

Aug. 23, 1966

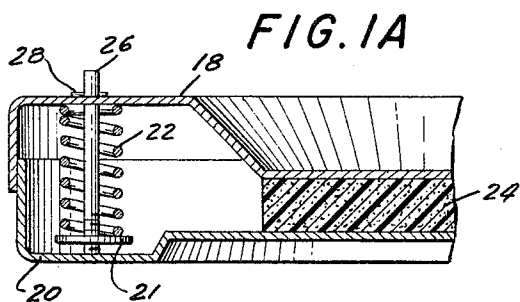
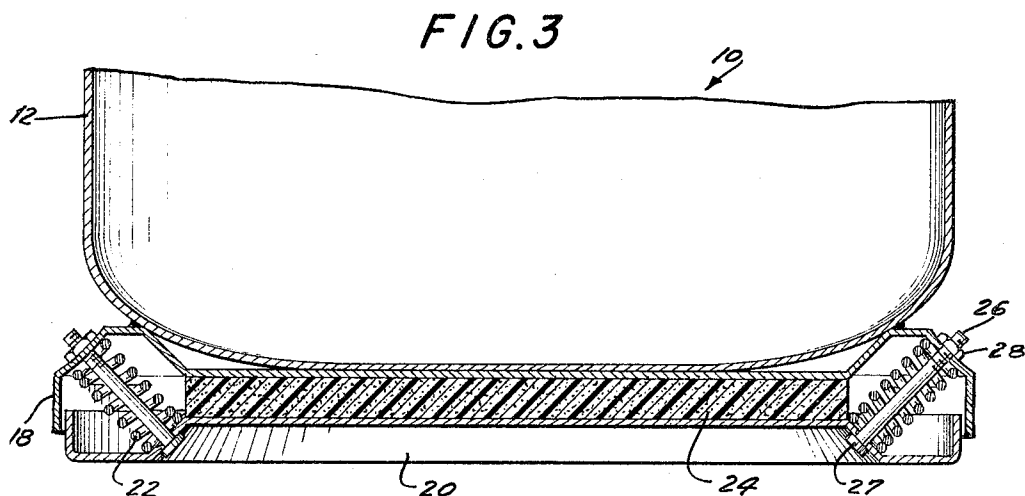
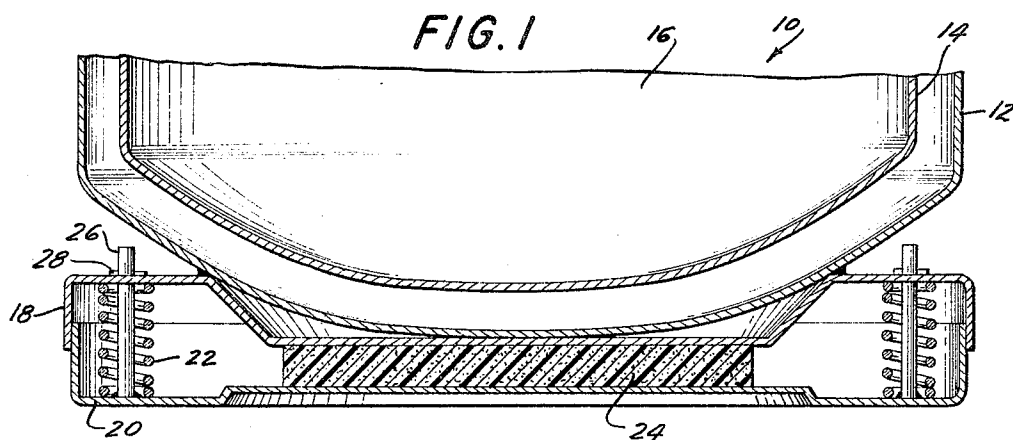
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SHOCK ABSORBENT SUPPORT STRUCTURE

