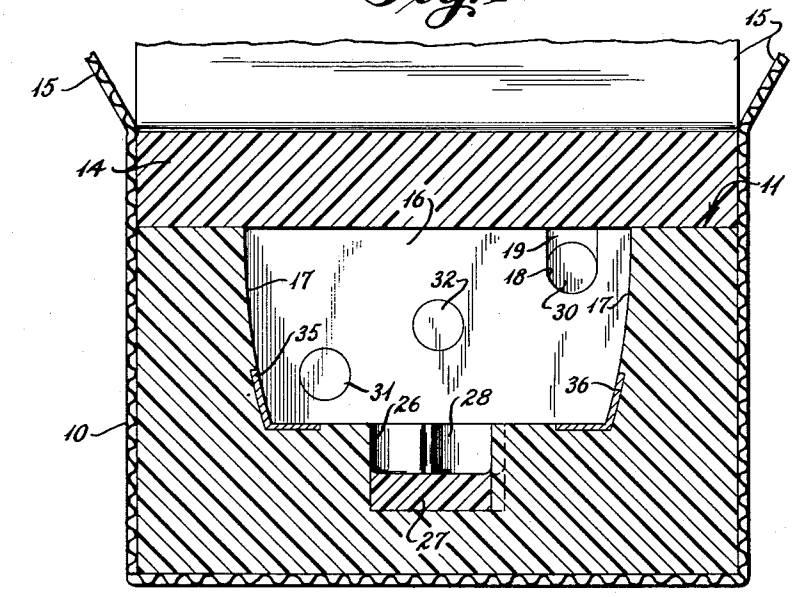
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PLASTIC FOAM PACKAGING

