July 19, 1955 A. S. FLETCHER ET AL 2,713,466

SHOCK ABSORBING DEVICE

Filed Jan. 25, 1950 2 Sheets-Sheet 1

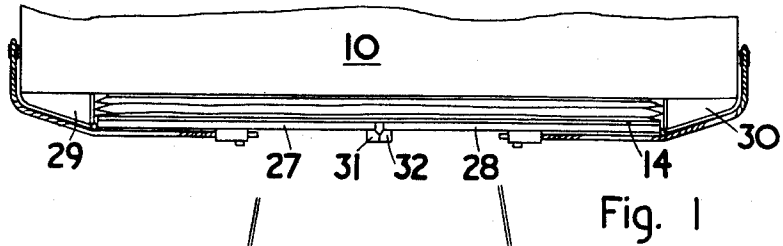


Fig. 1

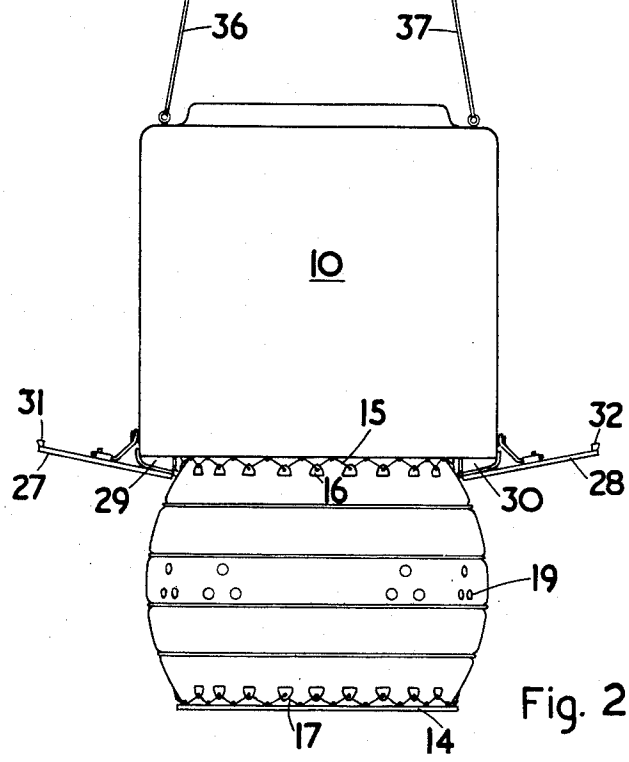


Fig. 2

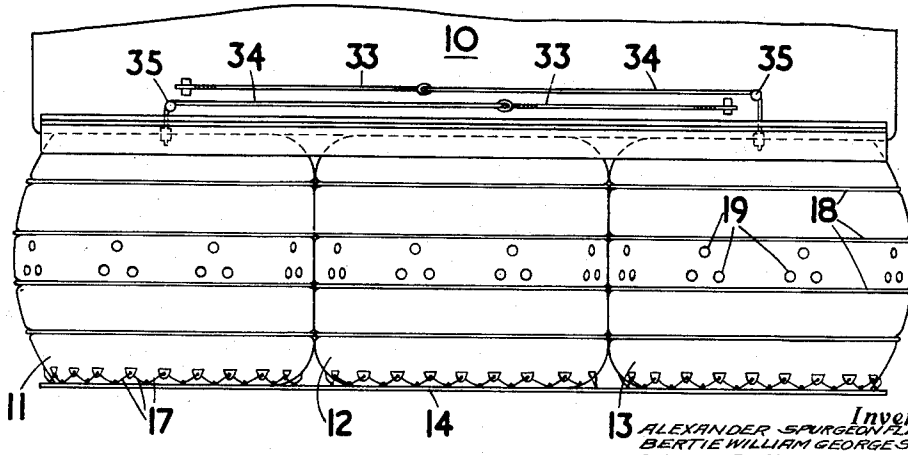


Fig. 3

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SHOCK ABSORBING DEVICE

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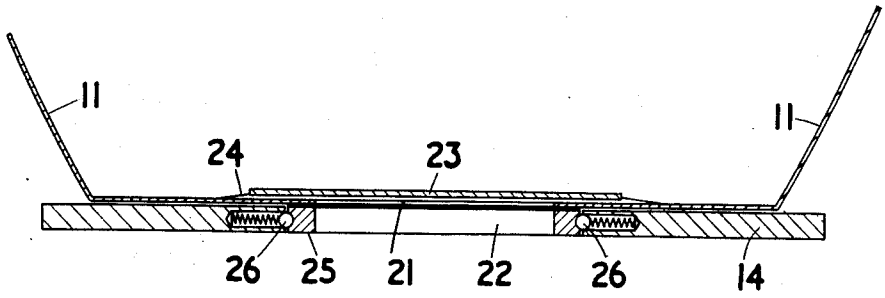