Filed May 8, 1964

6 Sheets-Sheet 1



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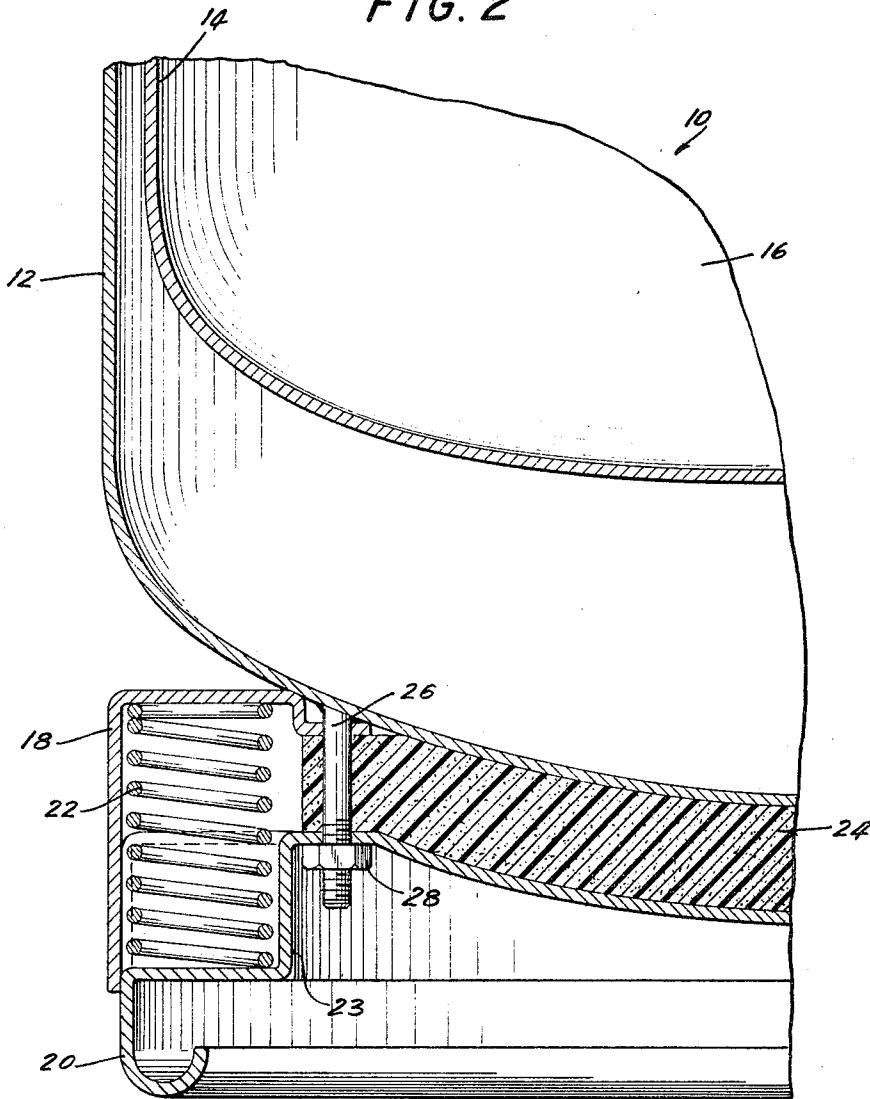
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SHOCK ABSORBENT SUPPORT STRUCTURE