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Fig. 1



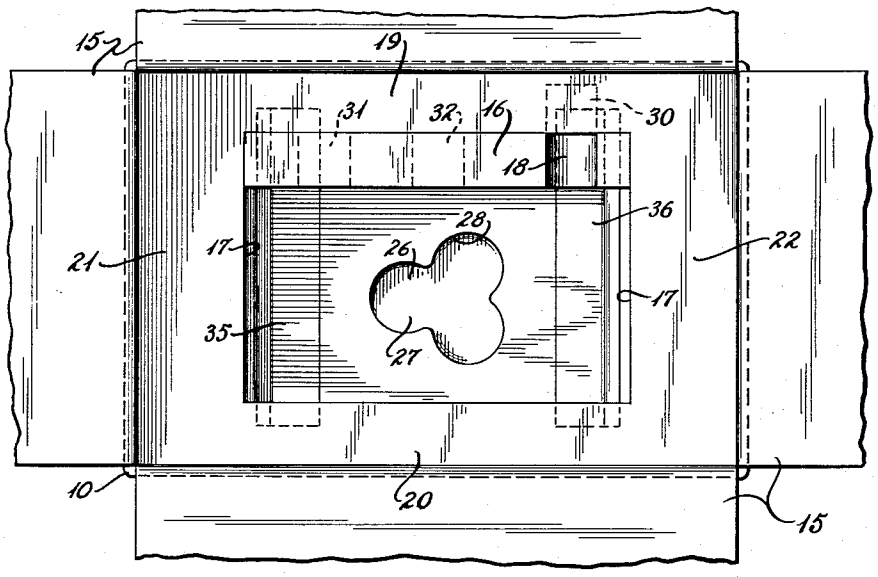


Fig. 2

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Fig. 3

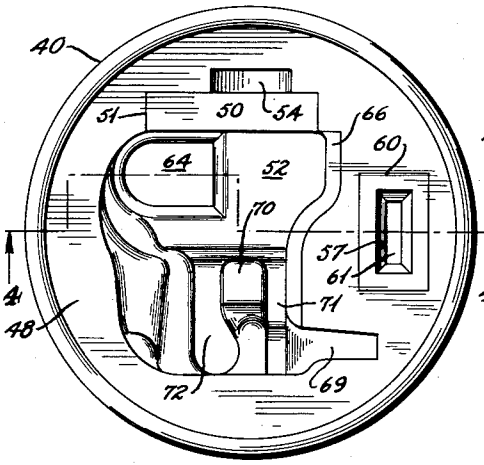


Fig. 4

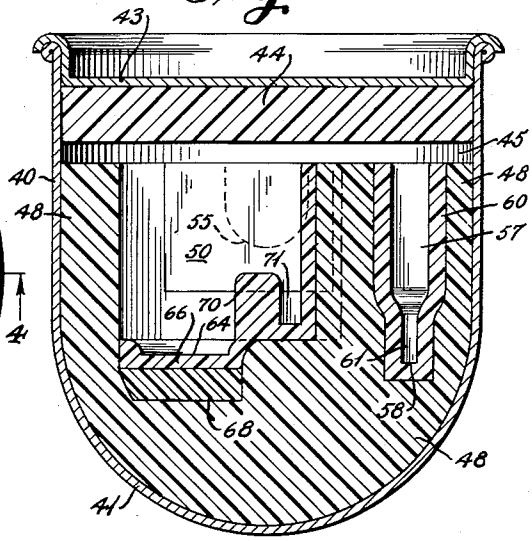
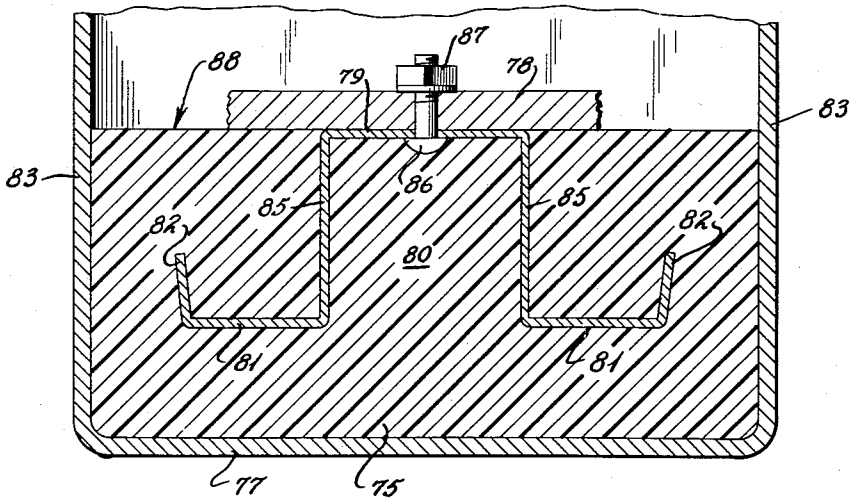


Fig. 5



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2,971,640

PLASTIC FOAM PACKAGING

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8 Claims. (Cl. 206—46)

This invention relates to the protection of articles in transit, especially such articles as are usually adequately guarded as a whole against distortion from outside shocks by suitable casings but should also be shielded against damage to fragile surfaces, delicate bearings, etc. caused by relative movement of the various elements of the article due to various causes such as difference in specific gravity of the elements.

The principal object of the invention, therefore, is to provide a method and apparatus for so shielding an article that the various parts of the article are cushioned in proportion to their need for protection.

A second object of the invention is to cover an article to be protected against both normal and abnormal shocks with a resilient, substantially integral foam lining of such varying strengths that when the article, which may or may not have moving parts, is encased in such lining and packed in a suitable carton, the package may be given a jolt equivalent to a drop of as much as twenty feet upon concrete without injury to the article even though the latter weighs a hundred pounds or more and has parts of widely different resistances to both light and heavy shocks.

A third object of the invention is to pack a highly sensitive and extremely delicate instrument containing moving parts in a rigid container such as a metal cask and cushion the instrument against shocks and jars with an organic plastic foamed-in-place protecting coat of one, two, or more different densities, with or without sizable voids, so that such instrument in its container may safely be dropped by parachute or be discharged as a missile at extreme speed.

A further object of the invention is to provide a suitable cushion in a container by first building a form following generally the contour of the article to be packed but being built up in locations wherever additional security is desired, filling the space between such first form and the container with a foam of a given density, then inserting a second form generally similar to the first form but smaller by the volume of the built-up portions, filling the space between the second form and the previous form with foam of a second density, and if necessary repeating the cycle with a still smaller third form, which however is larger than the article, and perhaps even a fourth and fifth form if necessary.

A still further object of the invention is to protect an article of a given contour and of differing resistances to shock by forming in a container a foam cushion of the general shape of the object and by adding proximate the location of the least resistant portions masses of a similar foam of an appreciably lower density but of a thickness of about twice that required so that when the object is forced into the foam cushion it will compress the softer foam portions and thus add greater protection than if the lining originally were thinner and denser.

Other objects of the invention relate to the general idea of modifying the density of a polyurethane-isocyanate foam lining so that the supporting strength of this material shall be adapted to the need of the various areas of the object to be protected against the exigencies of transportation of all types including those of supersonic speeds.

