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(71) Applicant: **Ricoh Company, Ltd.**
Tokyo 143-8555 (JP)

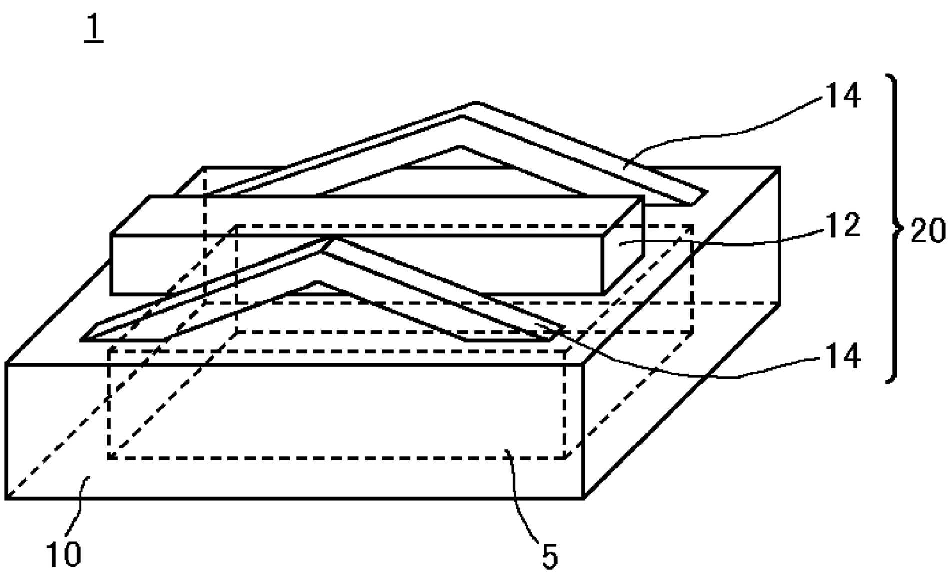
(72) Inventor: **SUEHIRO, Shinya**
Tokyo, 143-8555 (JP)

(74) Representative: **SSM Sandmair Patentanwälte Rechtsanwalt Partnerschaft mbB**
Joseph-Wild-Straße 20
81829 München (DE)

(54) **SHOCK ABSORBER AND PACKAGING SYSTEM**

(57) A shock absorber (1) includes a base structure (10) and a shock-absorbing rib structure (20). The shock-absorbing rib structure (20) is disposed on a face of the base structure (10). The shock-absorbing rib structure (20) includes a main buffer (12) and an auxiliary buffer (14). The main buffer (12) is supported by the base structure (10) and has a cubic or rectangular parallelepiped shape. The auxiliary buffer (14) is supported by the base structure (10) at opposed ends of the auxiliary buffer (14) and apart from the base structure (10) between the opposed ends of the auxiliary buffer (14).

FIG. 2



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Description

BACKGROUND

Technical Field

[0001] Embodiments of the present disclosure relate to a shock absorber and a packaging system.

Related Art

[0002] A packaging material for a precision machine product is provided with a shock absorber having a shock absorbing function to prevent a fragile packaged object from being deformed or damaged by vibration or drop impact received under distribution. Such a shock absorber absorbs the shock of an impact on the packaged object, in other words, an acceleration caused by impact, by its own deformation and buckling action. For example, some techniques have been proposed that reduce, with a shock absorber, an acceleration of up to several hundred G caused by impact on a packaged object to an acceleration of a hundred G or less.

[0003] As illustrated in FIG. 1, a shock absorber in the related art includes a shock-absorbing rib structure with a structural strength corresponding to the mass of an object to be packaged and an assumed drop height. Such a shock absorber exhibits a shock absorbing function by a compressive stress characteristic generated by compressive deformation of the shock-absorbing rib structure. It is already known that the maximum efficiency point of shock absorbing by the compressive stress characteristic is under a condition in which the compression strain is in a range of 0.5 to 0.65 and that the maximum efficiency point is a limit point of the shock absorbing function of the shock absorber having a configuration described above.

[0004] As another example, Japanese Unexamined Patent Application Publication No. H09-328172 discloses a packaging box that supports a top face or a bottom face of an accommodated product with a buffer formed by bending an end portion of an inner flap of a lid face plate or a bottom face plate, respectively.

[0005] Although the aforementioned shock absorber in the related art and the packaging box disclosed in Japanese Unexamined Patent Application Publication No. H09-328172 have good shock absorbing properties with a simple structure, the compressive stress characteristic of the shock-absorbing rib structure has a limit. In short, the aforementioned shock absorber and packaging box have some difficulties in enhancing the shock absorbing properties.

SUMMARY

[0006] In light of the above-described problems, it is an object of the present invention to provide a shock absorber including a shock-absorbing rib structure and enhancing the shock absorbing properties as compared with shock absorbers in the related art.

[0007] In order to achieve the above-mentioned object, advantageously, there is provided a shock absorber according to claim 1. Advantageous embodiments are defined by the dependent claims. According to an embodiment of the present invention, the shock absorber includes a base structure and a shock-absorbing rib structure. The shock-absorbing rib structure is disposed on a face of the base structure. The shock-absorbing rib structure includes a main buffer and an auxiliary buffer. The main buffer is supported by the base structure and has a cubic or rectangular parallelepiped shape. The auxiliary buffer is supported by the base structure at opposed ends of the auxiliary buffer and apart from the base structure between the opposed ends of the auxiliary buffer.

[0008] According to the embodiment of the present invention, the shock absorber includes the shock-absorbing rib structure including the main buffer that is compressed and deformed and the auxiliary buffer that is compressed and bent, thus being deformed. The main buffer exerts compressive stress; whereas the auxiliary buffer exerts compressive and bending stresses. Accordingly, the shock-absorbing rib structure exerts a combined stress action and enhances the shock absorbing properties as compared with a shock-absorbing rib structure in the related art.

