Feb. 14, 1928. 1,658,876

K. ARNSTEIN ET AL

GAS CELL FOR AIRSHIPS

Filed April 5, 1924

FIG 1

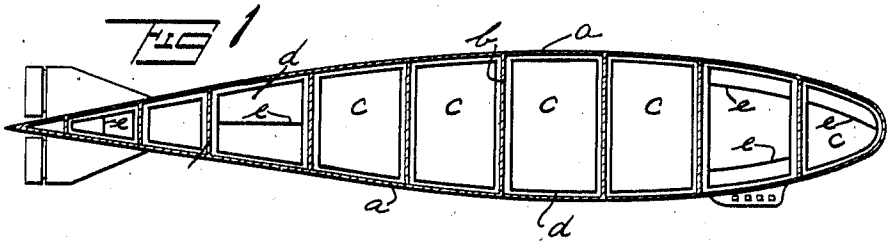


FIG 2

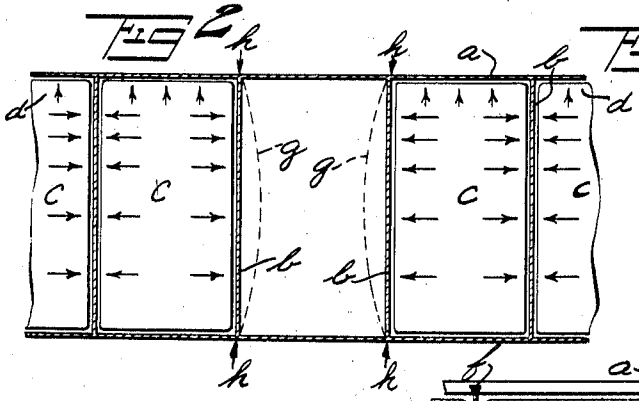


FIG 3

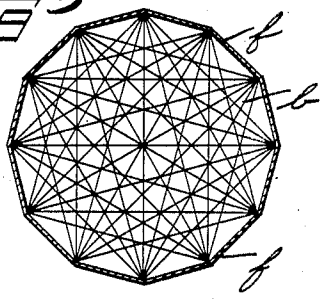


FIG 5

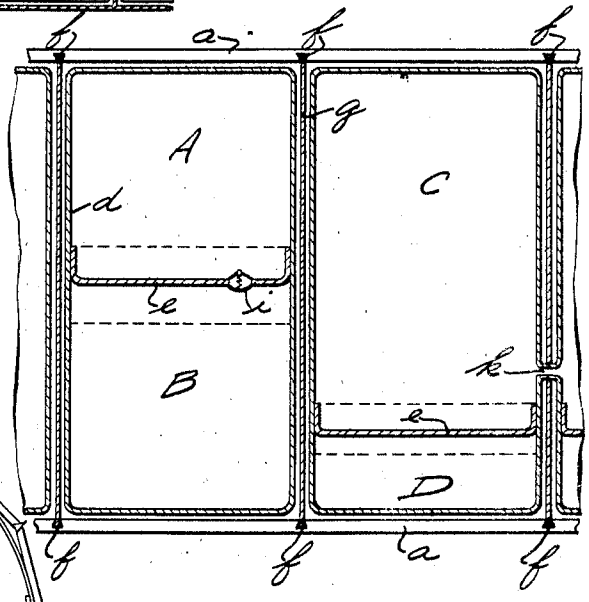
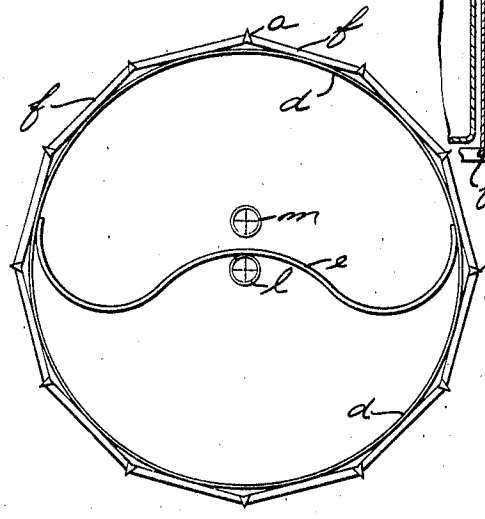


FIG 4



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UNITED STATES PATENT OFFICE.

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GAS CELL FOR AIRSHIPS.

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Our invention relates to means for limiting the loss of lifting gas, in case of accidents, from airships embodying cells inflated with such gas. In this way the safety of the airship is not imperilled. We will describe an airship embodying our invention and then point out the novel features thereof in claims.

In airships, the space filled with lifting gas forms the lifting power of the craft. A rent in the cover enclosing the lifting gas is of consequence because the gas will escape and thereby the airship will lose its buoyancy and be forced to come down. In larger airships therefore, it became necessary to subdivide the hollow gas space, so that there would be only a partial loss of the total gas. In rigid airships, this subdivision of the gas space is effected by the bracing of the rigid hull. That is, instead of one gas cell, a number of gas cells are provided, and they are separated by main rings consisting of circumferential girders arranged transversely of the structure, and which main rings are stayed or braced by wires running in various directions and generally connecting the corner or some of the corners of the main ring which is a polygon in contour. These main rings are connected by longitudinal girders and the longitudinal girders are braced by other wiring. Thus the hollow body of the hull structure is subdivided by the main rings into individual compartments. In each one of these compartments there is a gas-tight bag having generally a shape substantially that of its compartment, and termed a gas cell containing the lifting gas. All this is well-known, and ships constructed that way are generally called rigid airships of the Zeppelin type.