In the drawings:

Figure 1 is a central section;

Figure 2 is a plan view;

Figure 3 is a plan view of a modification;

Figure 4 is a vertical section on line 4—4 of Fig. 3; and

Figure 5 is a vertical section showing a modified form of metal support.

In the simple form shown in Figs. 1 and 2 the container **10** is a cardboard box which has been filled to a level such as **11** with a plastic foam which receives and supports an object not shown but fitting snugly in the recess in the foam. The space between the level **11** and the top of the box is filled with a block **14** of plastic foam which will cover the object to be transported and which block **14** may but need not be bonded to the four usual flaps **15** of the carton **10**. The plastic foam in the particular embodiment of the invention illustrated in Figs. 1 and 2 consists of bonded blocks of foam of quite different densities. The block of the greatest density is numbered **16** and is of uniform depth (smallest dimension) front to back as seen in Fig. 2 but is bowed slightly at both sides as at **17** to conform to an outline of the object being shipped. The block **16** has a notch **18** through which, in Fig. 1, can be seen the lining which is in contact with the carton and is bonded thereto. The rear portion of the lining thus seen is numbered **19**; the opposite front portion is numbered **20**; and the two side portions are numbered **21** and **22**.

These four portions are integral as they are formed in the corrugated pasteboard box **10** and being of the same firm density foam are cast as the first step in making the lining, using a mold, suitably coated with a release agent, to form a recess or well into which the block **16** of heavier density is later placed or formed. When the block **16** is in place the well **25** is about the size of the object to be packed. The well has a trefoil-shaped recess **26** in its bottom and this is filled with a foam such as the portion **27** of softest resilience. There is thus formed in the bottom of the lining a small extension **28** of the well which receives a downwardly projecting delicate part of the object to be packed, such part resting against the soft portion **27** of the lining which the packed object compresses to a quite considerable extent.

The notch **18** receives a rearwardly projecting part of the object to be packed, such part itself being quite rigid but ending in an easily harmed tip. This rearwardly projecting part engages a disc **30** of a softer density than the main foam lining **19—21** to save such tip from injury. The block **16** of relatively hard foam is also recessed to receive discs **31** and **32**, the latter in the particular embodiment shown being relatively firm but not as hard as the material of block **16** whereas the disc **31** which is engaged by another delicate part of the object to be packed is of much lighter density and therefore softer.

Frequently it is better to give the object to be packed a somewhat firmer support than can readily be afforded by the lining. To this end there is sunk at the bottom edges of the well a pair of metal angularly bent strips **35** and **36** which extend well forward and rearward of the well, as indicated by the dotted lines in Fig. 2. The object rests on the horizontal flanges of these two angle irons which need not be but usually are at exactly the same level. The weight therefore of the object is spread over a much greater area than would otherwise be the case, not only downward but sideways when the box **10** is tilted. These metal pieces also insure that the delicate

parts in contact with portions 27 and 30 are positioned exactly to receive appropriate protection.

In this reasonably simple embodiment of the invention an initial inner mold is used as previously stated and the fairly firm density lining 19, 20, 21, and 22 is poured in place, leaving space not only for the well 25 and the block 16 but also for the dics 30, 31, and 32 in addition to the well extension 28 including the space later to be filled by the material 27 of least density. The plastic foam which has been found most satisfactory is made by mixing a polyurethane with a suitable proportion of an isocyanate, sometimes with an inhibitor to delay the setting time. This foam bonds readily with the inside lining of the carton 10. The inside mold also carries well-known means to properly position the two metal strips 35 and 36 and the foamed-in-place plastic lining bonds excellently with these. After this initial and fairly firm lining has been cast the disc 30 is foamed in place; the block 16 is next put in place and it may if desired be pre-formed. The discs 31 and 32 are then foamed in placed as is the portion 27 at the bottom of the well extension 28. The object is next inserted, fitting snugly and in particular places compressing the least dense portions. The covering piece 14 of plastic may now be placed over the object and lining and the box flaps sealed. A package made in this way containing a 68 pound instrument having moving parts may be dropped from a second story window without injury to the instrument, this being the requirement of one of the largest users of this mode of protection against shock.