[0009] Advantageously, there is also provided a packaging system according to claim 15. According to an embodiment of the present invention, the packaging system includes an object to be packaged, the shock absorber made of foamed resin, and a packaging material that packs the object with the shock absorber attached.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0010] A more complete appreciation of the disclosure and many of the attendant advantages and features thereof can be readily obtained and understood from the following detailed description with reference to the accompanying drawings, wherein:

FIG. 1 is a perspective view of a comparative shock absorber;
FIG. 2 is a perspective view of a shock absorber according to an embodiment of the present disclosure;
FIG. 3 is a perspective view of the shock absorber of FIG. 2 with the stress acting in the shock absorber;
FIG. 4A is a graph illustrating characteristics of buffers;
FIG. 4B is a graph comparing the shock absorber of FIG. 2 with a comparative shock absorber as a comparative example for the characteristics;
FIG. 5 is a perspective view of a shock absorber including a plurality of shock-absorbing rib structures;
FIG. 6 is a perspective view of a shock absorber different from the shock absorber of FIG. 2 in the positions of the main buffer and the auxiliary buffer;
FIG. 7 is a schematic view of a shock absorber including a stack of flat plates;
FIG. 8 is a schematic view of another shock absorber including a stack of flat plates;
FIG. 9 is a perspective view of a shock absorber having no space for accommodating an object to be packaged;
FIG. 10A is a perspective view of an auxiliary buffer according to a first variation in shape;
FIG. 10B is a perspective view of an auxiliary buffer according to a second variation in shape;
FIG. 10C is a perspective view of an auxiliary buffer according to a third variation in shape;
FIG. 10D is a perspective view of an auxiliary buffer according to a fourth variation in shape;
FIG. 10E is a perspective view of an auxiliary buffer according to a fifth variation in shape;
FIG. 10F is a perspective view of an auxiliary buffer according to a sixth variation in shape;
FIG. 11 is a perspective view of a shock absorber including a modified main buffer;
FIG. 12 is a perspective view of a shock absorber having an opening for accommodating a deformed portion of an auxiliary buffer;
FIG. 13 is a side view of the shock absorber illustrated in FIG. 12; and
FIG. 14 is a diagram illustrating an overall configuration of a packaging system according to an embodiment of the present disclosure.

[0011] The accompanying drawings are intended to depict embodiments of the present invention and should not be interpreted to limit the scope thereof. The accompanying drawings are not to be considered as drawn to scale unless explicitly noted. Also, identical or similar reference numerals designate identical or similar components throughout the several views.

DETAILED DESCRIPTION

[0012] In describing embodiments illustrated in the drawings, specific terminology is employed for the sake of clarity. However, the disclosure of this specification is not intended to be limited to the specific terminology so selected and it is to be understood that each specific element includes all technical equivalents that have a similar function, operate in a similar manner, and achieve a similar result.

[0013] Referring now to the drawings, embodiments of the present disclosure are described below. As used herein, the singular forms "a," "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise.

[0014] For the sake of simplicity, like reference numerals are given to identical or corresponding constituent elements such as parts and materials having the same functions, and redundant descriptions thereof are omitted unless otherwise required.

[0015] FIG. 2 is a perspective view of a shock absorber according to an embodiment of the present disclosure.

[0016] A shock absorber 1 includes a base structure 10 and a shock-absorbing rib structure 20. The base structure 10 has an accommodation space 5, which is a space to accommodate an object to be packaged (e.g., a copier). The shock-absorbing rib structure 20 is disposed on an upper face of the base structure 10.

[0017] The shock-absorbing rib structure 20 includes a main buffer 12 and auxiliary buffers 14. The main buffer 12 is supported by the base structure 10 and has a cubic or rectangular parallelepiped shape. Each of the auxiliary buffers 14 is supported by the base structure 10 at opposed ends of the auxiliary buffer 14 and apart from the base structure 10 between the opposed ends of the auxiliary buffer 14.

[0018] Specifically, the main buffer 12 is disposed alone at a central position on the upper face of the base structure 10. The auxiliary buffers 14 are disposed in pair to sandwich the main buffer 12. Each of the auxiliary buffers 14 has an inverted V-shape (or an arch shape) and is intended to be bent and deformed.

[0019] The shock absorber 1 is attached to the object to be packaged such as a copier and packed in a packaging material. When the packaging material is subjected to at least one of vibration and drop impact, compression stress acts in the main buffer 12 in response to the compressive deformation of the main buffer 12 as illustrated in FIG. 3. At the same time, compressive and bending stresses act in the auxiliary buffers 14 in response to the bending deformation of the auxiliary buffer 14 as illustrated in FIG. 3.

[0020] A comparative shock absorber (see FIG. 1) lessens or absorbs the shock of an impact only by compressive deformation and compressive stress of a single shock-absorbing rib structure. By contrast, the shock absorber 1 of the present embodiment (see FIG. 2) generates a combined stress action with the main buffer 12 and the auxiliary buffers 14 that are not provided in the comparative shock absorber. With such a configuration, the shock absorber 1 absorbs the shock of an impact more efficiently than the comparative shock absorber and lessens the shock. Accordingly, the shock absorber 1 reduces the maximum impact force applied to the packaged object as compared with the maximum impact force applied to the same packaged object to which the comparative shock absorber is attached.

[0021] FIG. 4A is a graph illustrating the characteristics of the main buffer and the auxiliary buffer. FIG. 4B is a graph comparing the shock absorber 1 of the present embodiment with a comparative shock absorber as a comparative example for the characteristics. In FIGS. 4A and 4B, the horizontal axis represents an amount of deformation (mm); whereas the vertical axis represents the reaction force (N) that acts.

[0022] As indicated by the lowermost line in FIG. 4A, the compressive stress mainly acts in the auxiliary buffer at first, and then the bending stress acts in the auxiliary buffer in response to the bending deformation of the auxiliary buffer. The reaction force largely decreases at the time when the auxiliary buffer starts bending deformation, and then gradually increases in FIG. 4A.

[0023] On the other hand, as indicated by the middle line in FIG. 4A, the reaction force monotonously increases because the compressive stress acts in the main buffer. As indicated by the uppermost line in FIG. 4A, a composite force (reaction force) obtained by combining the forces of the main buffer and the auxiliary buffer rises faster and has a larger value than the force of the main buffer alone.

[0024] In addition to the above, in the present embodiment, the main buffer receives the shock of an impact in a reduced area and has a reduced volume to reduce the reaction force of the main buffer. In other words, as illustrated in FIG. 4B, the shock absorber 1 of the present embodiment raises the reaction force faster at an increased value of the reaction force at the time of starting the deformation as compared with the comparative shock absorber. In addition, the shock absorber 1 of the present embodiment reduces the reaction force acting on the packaged object after specific deformation as compared with the comparative shock absorber.

[0025] Although the shock absorber 1 illustrated in FIG. 2 includes the single main buffer 12 and the two auxiliary buffers 14 on one face of the base structure 10, the configuration of the shock absorber 1 is not limited to the configuration illustrated in FIG. 2. Alternatively, for example, at least one main buffer 12 and at least one auxiliary buffer 14 may be disposed on at least one face of the base structure 10. An appropriate shock-absorbing rib structure is selected for the shock of an impact assumed from the mass of the object to be packaged and an assumed drop height.

