Sept. 19, 1961 J. L. BITTING 3,000,418

DIFFERENTIAL PRESSURE CARGO AND LUGGAGE

Filed Feb. 6, 1959

2 Sheets-Sheet 1

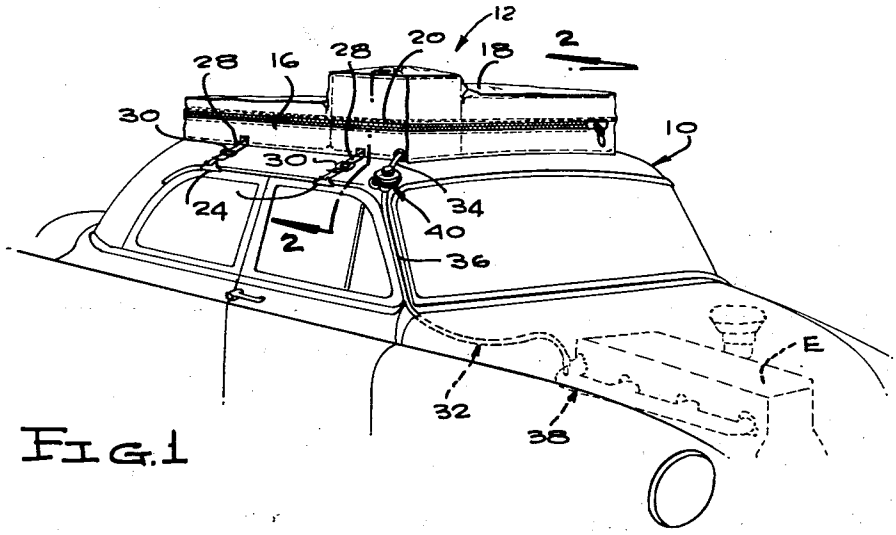

FIG. 1

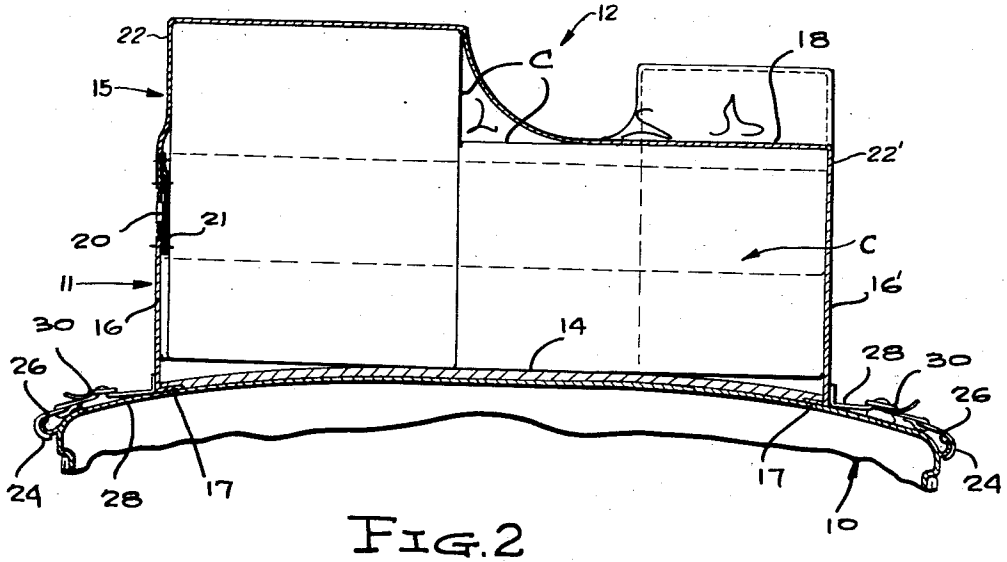

FIG. 2

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FIG. 3

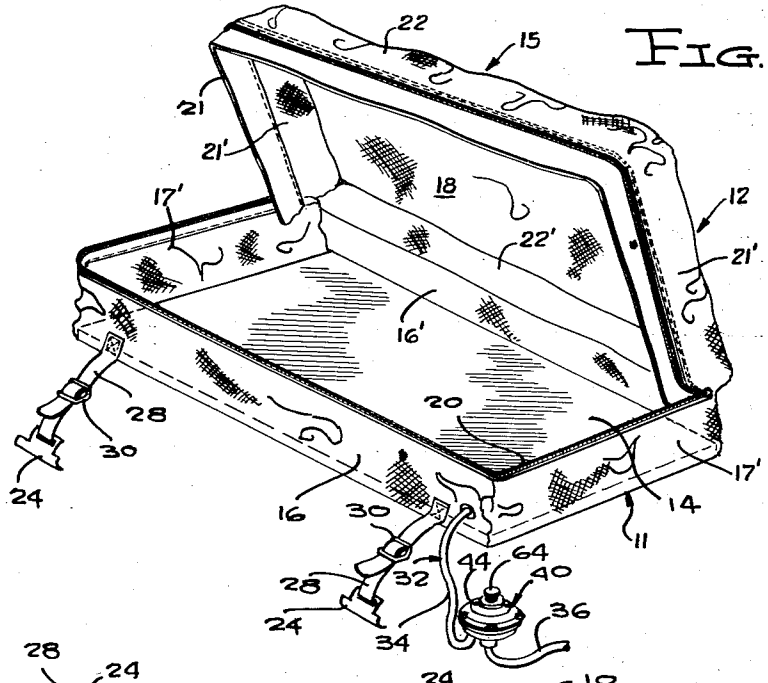
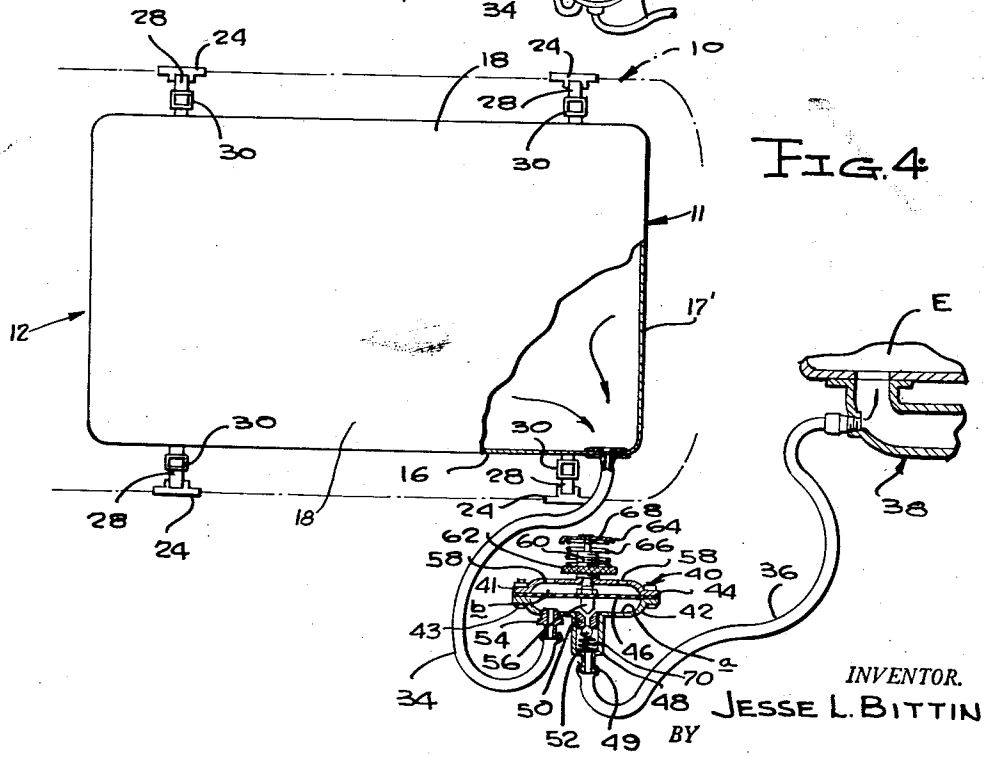


FIG. 4



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DIFFERENTIAL PRESSURE CARGO AND LUGGAGE CONTAINER

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6 Claims. (Cl. 150—52)

This invention relates to cargo containers, carriers, or related load-retaining structures. More particularly, the invention has reference to a device of this nature that will be designed for containing and securing cargo, luggage, or any other objects upon any type of vehicle.