This subdivision of the whole ship's gas capacity has the aforementioned advantage, that is, if one of the gas cells is damaged, only the lifting capacity of this one cell will be lost. In case such an accident should happen each of the rings separating the empty compartment from the adjacent two other compartments will be subjected to the high gas pressure from the cells in the two adjacent compartments. This gas pressure on the rings from one side only is dangerous for the light structure of the hull, because of distortion, and to prevent this distortion it generally is necessary for the pilot to partially deflate the adjacent gas cells, which is done by operating their respective valves. Thus, there will be lost additional lifting power. The pressure from the adjacent gas cells is on the bracing wires of each of the two rings forming the empty compartment, with the effect that they tend to draw the ring to a smaller diameter. The compression stresses thus set up in the different ring girders will be especially high in the upper part of the structure because of the higher gas pressure in the gas cells at those points.

Our invention reduces these disadvantages and we will explain our idea referring to the annexed drawings which form part of this specification.

Fig. 1 is a longitudinal section of a rigid airship embodying our invention. Fig. 2 is a detail longtudinal section of a portion of the airship and drawn to a larger scale and illustrating the direction of pressures of the adjacent gas cells on the main rings of a compartment from which the lifting gas has escaped. Fig. 3 shows a main ring; Fig. 4 is a cross section of a gas cell embodying our invention, and Fig. 5 is a vertical longitudinal section of gas cells, embodying our invention. The outer cover of the ship is assumed to have been taken off.

The structure of the hull is composed of longitudinal girders *a* and ring girders *f* of well-known construction. The wire bracing of the rings is designated *b*. The circumferential bracing is not shown. *c* designates the compartments formed in part by adjacent rings *f* and the bracing *b*. *d* designates the gas cells located in the compartments *c*, and *e* designates partition walls within the gas cells for forming separate chambers within the gas cells.

In Fig. 2 is shown the effect on the bracing of adjacent main rings of a compartment in which the gas cell therefor has been damaged and from which the inflating gas has escaped. Its existence in the compartment is neglected. The arrows in the adjacent cells show the direction and action of the gas pressure. Where there are cells on both sides of the ring bracing, the pressure of one cell is offset by the pressure of the adjacent cell. But where the pressure on one side is missing (as here with the middle compartment), the wire bracing of the ring is deflected as shown by the dotted lines *g*

and thereby the ring corners are drawn towards the center of the ring, as indicated by the arrows *h*.

This effect is overcome by our invention, that is, by subdividing the gas cells *d* by flexible walls provided inside the gas cells. An example of this is shown in Fig. 4. In case of a rent in the upper part of the wall of the gas cell *d*, only the gas above the flexible partition wall *e* will escape. The pressure of the gas below the flexible partition wall *e* will cause the wall *e* to take the place of the damaged part of the cell *d*. Thus the lifting power of the airship will be reduced only by a part of what it would have been if the partition wall *e* was not employed. In addition, the gas pressure against the wiring of the adjacent cells will not disappear totally so that the strain that tends to deflect the ring wiring is much lower and the compression stresses on the ring girders will also be reduced, compared to that which would occur if the whole compartment would be deflated. In Fig. 5, two gas cells subdivided by partition walls *e* are shown. The one to the left corresponds with the arrangement shown in Fig. 4, while the one to the right shows the partition wall in the lower part so that the chambers C and D have different gas capacities.

As shown in Fig. 1 there may be one or more partition walls in a cell and also the plane of their main direction may vary as exemplified in the two rear compartments of Fig. 1. The partition wall might also have its position in any vertical or inclined longitudinal plane, which is not shown in the drawings. Also valves *i* or connecting sleeves *k* may be arranged between the different divisions of one cell as well as between the corresponding divisions of adjacent cells, for the purpose of discharging gas from one chamber to another to equalize the degree of inflation after one or more chambers have been damaged.

We wish it understood that we do not limit ourselves to the examples described or shown in the drawings, as many possibilities of making use of our invention will occur to persons skilled in the art. To state another example—further use may be made of the partition wall for the purpose of employing two different gases in the different chambers of a gas cell. It might be too expensive to inflate the whole ship with a non-inflammable gas, for instance, helium. The ship may be inflated with helium and partly with hydrogen, and the automatic valves may be arranged in such a way that the hydrogen gas will escape by the valves *l* before the valves *m* controlling the helium gas open.

In a hydrogen inflated ship, it might be desirable to have a non-inflammable gas at certain spots, for example, in the forward upper part of the ship where lightning is most likely to strike, or in the lower part directly above the engine cars, because of fire danger. This can easily be obtained by our invention.

What we claim is:

1. A rigid airship comprising a substantially tubular frame-work; transverse members subdividing the space confined by said frame-work into compartments, a gas cell in each of said compartments; a wall dividing one of said cells into separate chambers; one of said chambers being inflated with ordinary lifting gas and another one with a non-inflammable gas; and means for allowing the ordinary gas to escape first before the non-inflammable gas will be expelled by gas super-pressure.

2. A rigid airship comprising a substantially tubular frame-work; transverse members subdividing the space confined by said frame-work into compartments; gas cells in said compartments; several of said cells being divided into separate chambers by means of walls; and connecting means between the chambers of two adjacent cells.

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