[0026] Now, a description is given of some advantageous configurations of the embodiments of the present disclosure.

[0027] FIG. 5 is a perspective view of a shock absorber including a plurality of shock-absorbing rib structures.

[0028] The main buffer 12 and the auxiliary buffers 14 are disposed on a plurality of faces of the base structure 10. In the example illustrated in FIG. 5, the main buffer 12 and the auxiliary buffers 14 are disposed on a maximum of five faces of the base structure 10, including the back face of the base structure 10 hidden in FIG. 5. Since a shock absorber 1a includes the shock-absorbing rib structures 20 in various directions, the shock absorber 1a exhibits the shock absorbing function in various directions.

[0029] Note that the shock absorber 1a is not limited to a hexahedron such as a rectangular parallelepiped or a cube. Alternatively, the shock absorber 1a may have a three dimensional shape with more faces each being provided with the shock-absorbing rib structure 20.

[0030] Now, a description is given of an arrangement (positions) of the main buffer 12 and the auxiliary buffers 14. In a case where the center of gravity of the object to be packaged is close to the center, the main buffer 12 is suitably interposed between the two auxiliary buffers 14 on a common face of the base structure 10 as illustrated in FIG. 2.

[0031] By contrast, in a case where the center of gravity of the object to be packaged is on one side (i.e., eccentric center of gravity), the auxiliary buffer 14 is suitably interposed between the two main buffers 12 on a common face of the base structure 10 as illustrated in FIG. 6. A shock absorber 1b reduces inclination at the time of shock absorbing.

[0032] FIGS. 7 and 8 are schematic views of shock absorbers each including a stack of flat plates.

[0033] As illustrated in FIG. 7, a shock absorber 1c may include a stack of plates 30a, 30b, and 30c as plate-shaped members. As illustrated in FIG. 8, a shock absorber Id may include a stack of plates 30d, 30e, and 30f as plate-shaped members. Since each of the plates 30a to 30f is easily manufactured without using an advanced molding technique such as injection molding, the shock absorbers 1c and 1d are efficiently and inexpensively manufactured.

[0034] FIG. 9 is a perspective view of a shock absorber having no space for accommodating an object to be packaged.

[0035] A shock absorber 1e includes a planar base structure 10e and a shock-absorbing rib structure 20e on a face of the base structure 10e.

[0036] The shock-absorbing rib structure 20e includes the main buffer 12 and auxiliary buffers 14e. The main buffer 12 is supported by the base structure 10e and has a cubic or rectangular parallelepiped shape. Each of the auxiliary buffers 14e is supported by the base structure 10e at opposed ends of the auxiliary buffer 14e and apart from the base structure 10e between the opposed ends of the auxiliary buffer 14e.

[0037] The shock absorber 1e differs from the shock absorber 1 illustrated in FIG. 2 in that the base structure 10e has no space for accommodating an object to be packaged. The shock absorber 1e absorbs the shock of an impact on a packaged object with the planar shock-absorbing rib structure 20e in contact with and attached to the packaged object.

[0038] In this configuration, similar to the configuration illustrated in FIG. 2, the auxiliary buffers 14e and the main buffer 12 of the shock absorber 1e exert a combined stress action to absorb the shock of an impact more efficiently than the comparative shock absorber (see FIG. 1) and lessen the shock. Accordingly, the shock absorber 1e reduces the maximum impact force applied to the packaged object.

[0039] FIGS. 10A to 10F are perspective views of auxiliary buffers according to some variations in shape.

[0040] The auxiliary buffer 14 may take various shapes according to at least one of the object to be packed to which the auxiliary buffer 14 is attached and an assumed shock of impact.

[0041] The auxiliary buffer 14 illustrated in FIG. 10A includes two supports 16 and a beam 18. The two supports 16 are disposed vertically, perpendicular to a face of the base structure 10. The beam 18 is supported by the supports 16 and disposed horizontally, parallel to and apart from the face of the base structure 10. The auxiliary buffer 14 is a structure in which the beam 18 disposed horizontally receives an evenly distributed load. Accordingly, the auxiliary buffers 14 attains an effect that bending stress largely acts when receiving a local load. The auxiliary buffer 14 illustrated in FIG. 10A is suitable for an object to be packaged having a relatively large mass.

[0042] The auxiliary buffer 14 illustrated in FIG. 10B includes the two intersecting supports 16 inclined with respect to a face of the base structure 10. When receiving a local load, the auxiliary buffer 14 is easily bent, thus exerting a small bending stress. The auxiliary buffer 14 illustrated in FIG. 10B is suitable for an object to be packaged having a relatively small mass.

[0043] The auxiliary buffer 14 illustrated in FIG. 10C includes the two supports 16 inclined with respect to a face of the base structure 10 and the beam 18 supported by the two supports 16 and disposed horizontally, parallel to the face of the base structure 10. The auxiliary buffer 14 is a structure in which the beam 18 disposed horizontally receives an equally distributed load while the two supports 16 at a relatively long distance from each other are easily bent, thus exerting a small bending stress. Like the auxiliary buffer 14 illustrated in FIG. 10B, the auxiliary buffer 14 illustrated in FIG. 10C is suitable for an object to be packaged having a relatively small mass.

[0044] In FIGS. 10D to 10F, the two or more auxiliary buffers 14 are disposed continuously in a longitudinal direction of the auxiliary buffers 14. The auxiliary buffers 14 illustrated in FIGS. 10D to 10F easily attain the effect that the bending stress largely acts because the distance between the supports 16 is relatively short. The auxiliary buffer 14 illustrated in FIG. 10A is suitable for an object to be packaged having a relatively large mass.

[0045] FIG. 11 is a perspective view of a shock absorber including a modified main buffer.

[0046] A main buffer 12f includes gradient side faces at opposed longitudinal ends of the main buffer 12f. The main buffer 12f includes a bottom face supported by the base structure 10 and having a greater area than an area of an upper face of the main buffer 12f. In short, the main buffer 12f is a tapered structure.

[0047] Since the compressed area of the main buffer 12f increases as the compressive deformation of the main buffer 12f progresses, the main buffer 12f absorbs increased impact energy. Note that the main buffer 12f may include at least one pair of opposed side faces with a gradient.

[0048] FIG. 12 is a perspective view of a shock absorber having an opening for accommodating a deformed portion of an auxiliary buffer.

[0049] As illustrated in FIG. 12, a base structure 10g has an opening 8 directly below the auxiliary buffer 14 in the vertical direction. When the auxiliary buffer 14 is bent and deformed, the deformed portion of the auxiliary buffer 14 is accommodated in the opening 8 (see FIG. 13). Even when the auxiliary buffer 14 is remarkably deformed, the auxiliary buffer 14 is bent and deformed as aimed, without falling into a state of only compressive deformation. Accordingly, the auxiliary buffer 14 generates a composite stress together with the main buffer 12.