To illustrate the invention, the container has been described and shown herein in the form of a device mountable upon the top of an automobile. However, it will be understood that this is merely exemplary of one form which the invention may take. In actuality, as will presently appear, the principles of the invention can be applied to containers used on aircraft, water craft, automobiles, trucks, etc. Obviously, the invention would differ in form according to the particular type of vehicle with which it is associated, all without, however, departure from the principles of the invention.

One important object is to provide a cargo and luggage container of the character described that will be so designed as to include an envelope having one or more flexible walls, said envelope being so designed as to permit the same to be connected in communication with a source of vacuum, in a manner such as to cause said wall or walls to collapse about the confined object or objects, in such manner as to support and restrain the cargo over the greatest part of the surface area of the cargo. In this way, it is proposed that the invention will firmly hold the cargo in place upon a base incorporated in the container.

Another object is to incorporate in a container of the character described a base construction which, in at least one form of the invention, will be so designed as to incorporate a means of fastening the same firmly to the load-bearing structure of the vehicle. It is further proposed, in connection with the base, to provide a construction wherein in at least some installations, the base will conform itself in shape to the configuration of the surface with which the base is in contact, thus to distribute the weight of the supported load over the full area of the vehicle surface underlying said load, in a manner to avoid over-stressing of any one point of said surface such as would result from undue concentration of all the weight on a relatively small area.

Yet another object is to incorporate in the container a cover so designed as to completely enclose the cargo, in a water-proof and airtight envelope in which a vacuum or partial vacuum condition can be readily created.

Another object is to provide a container for luggage or other cargo which, though adapted in the manner described above to permit the swift creation of a vacuum condition therein, will nevertheless be designed to facilitate the swift opening and closing of the envelope.

Yet another object is to so design the device as to adapt the same for connection to a pre-existing source of vacuum. Thus, in automobile-top applications of the invention, it is proposed to permit the device to be communicated with the intake manifold of the automobile engine. When the invention is utilized in an aircraft, it is proposed to permit the device to be connected in communication with light-weight vacuum pumps such as are conventional equipment in many aircraft, with a secondary source of vacuum being obtainable by mounting a venturi in the slip stream or by tapping low pressure areas of the fuselage or wing surfaces.

Another object is to provide a device of the character stated that will be designed, in many applications of the

invention, to permit full control of the vacuum introduced into the envelope, by means of a regulator or equivalent means adjustable to give a desired differential between ambient and inside pressures, ranging from zero differential up to and including the maximum of which the source of vacuum is capable.

Among other objects of the invention are the following:

To facilitate speed and ease of loading or unloading;

To adapt the differential pressure cargo and luggage container and carrier comprising the invention to almost any cargo (not of a liquid nature) capable of being confined in the envelope;

To permit differential pressure to be increased to provide more restraint for large heavy items, and to also permit the reduction of differential pressure when fragile items are being transported, in such a manner as to give firm restraint without damage;

To allow any shape of object to be accommodated, by reason of the fact that the cover conforms automatically to the shape of the confined load;

To so design the device that the retraint imposed upon the cargo against shifting or relative movement of the various pieces of the cargo, will be uniform or even over the entire surface of the cover and hence over the entire surface of the cargo, due to the fact that the restraint is produced by ambient pressure acting upon the outside of the cover, the arrangement being desirable in view of the characteristic thereof of eliminating pressure points which are ordinarily created by the use of hold-down ropes, cords, or straps;

To so design the device that it will make use of any of various available vacuum sources;

To provide a container as stated which will be characterized by economy in time, during the loading and unloading operations, as well as economy of manufacture;

To eliminate the use of wings, bolts, eyes, and equivalent devices ordinarily needed for tying down a cargo; and

To provide a device as stated which will occupy a minimum amount of space, by reason of the fact that because the cover collapses and folds about the cargo, the cargo and the container occupy the minimum possible cubage, resulting in substantial space savings when mounted inside a vehicle, as well as minimum clearance and aerodynamic drag when the device is mounted externally.

