IMPACT CUSHIONING APPARATUS

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ABSTRACT

An impact cushioning bumper comprises an elongated channel-shaped contact member attached at its edges to an elongated mounting member having a face convex-out in cross-section toward the contact member. Within the channel are positioned upright slabs of elastomer which, when the contact member is moved toward the mounting member, are tensioned by stretching over its convex face.

21 Claims, 7 Drawing Figures
IMPACT CUSHIONING APPARATUS

This application is a continuation-in-part of our applications Ser. No. 258,753, filed June 1, 1972, now abandoned, and Ser. No. 331,328, filed Feb. 9, 1973, now abandoned, both of which are incorporated by reference herein and made a part hereof.

This invention relates to an impact cushioning apparatus for motor vehicles and the like. It is more particularly concerned with impact cushioning apparatus of that type which utilizes an elastomer for the cushioning agent.

Various types of impact cushioning or absorbing bumpers have been devised using elastomers in compression for the cushioning material. A great disadvantage of bumpers of this type is the limited cushioning effect obtainable in practical designs because of the narrow range through which elastomers can be compressed before failing. For most elastomers failure in compression occurs between about 25 percent and 50 percent deformation and even in the absence of failure the modulus of elasticity increases so rapidly at high deformations that the energy absorbing capacity becomes negligible. Thus, if a bumper is to absorb a given amount of energy in a deflection of three inches, for example, an elastomer under compression should be at least six inches thick. Furthermore, as the deflection of an elastomer in compression increases the rate of deceleration of a bumper employing such an elastomer increases, which results in a hard stop. Elastomers in tension, on the contrary, absorb energy over a relatively great deflection and so make possible a softer stop. We have found, however, that an elongated bumper utilizing elastomer in tension as its sole or principal energy absorbing medium and which provides a soft stop when it makes contact with a wall or other object which engages it along all or more of its contact face may “bottom” and so provide a considerably softer stop when it makes contact with a pole or like object which engages only a limited portion of its contact face.

It is an object of our invention therefore to provide an impact cushioning bumper which will more uniformly cushion distributed and localized impacts. It is another object to provide such a bumper in which the principal cushioning agent is an elastomer in tension. It is still another object to provide such a bumper which utilizes as cushioning agent elastomer in tension in combination with pneumatic means. Other objects of our invention will appear in the course of the description thereof which follows.

We have found that we can achieve the objects above mentioned by adjusting the relative dimensions and disposition of certain of the elements of our apparatus and, in certain embodiments, by providing that apparatus with means for maintaining a gas under pressure therein. Our bumper, in its preferred embodiment, comprises an elongated channel-shaped contact member adapted to receive impact and be moved thereby, a mounting member toward which the contact member is moved, and discrete elements of elastomer spaced lengthwise of the bumper attached at their ends to the contact member and which are stretched when the contact member is moved toward the mounting member. When such a bumper makes contact with an object over only a portion of the bumper length there will inevitably be localized distortion of the contact member.

If this localized distortion of the contact member tends to reduce the capacity of the elastomer elements to absorb energy by stretching, the performance of the bumper is impaired. Our bumper to be described hereinafter is designed to minimize this undesirable effect of localized distortion. Embodiments of our invention presently preferred by us are illustrated in the attached figures, to which reference is now made.

FIG. 1 is a perspective, broken away in part, of an article of our invention;

FIG. 2 is a cross-section through the article of FIG. 1 on the plane 2--2;

FIG. 3 is a cross-section through the article of FIG. 1 on the same plane as that of FIG. 2 but showing the deformation of the article upon distributed impact with a plane surface;

FIG. 4 is a plan, broken away in part, of the article of FIG. 1 but showing the deformation of the article upon localized impact;

FIG. 5 is a perspective of a type of insert used in our invention;

FIG. 6 is a perspective of elements of another embodiment of our invention; and

FIG. 7 is a cross-section of that embodiment.

Our article comprises an elongated channel-shaped contact member 1 affixed to an elongated mounting member 5. The web 4 of member 1 is generally convex-out and the upper and lower flanges 2 and 3, respectively, diverge from web 4 toward mounting member 5. Web 4 is formed with a centrally located longitudinal corrugation 10 which is concave-out. The edges 14 and 15 of flanges 2 and 3, respectively, terminate in beads 8 and 9 which are sealed to mounting member 5 by facing member 6 which is elongated like member 5 and is provided with a groove along each edge into which beads 8 and 9 fit. Facing member 6 is attached to mounting member 5 by bolts 17 which pass through holes in member 5 and are tapped into threaded holes in member 6. The surface 7 of facing member 6 oriented toward contact member 1 is convex-out.