[0050] The shock absorbers 1 and 1a to 1g are preferably made of foamed resin.

[0051] However, the material of the shock absorbers 1 and 1a to 1g is not limited to the foamed resin.

[0052] As illustrated in FIG. 14, the shock absorber 1 of the present embodiment is attached to an image forming apparatus 50 (e.g., a copier or a printer) as an object to be packaged and is packed in a packaging material 60 (e.g., a cardboard box). The packaging material 60 is used in a packaging system 100 including, e.g., packing machinery equipment. In other words, the packaging system 100 includes the image forming apparatus 50 as an object to be packaged, the shock absorber 1, and the packaging material 60 that packs the image forming apparatus 50 with the shock absorber 1 attached.

[0053] Now, a description is given of a comparative verification test.

[0054] A comparative verification test of the acceleration caused by impact was performed to compare the shock absorber of the present embodiment with a comparative shock absorber.

[0055] For verification, the shock absorber of the present embodiment (FIG. 2) was compared with the comparative shock absorber (FIG. 1) for the acceleration caused by impact at the same buffer distance.

[0056] As a condition, the shock absorber of the present embodiment and the comparative shock absorber were made of foamed polyethylene (expanded polyethylene (EPE) having an apparent density of 22.5 kg/m^3).

[0057] As a result, as presented in Table 1, an average acceleration caused by impact on the shock absorber of the present embodiment was about 20% lower than an average acceleration caused by impact on the comparative shock absorber.

Table 1

SPECIFICATION		ACCELERATION CAUSED BY IMPACT (G's)	AVERAGE ACCELERATION CAUSED BY IMPACT (G's)	STANDARD DEVIATION(1 σ)
COMP ARATIVE EXAMPLE	N1	38.23	42.15	2.95
	N2	42.69		
	N3	40.22		
	N4	45.62		
	N5	43.99		
PRESENT EMBODIMENT	N1	33.14	34.40	2.29
	N2	35.63		
	N3	31.02		
	N4	36.65		
	N5	35.55		

Claims

1. A shock absorber (1) comprising:

    a base structure (10); and
    a shock-absorbing rib structure (20) on a face of the base structure (10),
    the shock-absorbing rib structure (20) including:

        a main buffer (12) supported by the base structure (10) and having a cubic or rectangular parallelepiped shape; and
        an auxiliary buffer (14) supported by the base structure (10) at opposed ends of the auxiliary buffer (14) and apart from the base structure (10) between the opposed ends of the auxiliary buffer (14).

2. The shock absorber (1) according to claim 1, wherein the base structure (10) has a space to accommodate an object to be packaged.

3. The shock absorber (1a) according to claim 1 or 2, wherein the main buffer (12) and the auxiliary buffer (14) are disposed on a plurality of faces of the base structure (10).

4. The shock absorber (1a) according to claim 3, wherein each of the main buffer (12) and the auxiliary buffer (14) is disposed on five faces of the base structure (10).

5. The shock absorber (1) according to any one of claims 1 to 4,

    wherein the shock-absorbing rib structure (20) further includes another auxiliary buffer (14), and
    wherein the main buffer (12) is interposed between the auxiliary buffer (14) and said another auxiliary buffer (14) on a common face of the base structure (10).

6. The shock absorber (1b) according to any one of claims 1 to 5,

    wherein the shock-absorbing rib structure (20) further includes another main buffer (12), and
    wherein the auxiliary buffer (14) is interposed between the main buffer (12) and said another main buffer (12)

on a common face of the base structure (10).

7. The shock absorber (1c, 1d) according to any one of claims 1 to 6, wherein the base structure (10) and the shock-absorbing rib structure (20) include a stack of plate-shaped members (30).

8. The shock absorber (1e) according to claim 1,

    wherein the base structure (10e) is planar, and
    wherein the shock-absorbing rib structure (20e) is configured to be attached to an object to be packaged, in contact with the object to be packaged.

9. The shock absorber (1) according to any one of claims 1 to 8, wherein the auxiliary buffer (14) includes:

    two supports (16) disposed perpendicular to the face of the base structure (10); and
    a beam (18) supported by the two supports (16) and disposed parallel to and apart from the face of the base structure (10).

10. The shock absorber (1) according to any one of claims 1 to 8, wherein the auxiliary buffer (14) includes two intersecting supports (16) inclined with respect to the face of the base structure (10).

11. The shock absorber (1) according to any one of claims 1 to 8, wherein the auxiliary buffer (14) includes:

    two supports (16) inclined with respect to the face of the base structure (10); and
    a beam (18) supported by the two supports (16) and disposed parallel to the face of the base structure (10).

12. The shock absorber (1) according to any one of claims 1 to 11, further comprising a plurality of auxiliary buffers (14) including the auxiliary buffer (14), wherein the plurality of auxiliary buffers (14) is disposed continuously in a longitudinal direction of the plurality of auxiliary buffers (14).

13. The shock absorber (If) according to any one of claims 1 to 12,

    wherein the main buffer (12f) supported by the base structure (10) includes a pair of opposed side faces with a gradient, and
    wherein the main buffer (12f) includes a bottom face supported by the base structure (10) and having a greater area than an area of an upper face of the main buffer (12f).

14. The shock absorber (1g) according to any one of claims 1 to 13, wherein the base structure (10g) has an opening (8) directly below the auxiliary buffer (14) in a vertical direction.

15. A packaging system comprising:

    an object to be packaged;
    the shock absorber according to any one of claims 1 to 14, made of foamed resin; and
    a packaging material configured to pack the object with the shock absorber attached.