Fig. 4

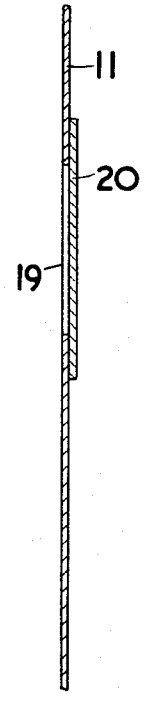


Fig. 5

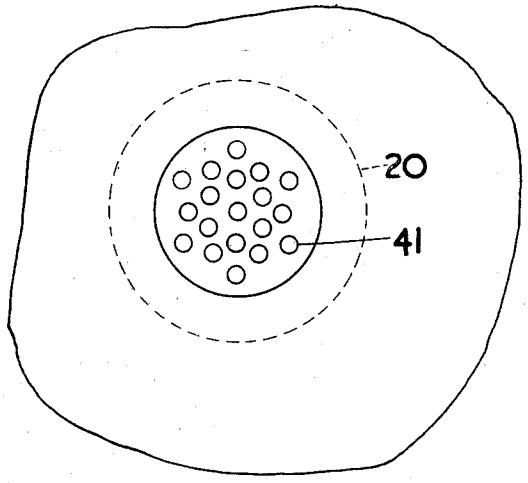


Fig. 6

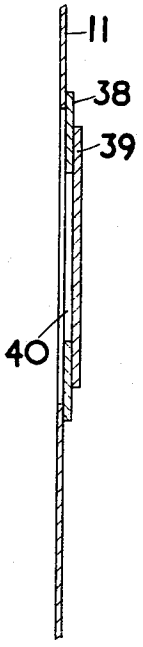


Fig. 7

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SHOCK ABSORBING DEVICE

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Claims priority, application Great Britain January 31, 1949

17 Claims. (Cl. 244—138)

This invention relates to shock-absorbing devices and is more especially, though not exclusively, concerned with such devices for use with parachute-borne and other objects dropped from aircraft.

In connection with shock-absorbing landing gear for parachute-borne objects, we have carried out experiments with air-filled bags provided with holes through which the air escaped as it was compressed under the momentum and weight of the object, giving a dash-pot type of shock-absorption. In order to prevent eventual bursting of the bags and consequent loss of cushioning effect just when most required, it was necessary to use holes of such size that air escaped freely in the early stages of collapse of the bags. The object of the present invention is to provide shock-absorbing devices giving more satisfactory cushioning and a feature of it is the covering of a hole or holes in a pneumatic shock-absorbing bag with a membrane or membranes which is or are of material which is more expansible than the material of which the bag itself is made and/or which will fracture at a much lower strain than will such latter material. The use of the membrane prolongs the retention of the original volume of air and ensures an initial compression thereof before relatively free or even full-bore escape through the hole or holes in the bag proper is permitted.

In our previous experiments, the filling of the bags during free fall was by way of the laterally disposed escape holes: this resulted in incomplete inflation of the bags and a reduced working volume of air. We now prefer, as a further feature of our invention, to employ holes in the bottom of the bags, whereby forced inflation is effected during descent, escape of air through the filling holes during compression under load being prevented by non-return valves.

The above and other features of the invention are embodied in the parachute-borne load-support and landing gear therefor which is illustrated by the drawings: in which:

Figure 1 is an end view of part of the support and landing gear, the bags of the latter being in deflated condition,

Figure 2 is a similar view, to an enlarged scale, the bags being shown inflated,

Figure 3 is a side view, the parts being shown in the same condition as in Figure 2,

Figure 4 is a section through the base-board and the lower portion of one bag of the landing gear,

Figure 5 is a sectional view through a portion of a bag to illustrate a detail,

Figure 6 is a view similar to that of Figure 5 illustrating a modified arrangement and

Figure 7 is a face view of a portion of a bag illustrating a detail arrangement alternative to those of Figures 5 and 6.

Referring first to Figures 1 to 5, the load-support illustrated is a freight container **10** and the landing gear

therefor comprises three inflatable bags **11**, **12** and **13** of multi-ply rubberised fabric suspended from the underside of the floor of the container and carrying a base-board **14** of plywood. The suspension of each bag is effected by means of cords **15** of suitable breaking strain passed through eyelets **16** in the rubberised fabric and through eyebolts (not shown) in the container floor; a similar form of attachment is employed between each bag and the base-board, the relevant cords being indicated at **17**.

