the actuation of said chamber.

2. The variable configuration and volume chamber as claimed in claim 1, further comprising at least one second chamber section hinge-joined to said first chamber section and comprising at least four substantially rigid panels with the marginal edges of each forming a substantially rectilinear acute triangle and having marginal edges hinge-joined to define a pyramidal chamber section, with the base marginal edges of said four panels being hinge-joined to the base marginal edges of the first panels of said first chamber section; whereby, when said chamber is completely expanded, the overall configuration comprises apparent base-joined pyramids.

3. The variable configuration and volume chamber as claimed in claim 2, further comprising at least one third chamber section said third chamber section comprising at least four generally rectangular, substantially rigid panels hinge-joined to each other said third chamber section further being inserted between said first and second chamber sections and having respective edges hinge-joined to the corresponding base marginal edges of said first and second chamber sections.

4. The variable configuration and volume chamber as claimed in claim 3, wherein a plurality of said chambers comprise a clustered array, with the rectangular panels of respective third chamber sections joined in aligned planar abutment.

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