FIG. 1

RELATED ART

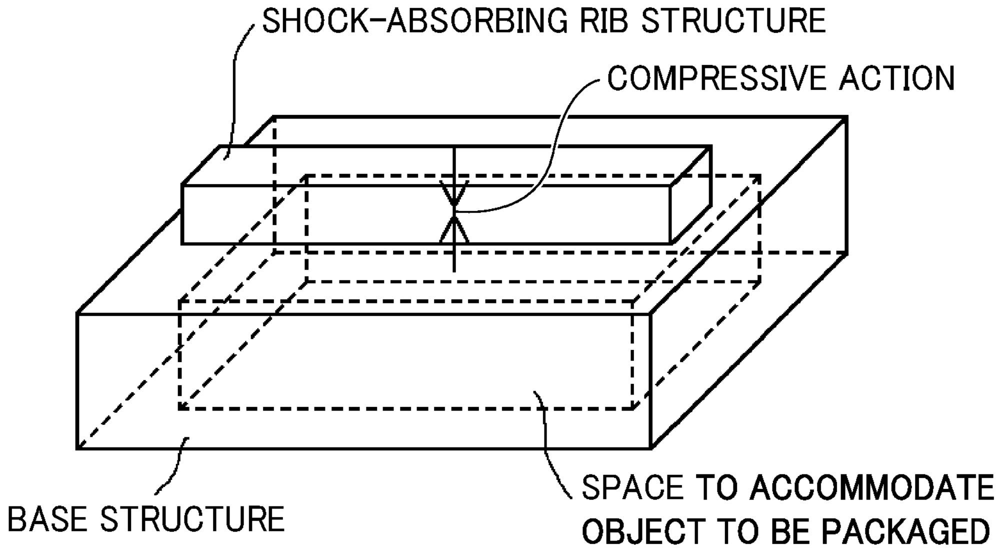


FIG. 2

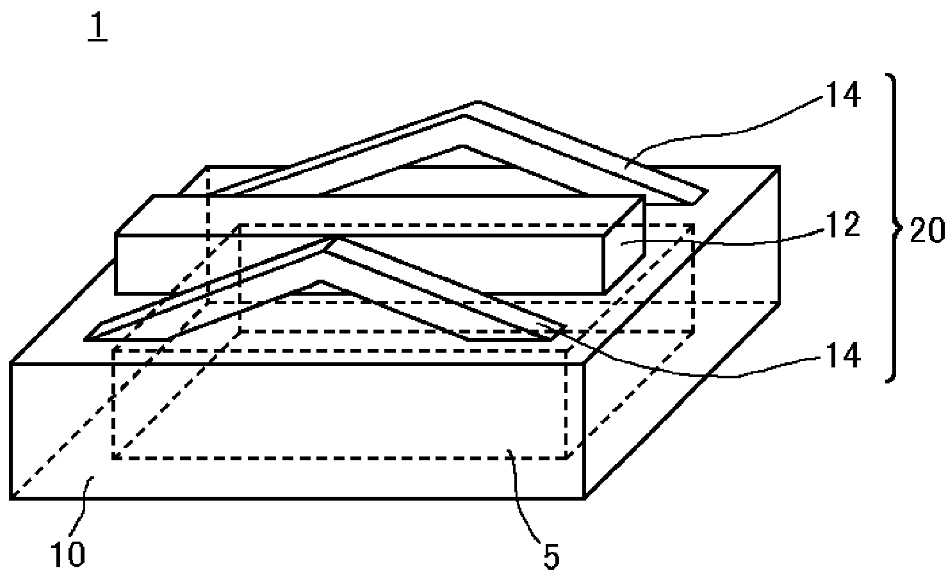


FIG. 3

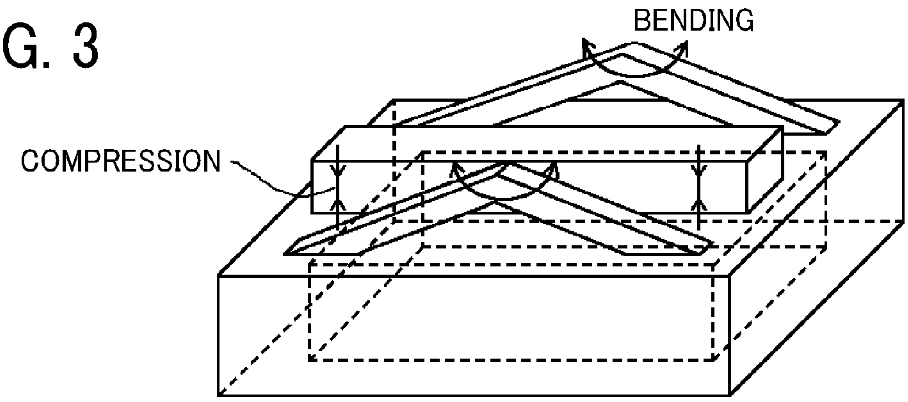


FIG. 4A

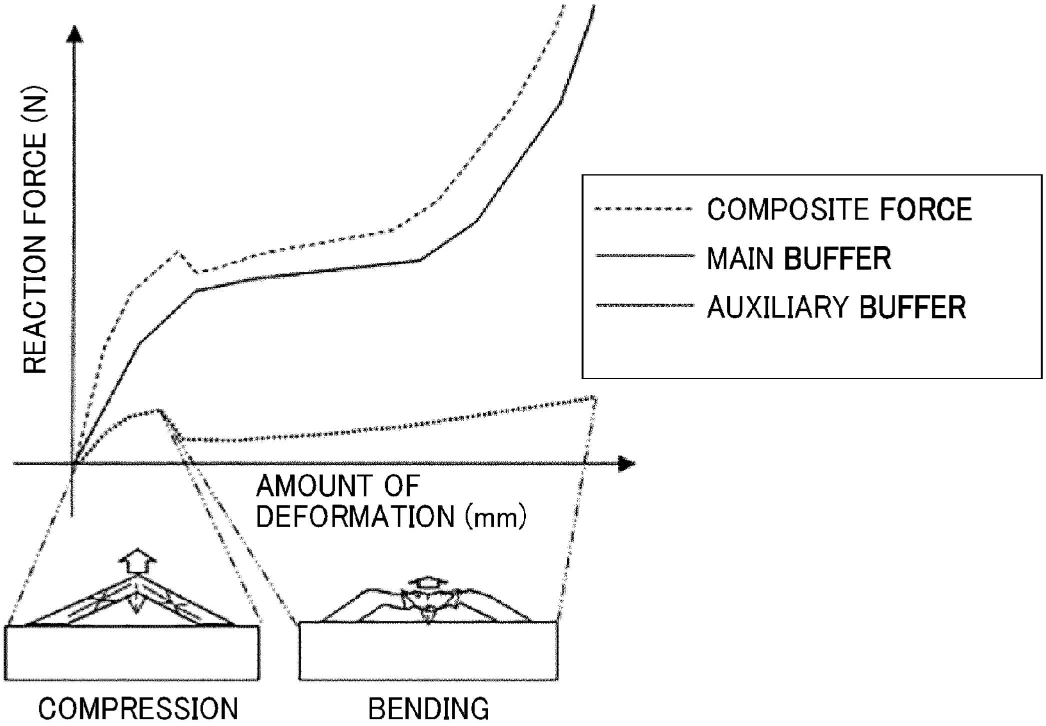


FIG. 4B

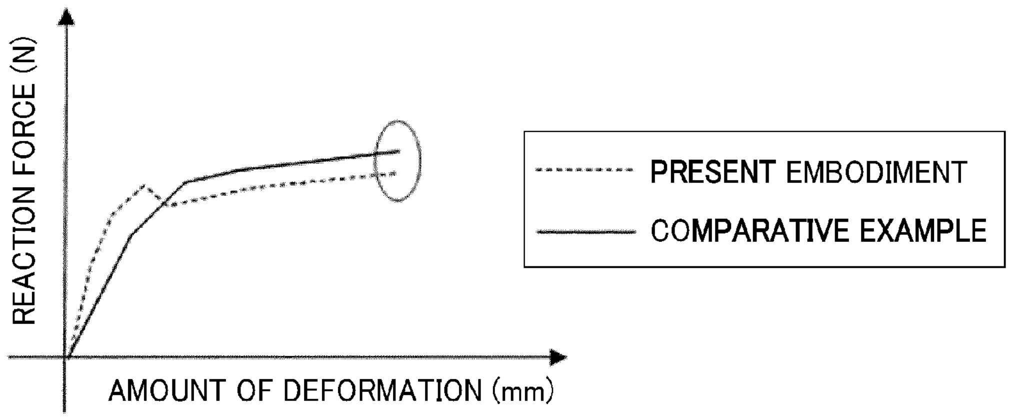


FIG. 5

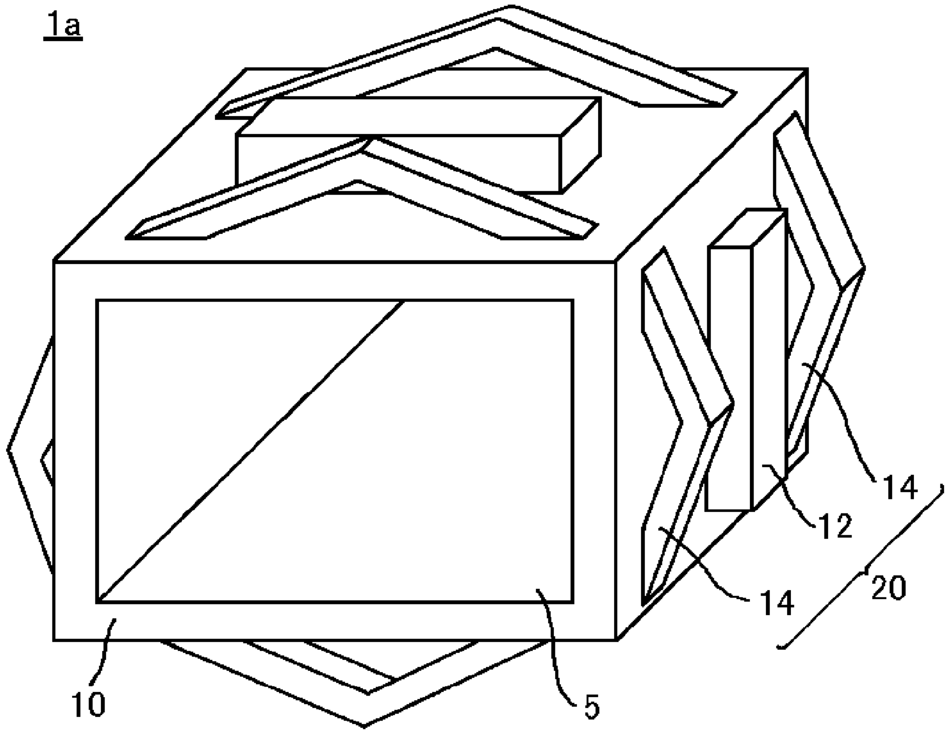


FIG. 6