Referring now to Figs. 3 and 4 which show the invention as applied to a delicate instrument of quite different form from the object to be packed in the cardboard carton 10 of Figs. 1 and 2: the container 40 in this case is of fairly heavy metal which could usually have a flat bottom but in view of certain circumstances concerned with the particular purpose, a so-called round bottom, curved as at 41, was used and is illustrated. This container 40 has a fairly heavy friction cover 43 to which is securely bonded a block 44 of firm-density foamed-in-place plastic and which block in the complete package rests firmly against the base 45 of the object to be packed, the remainder of the object being omitted in order that the configuration of the lining can the more easily be understood from the drawing. The major portion 48 of the lining is of firm-density formed-in-place plastic and this is bonded to the metal container or shell 40 throughout the area of the latter below the base 45 of the instrument.

A block 50 of foam of the least dense character is formed in a recess 51 which extends in the particular case illustrated nearly to the bottom of the well 52 which receives the major portion of the instrument which obviously is upside down. Behind the block 50 is a void 54 which is of a depth of only about half the depth of the block 50 (as indicated by the dotted line 55 of Fig. 4) and which is not filled with any portion of the object to be transported but is of great use because the block 50 protects the most delicate part of the instrument and should the instrument be jolted so as to tend to bring it to the top of Fig. 3, which is a plan view, the projecting delicate part of the object would press against the extremely soft block 50 and force it into the void 54.

The void 57 at the right in the figures is filled with a part of the object which is slender and upside down and projects to the bottom 58 of the void 57 which is entirely surrounded by a lining 60, in this case of the same density as the block 50 but instead of fitting the part of the object being transported, as does the upper portion of the void 57, the lower portion of the void as at 61 is materially smaller on all four sides so that as part of the object is pushed into the completed lining the sides of the lower portion 61 will be forced away sideways and in this manner will give much better protection to the slender part of the object in the void 57.

In the lower left hand side of Fig. 4 will be noted a slight depression 64 of the bottom of the well 52. The floor of this depression 64 is covered by a fairly thin portion 66 of a foam of a density between that of the firm foam 48 and of the small block 68 which is of a fairly soft foam of the next grade less resilient than that of the foam surrounding the void 57. The part of the instrument to be packed in this container touching the floor 64 of the well is only slightly less liable to damage than the portion which enters the void 57. In Fig. 3 the shallow groove 69 supports a laterally extending part of the instrument while the so-called bridge 70 extends between fairly deep and narrow depressions 71 and 72 which extend to an elevation only slightly higher than the bottom of the well 52.

In Fig. 5 there is shown a support which is of great advantage in holding an object which may be bolted to a supporting structure. The latter is shown as being of channel formation and can be imbedded in a quite heavy foam 75 thoroughly bonded to the container which in this case is numbered 77. The base 78 of the object rests on the central portion 79 of the channel member denoted as a whole by the numeral 80 and which has two spaced parallel portions 81 parallel to the bottom of the container 77 and having upstanding flanges 82 which may be parallel to the sides 83 of the container in this case of quite heavy steel but it is preferred that the side flanges extend at a slight angle as illustrated so that the angle between the faces 81 and 82 is about 100°. The two main sides 85 of the channel, however, are preferably parallel to each other. In this case as with angle irons 35 the object of the construction described is to make a more firm support. A number of screws 86 with nuts 87 are preferably applied through holes in the base or central portion 79 of the support with their heads imbedded in the foam 75 as it is normally much more convenient to secure the nut 87 directly to the object base 78 rather than imbed the nut 87 underneath the central portion 79.

In this particular installation the upper portion, not shown, of the container 77 carries a lining of a number of different densities and can be pushed down over the object so that denser portions of the lining are in contact with the top 88 of the lining 75. As in the other various forms of the invention, preferably all portions of the linings are bonded together so that when the package is complete the lining is an integral piece. There are special cases where a portion of the lining, as for example the block 16, could readily be inserted in place without bonding as a block of this type with two large parallel sides and resting firmly on the metal reinforcement has no tendency to move and in this particular case actually is of a more firm body than even the portion 19 between it and the proximate side of the cardboard container.

A preferred plastic lining is polyurethane foam formed in place by mixing a somewhat viscous polyurethane resin and a non-viscous catalyst. These two liquids may be stored separately for a fairly long time without any deterioration. When they are mixed together, however, which in accordance with instructions from the proprietor should be accompanied by rapid mechanical stirring, the ingredients start at once to produce a foam which has a cubic capacity greatly in excess of the volume of the two liquids. Foaming stops in as little as a quarter of an hour and the foam product is then baked for an hour or so at a temperature specified by the chemical firm distributing the chemicals.