Other objects will appear from the following description, the claims appended thereto, and from the annexed drawings in which like reference characters designate like parts throughout the several views and wherein:

FIGURE 1 is a perspective view showing a conventional automobile fragmentarily, the container being illustrated in perspective as it appears when in use upon the vehicle;

FIGURE 2 is an enlarged transverse sectional view on line 2—2 of FIGURE 1;

FIGURE 3 is a perspective view, on a scale between that of FIGURES 1 and 2, showing the device per se in its open condition; and

FIGURE 4 is a top plan view of the device on a scale substantially equal to that of FIGURE 3, portions being shown in section, the device and its associated connections to a source of vacuum being illustrated somewhat diagrammatically.

Referring to the drawing in detail, generally designated at **10** is a vehicle on which is mounted a cargo container **12** according to the present invention. At this point, it should be noted that a conventional automobile is shown, with the container being one that is specifically adapted for mounting on the top of the vehicle. However, while this will be one of the readiest applications of the invention, it should not by any means be considered as the only possible application of the construction. The

invention could be used in or on water craft, aircraft, or other types of land vehicles besides the type shown in the drawing. According to the type of vehicle on which the device is used, the construction might be modified somewhat.

The container 12 comprises upper and lower pan-shaped sections 15 and 11 respectively. The lower section 11 includes a bottom wall 14 which, in the case of the container being for the top of the vehicle, would be semi-rigid so as to enable it to conform, more or less, to the shape of the top of the vehicle, as shown in FIGURE 2.

In the case of a custom installation, the bottom of the unit might be made to fit exactly to the contour of the automobile top. This is not completely essential to successful operation of the invention, however, and any construction which would permit the base portion to conform itself or be readily conformed by a user to the general shape of the vehicle top will be completely adequate for its intended purposes.

In still other arrangements, the base might be rigidly constructed, and might even consist wholly or in part of one or more surfaces of the load-carrying vehicle itself.

The cover section 15 comprises a flexible top wall 18 and a flexible depending peripheral wall which includes side walls 22 and 22' and end walls 21', and a sealing flap 21 extends around the peripheral wall, except for the side wall 22', at the inward side of the peripheral wall and extends therebelow and telescopes into the lower section 11.

The lower section 11 which is pan-shaped and rectangular includes a bottom wall 14 and has an upstanding flexible peripheral wall rising therefrom, the flexible wall including side walls 16 and 16' and end walls 17' The side walls 16 and 16' have inwardly-directed flanges on the lower edges which are secured sealably to the periphery of the bottom wall 14.

In the illustrated device, closure means is provided, said closure means comprising a slide fastener 20 which extends along the top of the side wall 16 and along both end walls 17'.

Any of various suitable means can be employed for connecting the container upon a vehicle. In a car-top application, such as shown, such means comprises retaining hooks 24 engageable with the rain gutters at the opposite sides 26 of the vehicle. Connected to the hooks 24 are straps 28, having buckles 30 incorporated therein to facilitate adjustment of the length of the straps, the straps being secured to the side walls 16 and 16' of the lower section 11.

The cover is adapted to be connected in communication with a readily available source of vacuum. Accordingly, in the car-top application of the invention there is provided a line generally designated 32 extending from the lower section 11 of the container to the intake manifold 38 of the engine E of the vehicle. Line 32 is flexible from end to end, and comprises a pair of tubes 34 and 36 connected to the lower container section 11 and to the intake manifold 38 of the vehicle engine E.

Connected in line 32 is an adjustable pressure regulator 40. For example, if fragile objects are carried in the container 12, it would be desirable that the container collapse about such articles rather gently, rather than with a strong confining force. In this event, a partial vacuum is produced within the container which is on the order of only a half-pound less in pressure than the external atmospheric pressure upon the outer surface of the container. Where stronger objects are carried, a greater vacuum is produced within the container. As a result, outside pressure upon the container causes the cover to be collapsed into firm restraining engagement with the confined cargo C in the container.

The illustrated regulator 40 includes a shallowly-dished or concavo-convex lower casing section 42 disposed in opposing relation to a similar upper casing section 44.