Within contact member 1, which is closed at its ends, are positioned a plurality of upright slabs or panels 11 of elastomer spaced from each other and disposed crosswise of contact member 1. These slabs 11 are attached at the tops and bottoms to flanges 2 and 3, respectively, and at an end to web 4. The other end 12 of the slab stops just short of surface 7 of facing member 6. This end 12 is generally plane. The space between successive slabs 11 is filled by blocks of foamed elastomer 16. The portion 14 of flange 2 between end 12 of slab 11 and bead 8 has a thickness less than that of the remainder of flange 2 and the corresponding portion 15 of flange 3 likewise has a thickness less than that of the remainder of flange 3. A valve 13 is positioned in flange 2 through which air or other gas may be introduced to increase the pressure within our article above atmospheric pressure. It is convenient to mold contact member 1 with its thinner extremities 14 and 15, beaded edges 8 and 9, and enclosed slabs or panels 11 in one piece from an elastomer such as polyurethane.

The operation of our article will be explained in connection with the foregoing description thereof as well as the attached figures. When contact member 1 meets an unyielding object such as a wall, it tends to deform in the manner shown in FIG. 3. The convex web 4 flattens out, flanges 2 and 3 are forced back toward facing...
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The blocks of foamed elastomer 16 which fill the spaces between successive slabs 11 support those slabs against lateral buckling. This action is enhanced by making the blocks 16 of dimensions somewhat greater than those of the spaces to be filled and compressing the blocks when they are inserted. The tendency of the foamed elastomer to expand maintains slabs 11 under tension. For this purpose, we prefer to dimension the blocks 16 with the same width and depth as the spaces between slabs 11 but with a height greater than the distance between flanges 2 and 3. We prefer to make blocks 16 out of foamed polyurethane.

Our invention also comprehends other support means for the elastomer slabs. FIG. 5 illustrates an insert 19 conveniently made of a molded elastomer which is inserted in the spaces between the slabs 11. The insert has parallel end walls 20 which have the contour of a cross-section of shell 1 such as is shown in FIG. 2, flat top and bottom walls 21 and a curved front wall 22. The back wall 23 which faces mounting member 5 is planar and generally rectangular in shape. The insert is provided with a hollow center 24 which opens out of back wall 23, the thickness of the walls so formed being proportioned to provide the desired amount of support. The slabs 11 may also be supported by sealed cells of a shape similar to that of insert 19 except for the absence of a cavity 24. Those cells are conveniently made of relatively thin elastomer sheet and are sealed so as to form cushions with their contained air or other gas. The cushioning effect of the gas filled cells is enhanced by disposing within them a foamed elastomer of the type previously mentioned.

A further modification of our invention is illustrated in FIGS. 6 and 7. We have found that it is desirable for some purposes to make the contact member of our bumper of modular units. In this way, bumpers for vehicles of different widths such as trucks, buses and passenger cars can be made by assembling the appropriate number of identical contact member modules on a mounting member. Two such modules 26 are shown side-by-side in FIG. 6. As before, the contact member module has a convex-out web 4 provided with a central concave-out corrugation 10, an upper flange 2, and a lower flange 3, which diverge from web 4. Module 26 is closed at each end by a flat wall 27 so that adjacent modules fit closely together.

FIG. 6 also illustrated a modified form of the elastomer slab structure. Vertical slabs or panels 28 spaced from each other are attached along their upper sides to flange 2, along their lower sides to flange 3, and along their front ends to web 4. A horizontal slab 29 is attached at each end to wall 27 of the module and is attached to vertical slabs 28—28 where it intersects them.

FIG. 7 shows a module 26 attached to mounting member 5. The heads 8 and 9 of top and bottom flanges 2 and 3 are clamped between a tray 30 and a facing member 31. Tray 30 has a rectangular flat bottom 32 surrounded by an upstanding rim 33 dimensioned to receive module 26. Facing member 31 comprises a rectangular plate 34 sized to fit within tray 30 with clearance all around for the flanges and ends of module 26. All four edges of plate 34 are bent over, as at 37, so as to clear the head 8. For example, of the module flange and clamp it between turned-over edges 37 and the rim 33 of tray 30. The other face of plate 34 is provided with an upstanding rib 35 positioned longitudi-
nally of plate 34 and terminating in a wider member 36 which has a convex-out face toward contact member module 26. Facing member 31 and tray 30 are fastened to mounting member 5 by bolts 17.

The embodiments of our invention illustrated in FIGS. 6 and 7 operate in the same way as those previously described herein. When web 4 of contact member 26 meets an obstacle it is forced back towards member 36. Flanges 2 and 3 tend to move outwardly from each other and elastomer slabs 28—28 as a result are stretched over the convex surface of member 36. Horizontally positioned slab 29 braces vertical slabs 28—28 so as to resist their buckling. Buckling forces transmitted to an end wall 27 of module 26 are resisted by adjoining module 26, where modular units are used. The arrangement of slabs 28 and 29 shown in FIG. 6 for a modular contact unit 26 is also suitable for a unitary contact member extending the length of the bumper. In both cases, that structure provides improved resistance to localized impact as well as to distributed impact, with less danger of bottoming.