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FIG. 2



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FIG. 5

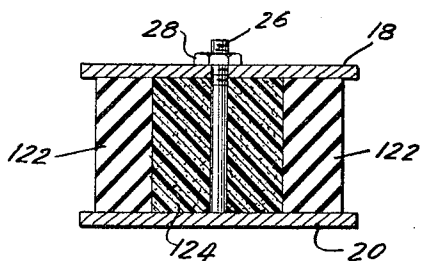


FIG. 4

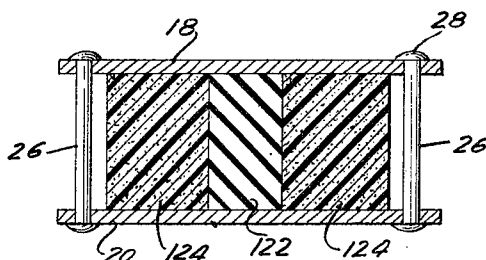


FIG. 6A

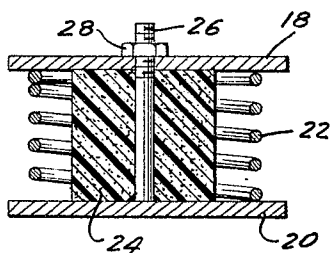


FIG. 6B

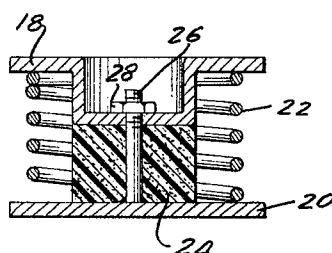


FIG. 7A

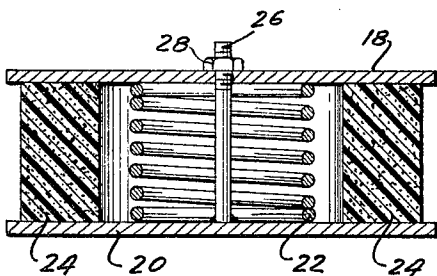
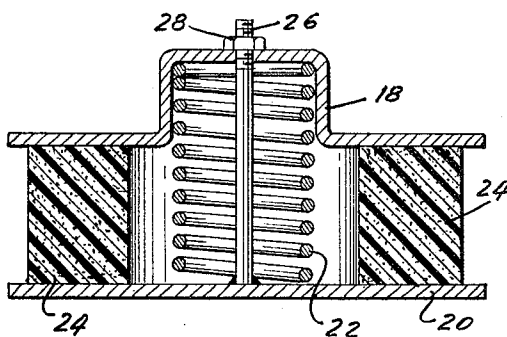