Each bag is of substantially oblate spheroid shape when inflated and the bags are reinforced with endless flexible wire grommets **18**. A number of circular holes **19** are formed in the side wall of each bag, in the neighbourhood of the equator thereof and so positioned as not to be masked by an adjacent bag. These holes are covered by thin membranes **20** of rubber or other suitable expansible material cemented to the inside of the bags' walls. A circular hole **21** is formed centrally in the bottom of each bag and registering holes **22** are provided in the base-board; the passage of air through these holes is controlled by simple non-return valves each comprising a disc **23** of fabric of greater diameter than the associated hole, anchored inside the bag by elastic cords **24** to lie concentric with the hole. The alignment of the holes in the bags with the corresponding holes in the base-board is ensured by means of annular plywood frames **25** (see Figure 4) cemented to the outside of the bags concentric with the holes therein and normally retained within the corresponding holes in the base-board by means of spring-pressed ball catches **26**.

The landing gear is completed by door members **27**, **28** hinged to fairings **29**, **30** carried by the container at each side thereof. These door members are normally locked together, by means of releasable locking means **31**, **32** in the position indicated by Figure 1 in which they contact the base-board and retain the bags in deflated, folded condition against the underside of the container floor. Elastic cords **33**, anchored to the container are attached to wire cables **34**, which pass over pulleys **35** and are anchored to the respective door members: the elastic cords **33** are normally stretched and serve to cause the door members **27**, **28** when released by the locking means **31**, **32**, to open outwardly to the positions shown in Figure 2, where they abut against the respective fairings and are inclined slightly upwards.

Upon the container being dropped from the transporting aircraft to descend under the retarding influence of parachute equipment attached by means of lines (of which two are shown at **36** and **37** in Figure 2), delay mechanism (not illustrated) is set in operation which releases the door members after a predetermined interval. The opening of the door members, by means of the elastic cords, releases the base-board which drops to extend the bags; the non-return valves **23**, **24** are opened by the dynamic pressure due to the passage of the equipment through the air, which pressure also results in rapid and complete inflation of the bags.

When the base-board strikes the ground, the non-return valves prevent escape of air through the filling holes and the air within the bags becomes compressed, the thin membranes **20** being forced to expand through the holes in the bag to form small balloons; when a sufficient internal pressure is reached, the membranes burst and the absorption of shock is thereafter achieved by the dash-pot effect of the air escaping through the holes in the bags.

Horizontal velocity of the container relatively to the ground and/or the base-board is accommodated by a rolling action in the deflating bags and the effect of

this action in preventing damage to the container and contents is augmented by the use of cord of suitable breaking strain for the securing of the air bags to the container and to the base-board; if and when, the attachment cords break, the ball catches **26** associated with the plywood frames **25** offer very little resistance to complete detachment of the bags from the base-board. The function of the door members, when in the opened condition, is to give stability against overturning of the container, particularly if dragged along the ground by a parachute which has not been freed on touch-down.

In the modification illustrated by Figure 6, small holes **41** are provided in the membranes **20**; in operation these holes become enlarged as the material of the membranes expands under the internal air pressure, providing gradually increasing exit paths for the air. The arrangement may be such that the membranes eventually burst (as in the previously described arrangement) or that the holes therein become sufficiently large to provide the required escape path for air.

In the modification illustrated by Figure 7, the single membranes so provided to cover each hole **19** in the arrangements according to Figure 5 or 6 are replaced by pairs of membranes **38** and **39** of which each membrane **38** is apertured, as at **40** and is of material more easily frangible than the material of which the bag is made; each membrane **39** covers the aperture **40** in the associated membrane **38** and is of material which is more easily frangible than that of which the membranes **38** are made. Normally, the action will be similar to that previously described the membranes **39** above being fractured in the shock-absorbing action. Should the container land at an unduly high speed, however (for example, due to a parachute failure), fracture of the membranes **39** will be quickly followed by fracture of the membranes **38** to provide enlarged air-escape holes with a view to preventing bursting of the bags and consequent complete loss of shock-absorbing effect.

We claim:

1. A pneumatic shock-absorbing device comprising an inflatable, perforated bag and a membrane covering a perforation in said bag and of lower breaking strain than said bag, whereby said bag will absorb a relatively violent initial impact without bursting, but will still retain sufficient air to afford continued cushioning after the initial impact.

2. A pneumatic shock-absorbing device comprising an inflatable, perforated bag and a membrane covering a perforation in said bag and of elastic material which is more expansible than the material of which said bag is made, whereby said bag will absorb a relatively violent initial impact without bursting, but will still retain sufficient air to afford continued cushioning after the initial impact.

3. A pneumatic shock-absorbing device comprising an inflatable, perforated bag and a perforated membrane covering a perforation in said bag and of material which is more expansible than that of which said bag is made, whereby said bag will absorb a relatively violent initial impact without bursting, but will still retain sufficient air to afford continued cushioning after the initial impact.