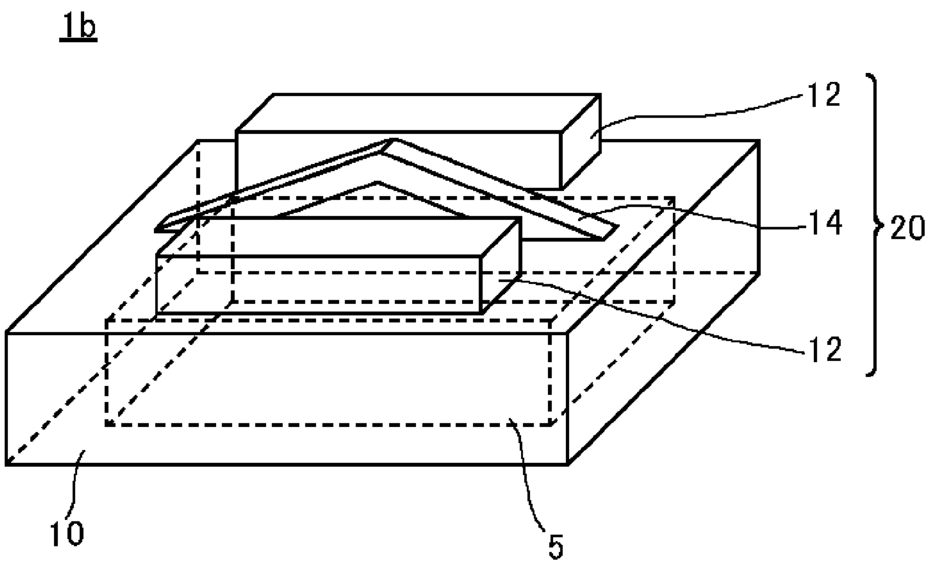


FIG. 7

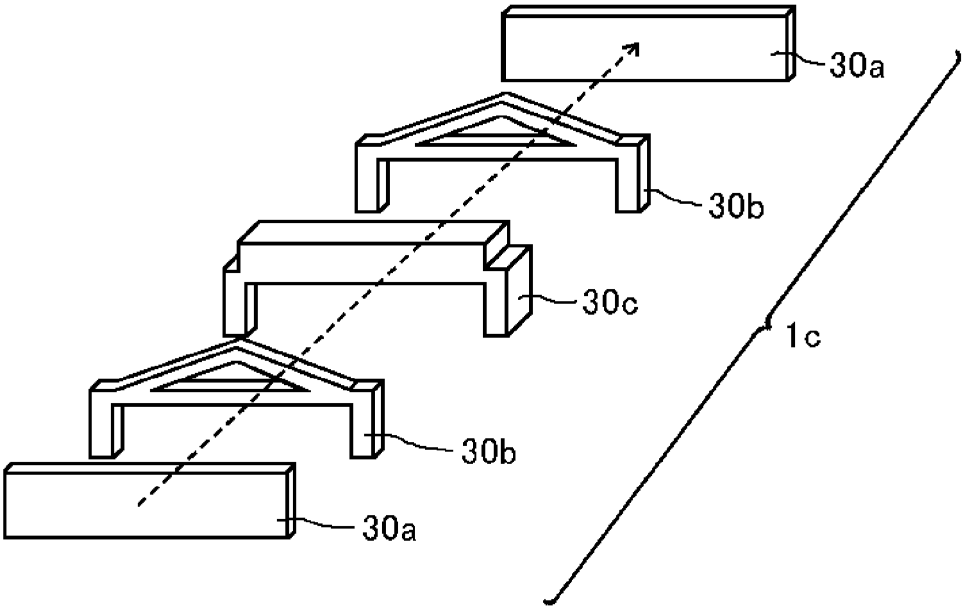


FIG. 8

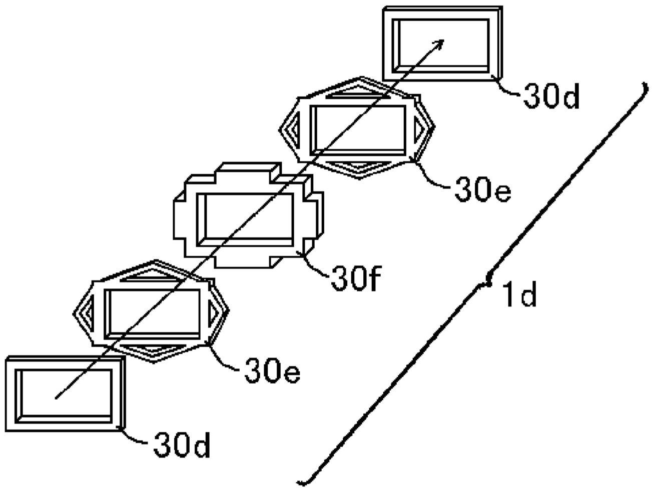


FIG. 9

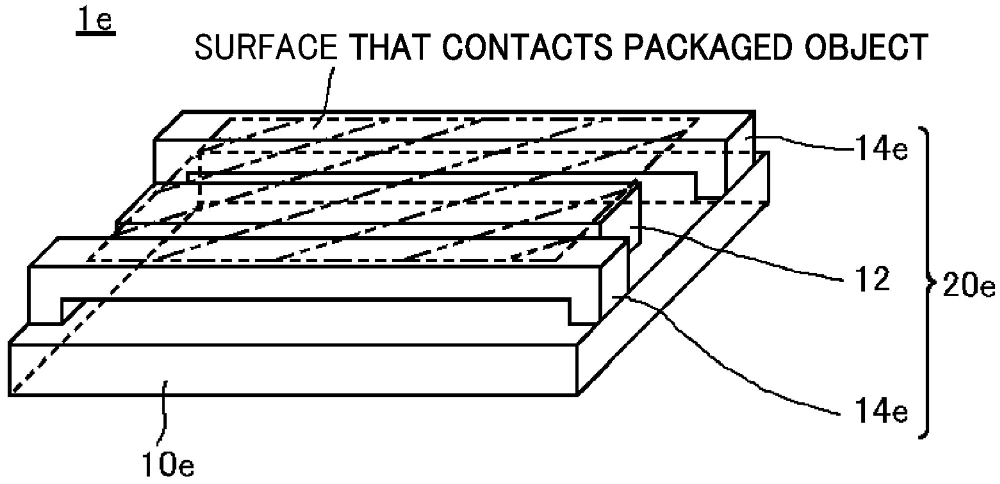


FIG. 10A

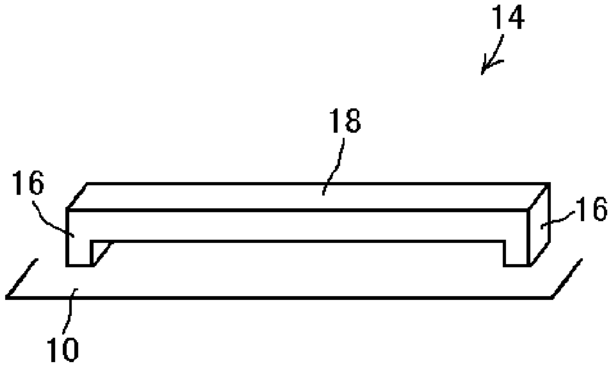


FIG. 10B

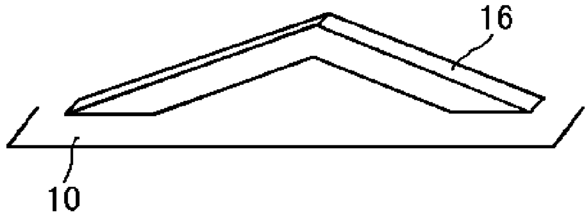


FIG. 10C

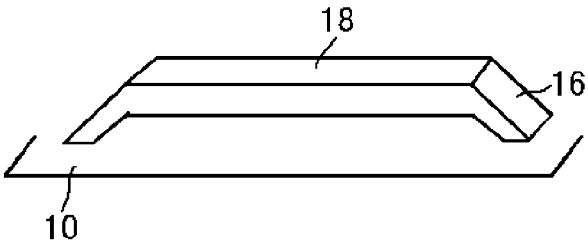