FIG. 7B



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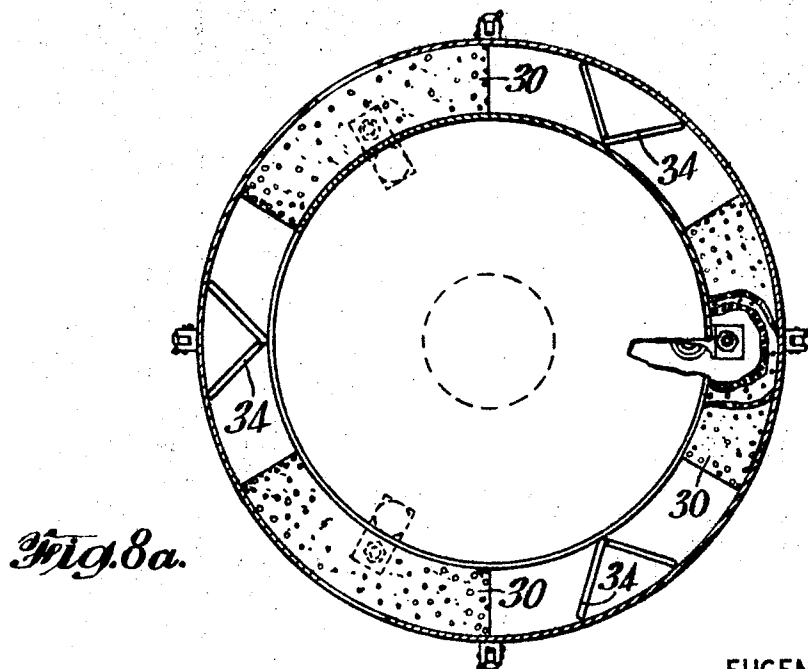
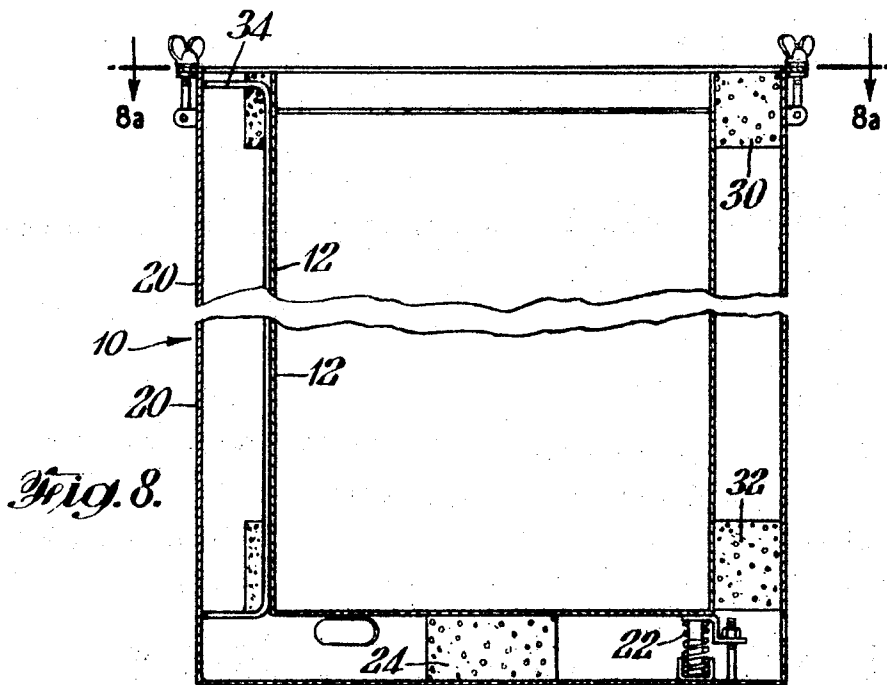
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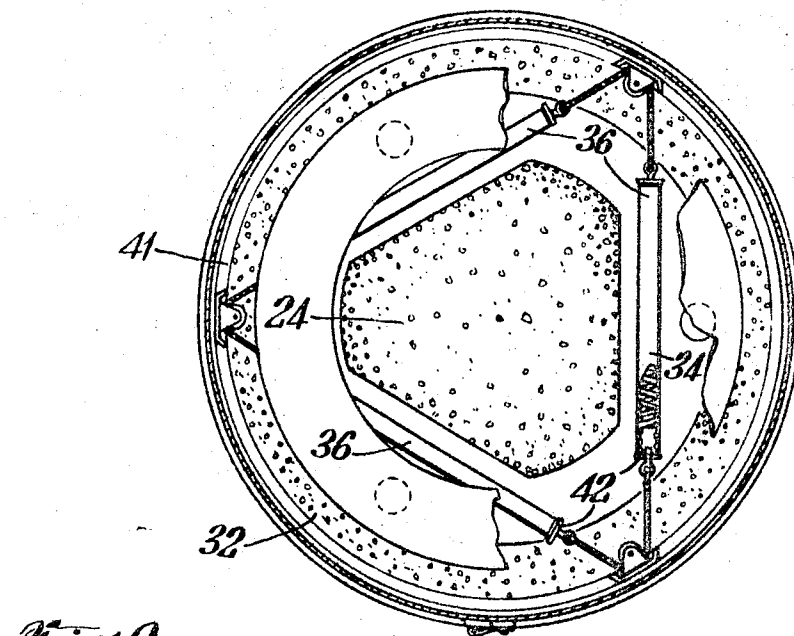
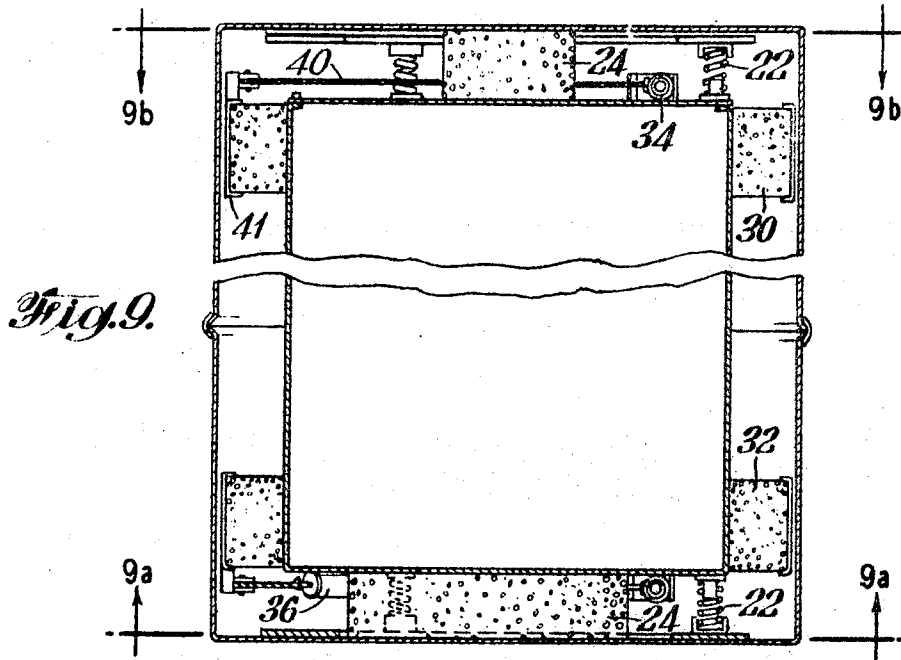
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SHOCK ABSORBENT SUPPORT STRUCTURE