4. A pneumatic shock-absorbing device comprising an inflatable, perforated bag, an apertured membrane covering a perforation in said bag and of lower breaking strain than said bag and a second membrane covering the aperture in said apertured membrane and of lower breaking strain than said apertured membrane, whereby said bag will absorb a relatively violent initial impact without bursting, but will still retain sufficient air to afford continued cushioning after the initial impact.

5. A pneumatic shock-absorbing device comprising an inflatable, perforated bag of rubberized fabric and membranes of rubber covering perforations in said bag whereby said rubber membranes will permit said bag to absorb a relatively violent initial impact without bursting, but will retain sufficient air to afford continued cushioning after the initial impact.

6. Pneumatic shock-absorbing means for cushioning the alighting of an object dropped from the air comprising a perforated bag, a membrane of relatively easily frangible material covering a perforation in said bag and non-return valve means in the bottom of said bag whereby said bag may be inflated by the air pressure developed during the dropping of the object.

7. A support for a load to be dropped from the air provided with shock-absorbing alighting gear comprising an inflatable, perforated bag, a membrane covering a perforation in said bag and of lower breaking strain than said bag, a base-board attached to said bag and means for releasably securing said base-board to said support in a relation such that said bag is retained in a deflated condition.

8. A load-support as claimed in claim 7 in which the means for releasably securing said base-board comprises a pair of members hinged to said load-support, spring means urging said hinged members to swing clear of said base-board and locking means for releasably holding said hinged members against the action of said spring means.

9. A load-support as claimed in claim 8 in which said hinged members are hinged on axes substantially parallel to the normal direction of horizontal motion of the load-support and are arranged, under the action of said spring means, to take up positions in which their under surfaces are upwardly inclined in relation to the load-support.

10. A support for a load to be dropped from the air having shock-absorbing alighting gear comprising a plurality of perforated, inflatable bags, membranes covering perforations in said bags and more easily frangible than said bags, a base-board and cords of lower breaking strain than the material of said bags securing said bags to said base-board.

11. A support for a load to be dropped from the air having shock absorbing alighting gear comprising an inflatable, perforated bag, a membrane of relatively elastic material covering a perforation in said bag, a base-board, and cords securing said bag to said load-support and to said base-board and of breaking strain less than that of the material of which said bag is made.

12. A support for a load to be dropped from the air having shock-absorbing alighting gear comprising an inflatable, perforated bag, a relatively easily frangible membrane covering a perforation in said bag, an apertured base-board, non-return valve means whereby said bag may be inflated by way of the aperture in said base-board, cords of relatively low breaking strain securing said bag to said load-support and to said base-board, an apertured member secured to said bag and spring-pressed locking means for releasably securing said member with its aperture co-axial with that of said base-board.

13. A support for a load to be dropped from the air having shock-absorbing alighting gear comprising a plurality of perforated, inflatable bags, an apertured base-board, cords of relatively low-breaking strain securing said bags to said load-support and to said base-board so that the perforations of one bag are not masked by another bag when in the inflated condition, membranes of relatively easily frangible material covering perforations in said bags and non-return valve means whereby said bags may be inflated by way of apertures in said base-board.

14. A support for a load to be dropped from the air having shock-absorbing alighting gear comprising a plurality of perforated, inflatable bags, membranes of relatively expansible elastic material covering perforations in said bags, a base-board secured to said bags, hinged members carried by the load-support, releasable locking means for holding said hinged members in positions such that they contact said base-board and thereby retain said bags in deflated condition and elastic cords adapted, upon re-

lease of said hinged members, to pull them clear of said base-board.

15. A load-support as claimed in claim 14 in which said elastic cords are anchored to the load-support and are secured to relatively non-extensible cords anchored to said hinged members.

16. A parachute-borne load-support having shock-absorbing alighting gear comprising a plurality of perforated bags of substantially oblate-spheroid shape, cords securing the upper portions of said bags to said load-support, membranes covering perforations in said bags and more expansible and more easily frangible than said bags, an apertured base-board, cords securing said base-board to the lower portions of said bags, non-return valve means whereby said bags may be inflated by way of the apertures in said base-board, hinged members carried by said load-support, releasable locking-means adapted to retain said hinged members in contact with said base-board and thereby to retain said bags in deflated condition and spring means, carried by said load-support, adapted to cause said hinged members, when released by said locking means, to

swing clear of said base-board to allow it to fall in relation to said load-support.

17. A support for a load to be dropped from the air having shock-absorbing alighting gear comprising an inflatable, perforated bag, membranes covering perforations in said bag and more easily frangible than said bag, a baseboard carried by said bag and having an aperture therein, said bag having an opening aligned with said aperture to permit air to enter and inflate said bag, and non-return valve means associated with said aperture preventing egress of air from the bag through the aperture in said baseboard.

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