The casing sections have peripheral flanges 41 which are secured together as by bolts 43. A diaphragm 46 extends across the casing with its edge engaged between the flanges 41 of the casing sections, defining at one side of the diaphragm a chamber *a*, while defining at the opposite side of the diaphragm a chamber *b*.

Centrally formed and extending downwardly from the lower casing section 42 is a hollow boss 48 terminating in a fitting 49 connectable to the suction tube 36. A plug 50 having a dual valve seat is secured in the upper end of the boss 48. A spring-pressed ball valve 52 is engaged with the lower one of the dual valve seats of the plug 50.

Adjacent boss 48 there is secured to the lower casing section 42 a fitting 54, to which is connected the suction tube 34.

A plunger valve 56 is secured to the diaphragm 46 and is normally spaced from the upper end of the seat 50 by the diaphragm.

In the upper casing section 44 there are formed vents 58 providing continuous communication between the interior of the chamber *b* and outside air.

Rigid with the center of the upper casing section 44 is an upstanding threaded tubular boss 60 on which is threaded a flat circular knurled nut 62. Spaced from the outer end of the boss and nut 62 is a spring cap 64, and a coil spring 66, circumposed about the boss 60, is compressed between the boss and the nut. Obviously, the tension of the spring can be adjusted for purposes to be made presently apparent by turning the nut 62 along the boss 60.

Reciprocable in the bore of the boss 60 is a stem 68, the outer end of which carries the spring cap 64, and the inner end of which is connected to the conically-tipped plunger 56.

Air is evacuated from the container 12 and enters the regulator 40 at the intake fitting 54. The air passes through chamber *a* through the plug 50, past the unseated ball valve 52 to the tube and thence to the manifold 38. The ball valve 52 is only lightly loaded by a spring 70, the tension of the spring 70 being only great enough in a static condition to hold the check ball against the adjacent valve seat of the plug 50.

Initially, the vacuum in the diaphragm chamber *a* remains low, due to the large volume of air passing in through the vacuum outlet fitting 54. As the air is evacuated from envelope 12 and pressure in the envelope decreases, the lower pressure is communicated to the vacuum chamber *a* through the vacuum outlet fitting 54. As the pressure in the diphragm chamber *a* decreases, ambient pressure enters the regulator through the vents 58, and acts upon that surface of diaphragm 46 shown as the upper surface in FIGURE 4, this being the surface bounding chamber *b*.

As the pressure differential increases, diaphragm 46 is deflected in a direction toward the boss 48, that is, downwardly in FIGURE 4. This moves stem 68 in a corresponding direction, together with the plunger or valve element 56. Spring 66, meanwhile, is placed under increased compression by the mentioned movement of the stem 68.

When the vacuum in the envelope and in the diaphragm chamber *a* has reached a predetermined value, the differential pressure will have moved diaphragm 46, stem 68, and valve element or plunger 56 downwardly in FIGURE 4 to such an extent as to cause the valve element 56 to seat upon the adjacent valve seat of plug 50, this being the upper valve seat of said plug viewing the same as in FIGURE 4.

This closes off the vacuum source, and allows the pressure differential on both the diaphragm chamber *a* and envelope 12 to remain at the predetermined value, which value can be determined in advance by selective adjustment of the tension of the spring 66 through the provision of the nut or abutment 62.

Once the pressure differential has been established,

the vacuum source is closed off and no air flow is allowed. If, then, vacuum in the envelope **12** should decrease due to leakage in the envelope or in the vacuum line, the vacuum in the diaphragm chamber *a* will also decrease. The tension of the spring **66** overcomes the lower pressure differential on the diaphragm **46**, causing the diaphragm to be deflected in a direction upwardly in FIGURE 4, thus to lift the valve element **66** off its associated valve seat. This opens the vacuum source to re-establish the desired pressure differential.

It will thus be seen that if a leak in the envelope does develop, air flow will be allowed by the regulator, but only in the exact volume necessary to compensate for the leak.

It will also be observed that the check ball **52** has been located at the down-stream side of the regulator, since it might cause a certain amount of restriction, which would be undesirable on the up-stream side of the regulator. To obtain the optimum operational characteristics and sensitivity, the passages up-stream of the regulator, that is, between the regulator **40** and the envelope **12**, should be of uniform size and completely free of obstructions or restrictions.