The so-called catalyst is usually an isocyanate. In protecting especially delicate portions of an object to be packed, still greater protection may be given when the thickness of the uncompressed very soft foam is considerably greater than its thickness when such foam is compressed between the package and the instrument. In these cases the instrument is gently forced into the recess

lined by the very soft foam as for example in the recess 57. In general the density of the foam ranges from one pound per cubic foot to even in excess of thirty pounds per cubic foot but where it is deemed advisable the foam can be made considerably less dense by using less ingredients than will fill a mold cavity and then applying a mild vacuum ranging for example from one-tenth of an inch to fifteen inches or more of mercury. About two inches of mercury vacuum increases the expansion by a tenth, which is usually quite satisfactory.

What I claim is:

1. A package comprising a container, an irregularly shaped object to be shipped having parts of varying resistance to shock and spaced within the receptacle, and a resilient lining between the object and the wall of the container, said resilient lining comprising a plastic foam of varying densities, the denser portions of the foam adapted to directly support parts of the object well capable of resisting shock and the lining being of lesser density where supporting parts of the objects where such parts are of least resistance to damage by jarring, said portions of the lining being fused together to form an integral body of lining forming a well to receive the object, and a block of dense lining, having spaced portions of plastic foam of less density, fitting one side wall of the well.

2. The package of claim 1 in which the lining is bonded to the receptacle, and a pair of parallel metal strips are imbedded in the lining forming a portion of the corner edges of the well and extending beyond the margin of the well to be firmly embedded in the lining at both sides of the well.

3. Packaging means for protecting against abnormal shocks a highly sensitive instrument having delicate moving parts, comprising a container, a plastic foam bonded to the container and having a plurality of wells therein spaced from the wall of the container, one of said wells to accommodate a slender portion of the instrument of uniform cross section, said well having a lining of lesser density than the major portion of the plastic foam and being constricted in cross section at its closed end so that as the instrument is pushed into place the slender portion will force the constricted lining sideways and will therefore give better protection to the slender portion.

4. Packaging means of the type described comprising a container, a dense plastic foam bonded to the container, a rigid metal support embedded in the foam to support an object to be packaged, the foam having recesses therein lined with foam of less density to receive delicate portions of the object, and means, to which is bonded a plastic foam, for closing the container and holding the object firmly in contact with said foam of less density and with the dense plastic foam bonded to the container.

5. A package for protection against abnormal shocks, comprising an instrument having delicate moving parts and a base, a container for housing the instrument, a plastic foam bonded to the container and having a plurality of recesses to receive portions of the instrument, and a cover for the receptacle having bonded thereto a dense plastic foam to engage the base of the instrument and force portions of the instrument into the recesses, at least one of said recesses being filled with a foam of lesser density engaging the object on one side and closing a void in the foam bonded to the container on the opposite side, whereby a portion of the object of minimum resistance to shock may gently press the lesser density foam into the void and therefore obtain maximum protection.

6. Packaging means for an object of complex contour and having delicate parts, comprising a body of dense plastic foam having a major well with an irregular bottom, a block of dense plastic foam closing one side of the major well, a plurality of inserts of less dense foam in said block, an insert of foam of least density filling a portion of the bottom of the well; each of the foam portions being in contact with the object.

7. A package comprising a container, an irregularly shaped object to be shipped having parts of varying resistance to shock and spaced within the receptacle, and a resilient lining between the object and the wall of the container, said resilient lining comprising a plastic foam of varying densities, the denser portions of the foam adapted to directly support parts of the object well capable of resisting shock and the lining being of lesser density where supporting parts of the objects where such parts are of least resistance to damage by jarring, the resilient lining having a main well and a spaced minor well, the main well having a lining of one density backed in part by a lining of a different density and the said lining of one density covering a part only of the wall of the well.

8. A package comprising a container, an irregularly shaped object to be shipped having parts of varying resistance to shock and spaced within the receptacle, and a resilient lining between the object and the wall of the container, said resilient lining comprising a plastic foam of varying densities, the denser portions of the foam adapted to directly support parts of the object well capamle of resisting shock and the lining being of lesser density where supporting parts of the objects where such parts are of least resistance to damage by jarring, a central well is formed in the resilient lining, opposite walls of the well being plastic foams of different densities, one of which walls being of the density of the lining in contact with all of the wall of the container, and a plastic foam of greater resilience than the lining in contact with the wall of the container forms a portion of the bottom of the well.

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