Our module 26 is illustrated as having a dimension greater along the bumper than crosswise of it. Preferably, its dimension crosswise of the bumper would be that appropriate for a passenger vehicle. We use the same module for the wider bumpers required for buses, for example, by making the module length equal to the width of a bus bumper and mounting the modules on mounting member 5 with the longer dimension crosswise of the bumper.

Although we have described and illustrated embodiments of our invention in which the energy absorbing elastomer is attached to the impact receiving member, the movement of which stretches the elastomer over the mounting member, our invention also encompasses the complementary structure in which the elastomer is attached to the mounting member and is stretched over the moving contact member. The mounting member in the embodiments of our invention need not necessarily be a member separate from the vehicle but may be a structural element of the vehicle itself.

In the foregoing description the words “top,” “bottom,” “upper,” “lower,” “vertical,” “vertically,” “horizontal,” “horizontally,” and “upright” are used in the context of a conventional bumper positioned crosswise of a vehicle and parallel to the ground.

In the following specification we have described a presently preferred embodiment of this invention, however it will be understood that this invention can be otherwise embodied within the scope of the following claims.

We claim:

1. Impact cushioning apparatus comprising a mounting member adapted to be attached to the article to be cushioned, a contact member adapted to receive impact and be moved toward the mounting member thereby, one of those members being U-shaped in vertical cross section with the open end of the U facing the other member, and elastomeric means interposed between the contact member and the mounting member and affixed to the U-shaped member so that those means are stretched over the other member by that movement of the contact member towards the mounting member and retard that movement by that stretching, those means comprising a plurality of slabs of elastomer spaced from each other and positioned in planes parallel to said vertical cross section of the U-shaped member.

2. Apparatus of claim 1 in which the elastomeric means are affixed to the contact member.

3. Apparatus of claim 1 in which the other member is convex in vertical cross section facing the open end of the U.

4. Apparatus of claim 3 in which the face of the mounting member is the convex face.

5. Apparatus of claim 1 in which the members are attached to each other along the edges defined by the open ends of the U-shaped cross section.

6. Apparatus of claim 5 in which the contact member is readily deformable outwardly in planes parallel to its cross-section so that the elastomeric means are stretched by that deformation.

7. Apparatus of claim 5 in which the contact member is channel-shaped having a web with a convex-out impact surface and flanges diverging from the web flat between the web and the edges.

8. Apparatus of claim 7 in which the slabs of elastomer are affixed to the channel-shaped contact member, the flanges of the channel-shaped contact member extend beyond the free edges of the slabs, and the extended portion of the flanges are more flexible than the remaining portion.

9. Apparatus of claim 8 in which the extended portions of the flanges are thinner than their remaining portions.

10. Apparatus of claim 5 in which the flanges of the channel-shaped contact member are sealed to the mounting member, and including a valve adapted to admit gas under pressure to the interior of the contact member.

11. Apparatus of claim 10 in which the interior of the apparatus is filled with gas at a pressure above atmospheric pressure.

12. Apparatus of claim 11 in which the pressure of the gas is about half an atmosphere.

13. Apparatus of claim 1 in which the free ends of the slabs are spaced from the other member a distance sufficient to provide free flow of gas into and out of a space between slabs.

14. Apparatus of claim 13 in which the spaces between the plurality of slabs of elastomer contain yieldable means for holding those slabs upright.

15. Apparatus of claim 14 in which the yieldable means comprise a foamed compressible material.

16. Apparatus of claim 14 in which the yieldable means comprise a molded elastomer.

17. Apparatus of claim 16 in which the molded elastomer comprises at least one slab of elastomer positioned normal to the other slabs.

18. Apparatus of claim 14 in which the yieldable means comprise a gas-filled cell.

19. Apparatus of claim 1 elongated in the direction of the contact surface of the article to be cushioned in which the contact member comprises a plurality of modules positioned adjacent each other along the mounting member, each module having an impact-receiving surface and enclosing a plurality of the slabs of the elastomer and a portion of the other member.

20. Apparatus of claim 19 in which the module is made of an elastomer, is open toward the mounting member with walls adjacent the mounting member formed with a turned-in bead, and including a plate inserted into the module covering the bead on all sides.
the plate on its side away from the mounting member carrying the portion of the other member, and means fastening the plate to the mounting member.

21. Apparatus of claim 19 in which the portion of the other member is provided with a surface convex-out only in planes normal to the direction of elongation of the apparatus.

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