The valve, when operating, will have a slight difference in opening and closing pressures. For example, the valve might close at a differential pressure of 4" Hg, but would not reopen until pressure dropped to 3.85" Hg. This feature is desirable in that it will prevent chattering during operation. It may be noted that the feature comes into operation, and is controllable, by the area of the orifice of the double valve seat in the plug **50**. Thus, when the valve closes, the maximum vacuum available at the source will be effective on the area of the valve exposed by the orifice, thus adding slightly to the closing force. This of course would require a very slight drop in vacuum on the diaphragm surface before opening would occur.

As previously mentioned, this effect is desirable, to prevent overwork and valve chatter, and can be controlled easily by designing either a larger or smaller valve and seat as desired.

As to the relief of vacuum within the envelope prior to opening, this might be done in several ways, including a small bleed valve between ambient pressure and the valve chamber *a*. However, this should not be done by unseating of the check ball, it may be noted, particularly when an intake manifold is the source of vacuum. Were the check ball unseated under these conditions and for this purpose, there could be caused a drawing of the fuel-air mixture out of the manifold and into the envelope **12**

It will be seen that by reason of the operational characteristics described above, when the device goes into operation the side, top, and end walls of the envelope or container **12** will collapse about and will conform very closely to the shape of the cargo C in the manner shown to particular advantage in FIGURES 1 and 2. In this way, a restraining force is immediately exerted upon the cargo, tending to hold the same in place upon base portion **14** without danger of shifting. Further, any tendency of the cover to flap in the wind during movement of the vehicle, in circumstances that would obviously create a weakening of the cover, is eliminated. Still further, aerodynamic drag is reduced to a minimum.

It is believed apparent that the invention is not necessarily confined to the specific use or uses thereof described above, since it may be utilized for any purpose to which it may be suited. Nor is the invention to be necessarily limited to the specific construction illustrated and described, since such construction is only intended to be illustrative of the principles, it being considered that the invention comprehends any change in construction that may be permitted within the scope of the appended claims.

What is claimed is:

1. In combination, a motor vehicle having a body and an engine-driven source of suction, a closed collapsible cargo container mounted on said body, a suction conduit leading from said source to the container, and an adjustable suction regulator connected in said conduit.

2. In combination, a motor vehicle having a body and an engine-driven source of suction, a closed collapsible cargo container mounted on said body, a suction conduit leading from said source to the container, and an adjustable suction regulator connected in said conduit, said source being an engine intake manifold.

3. In combination, a motor vehicle having a body top and an engine-driven source of suction, a flexible and collapsible closed container resting upon and conforming to the contour of said body top, and a suction conduit leading from the container to the suction source.

4. In combination, a motor vehicle having a body top and an engine-driven source of suction, a flexible and collapsible closed container resting upon and conforming to the contour of said body top, and a suction conduit leading from the container to the suction source, said source being an intake manifold of the engine, and a suction regulator connected in said conduit.

5. A differential pressure container comprising pan-shaped lower and upper sections, said lower section having a bottom wall and an upstanding flexible peripheral wall, said upper section having a flexible top wall and a flexible peripheral wall, said peripheral walls having end walls and first and second side walls, said walls having free edges, a flexible sealing flap secured to the inward side of the peripheral wall of the upper section to telescope into the lower section when the upper section is closed onto the lower section, means sealingly hinging the second side walls of the section together, separable fastening means along the free edges of the walls of the sections, a suction conduit leading into the interior of the container, and means secured to the lower section for securing the container on a support.

6. In combination, a vehicle body having a top, a differential pressure container comprising pan-shaped lower and upper sections, said lower section having a bottom wall and an upstanding flexible peripheral wall, said upper section having a flexible top wall and a flexible peripheral wall, said peripheral walls having end walls and first and second side walls, said walls having free edges, a flexible sealing flap secured to the inward side of the peripheral wall of the upper section to telescope into the lower section when the upper section is closed onto the lower section, means sealingly hinging the second side walls of the section together, separable fastening means along the free edges of the walls of the sections, a suction conduit leading into the interior of the container, and means secured to the lower section for securing the container on the body top with the bottom wall of the lower section resting upon the body top.

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