FIG. 10D

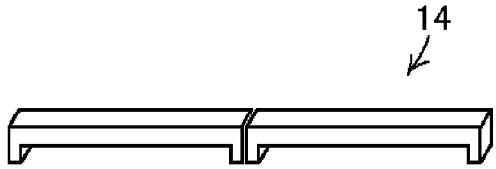


FIG. 10E

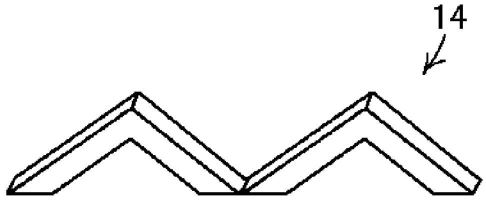


FIG. 10F

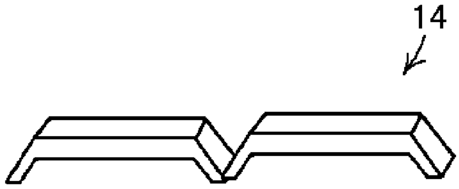


FIG. 11

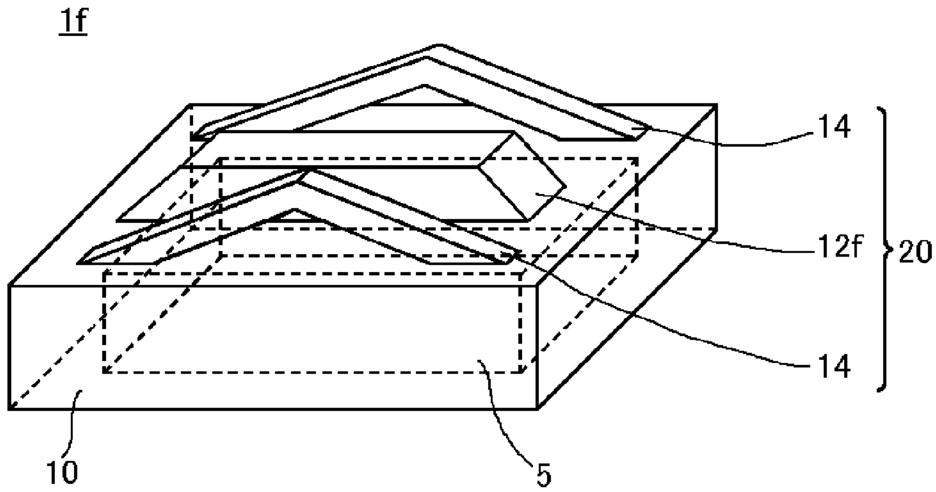


FIG. 12

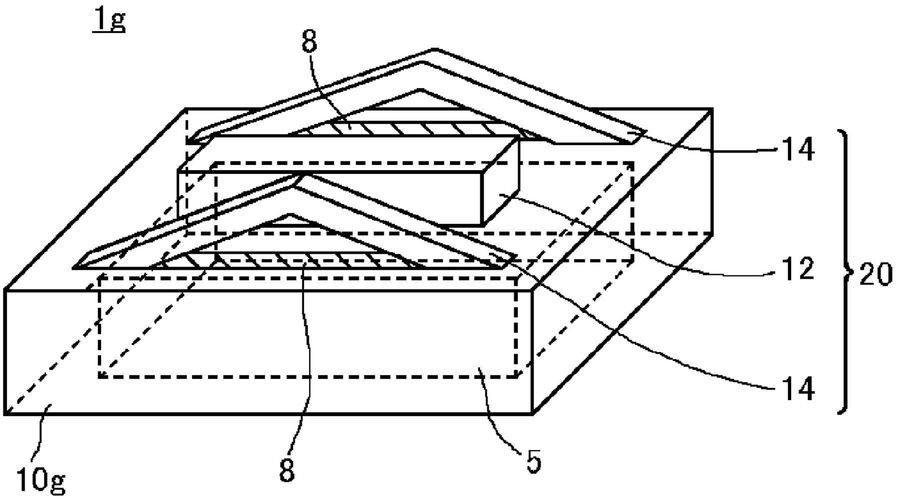


FIG. 13

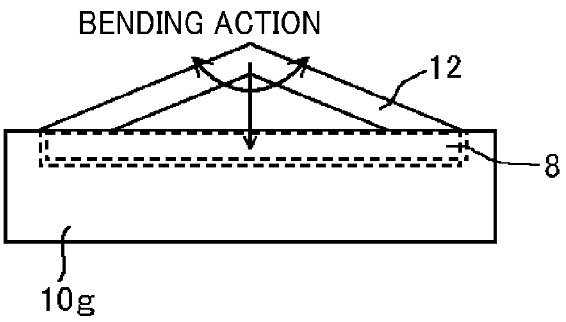
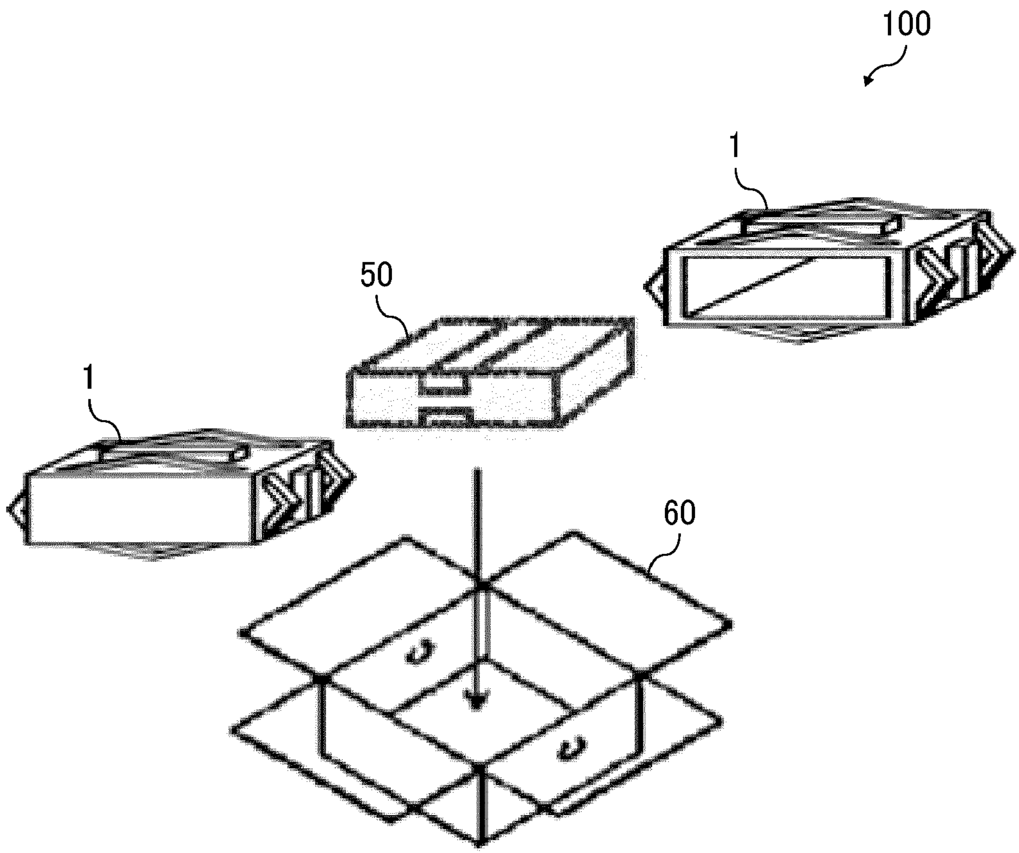


FIG. 14



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The present search report has been drawn up for all claims

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Place of search	Date of completion of the search	Examiner
Munich	2 December 2022	Derrien, Yannick

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