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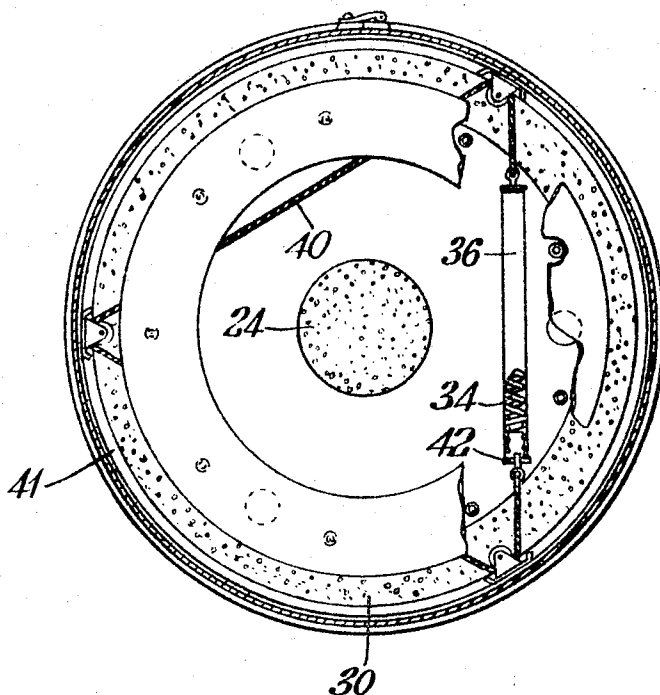
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Fig. 9b.



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SHOCK ABSORBENT SUPPORT STRUCTURE

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Filed May 8, 1964, Ser. No. 366,689

5 Claims. (Cl. 248—350)

This application is a continuation-in-part of copending application Serial No. 43,588, filed July 18, 1960 and now abandoned.

This invention relates to an improved shock-absorbing support structure. More particularly, it relates to such a structure for supporting delicate equipment and especially portable containers for liquefied industrial gases during normal and rough usage.

It is well known that double walled insulated containers for industrial liquefied gases require special construction to retard heat inleak and maintain resulting vaporization loss of the contained product at a very low level. For aggravated reasons, containers for handling very low-boiling liquefied gases, such as hydrogen and helium, require extra special design techniques such as the use of long, thin neck tubes, load rods of small cross-section, etc., all of which are inherently delicate and necessitate careful handling of the container to prevent damage. In order to adequately protect these relatively fragile containers from damage and subsequent loss of their valuable content during handling, an effective shock-absorbing or cushioning base is required.

Presently available formed-metal type supporting bases do not provide adequate shock-absorbing characteristics for more delicate equipment such as the above-mentioned containers designed for very low heat inleak. Other mountings such as coil springs alone, shear-loaded rubber, rigid or semi-rigid foam plastics such as Styrofoam, and bellows or Belleville spring designs are not fully satisfactory for the protection of delicate equipment. Although coil springs or some pneumatic devices may provide adequate initial shock absorption, they are found to be either too springy and thus may make the container relatively unstable or to exhibit too much rebound, either of which is very undesirable. Shear-loaded rubber may be slightly less springy than coil springs, but still exhibits excessive rebound; it is also expensive and usually requires undesirable guidance members. Styrofoam is somewhat brittle and is progressively crushed, resulting in ultimate loss of shock protection after repeated use. The use of bellows or Belleville spring type designs does not provide sufficient energy absorption capacity within allowable design considerations.

It is accordingly an object of the present invention to provide a novel shock-absorbing supporting structure for portable delicate equipment which will be subject to repeated sharp jolts.

It is a further object to provide a shock-absorbing base for portable liquefied gas containers designed for very low heat inleak.

It is a still further object to provide such a base which is relatively simple, inexpensive, rugged and long lasting.

Other objects and advantages will be apparent from the accompanying description and drawings in which:

FIG. 1 shows a side view in cross-section of a preferred form of the invention mounted on the base portion of a liquefied gas storage container;

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FIG. 1a is a fragmentary cross-sectional detail view on an enlarged scale of a modification of the mounting means shown in FIG. 1;

FIG. 2 is a fragmentary cross-sectional detail view on an enlarged scale of another embodiment of the invention also showing the details of the mounting means secured to a liquefied gas container;

FIG. 3 is a cross-sectional view in the nature of FIG. 1 of another embodiment of the present invention;

FIGS. 4 through 7b are cross-sectional detail views of still other embodiments of the present invention.

FIGS. 8, 8a and 9, 9a, 9b are cross-sectional detail views of still other embodiments of the present invention.

The objects of the present invention are accomplished in general by a shock-absorbing mounting means which comprises a first or base support member and a second support member spaced therefrom to which a shock sensitive device is affixed. The second member is attached to the first member by resilient means having low energy dissipation and a low spring rate capable of supporting the static load of said device with only slight flexure. A relatively-inelastic flexible foam plastic energy absorbing means having high energy dissipation and a slow return rate is also interposed between the first and second support members, such plastic foam being so positioned to be substantially undeformed under said static load conditions. Thus, when a sharp dynamic force is applied to the assembly causing the two members to move together, as by dropping the assembly on its base, the energy absorbing means is deformed but due to its physical composition deforms at a relatively slow rate and absorbs the greater part of the impact energy and at a lower extreme of travel. After the impact has been substantially absorbed, the resilient means returns the two members to their original separation at a relatively slow rate due to its low spring rate. The foam plastic energy absorbing element thus dissipates a high percentage of the impact energy momentarily absorbed therein, as evidenced by its having low rebound characteristic.

An important advantage of this invention is that the combination support structure has no noticeable natural frequency, since the relatively-inelastic plastic foam member tends to break up and destroy any harmonic vibration. This factor also contributes to low rebound for the base structure, for example, less than 40% or about half that of coil spring alone.

Another important advantage of this support structure over conventional metal springs is that the flexible plastic foam element will absorb many times more energy per unit weight than metals or dense elastomers such as rubber. Thus, the total weight of the base structure will be much less for a particular energy absorption and allowable deflection requirement than for such conventional absorption methods or devices.

This novel shock-absorbing mounting means utilizes a relatively-inelastic flexible foamed plastic as an energy absorbing material in combination with a compressed elastic material or member to provide a structure having superior overall shock-absorbing characteristics. The relatively-inelastic foamed plastic material or element is principally characterized by having high energy dissipation, for example, greater than 75%, as determined by its exhibiting low rebound such as less than 25%. In contrast, the compressed elastic material or element is principally characterized by having low energy dissipa-

tion, for example, usually less than 20-40% as demonstrated by its exhibiting a high rebound such as greater than 80% for metal springs and greater than 60% for rubber. Used alone, either of these two materials or elements would provide an inadequate and unsafe shock-absorbing support arrangement.

The plastic foam also exhibits large deflection for a relatively small applied force per unit thickness and has a relatively slow release or return rate, as defined by deflection change per unit time. By relatively slow release or return rate is meant materials which require many fold times as long to return to their original condition after deformations compared with an elastic material, such as compressed metal springs, compressed rubber, etc. The compressed elastic material or member is characterized by having low energy dissipation and a rapid return rate, such as only a very small percent as long as for the foam material. Under both static and dynamic load conditions, the plastic foam material exhibits large deflection per unit thickness, and has a similar relatively release or return rate, due principally to its having predominantly a close cell or pore structure. However, the plastic foam material does exhibit greater resistance to deformation under impact loading than under static load conditions. The preferred plastic foam material is defined as an expanded polyvinyl chloride resin, one example being obtained from U.S. Rubber Company under the trademark "Ensolite" No. 266. Other materials which can be used to advantage are specially formulated polyurethane foams and other vinyl foams, preferably of closed cell type.

After being deformed, the plastic foam material returns to its original shape or condition at a rate dependent upon the degree of deformation. That is, the initial rate of recovery from deformation is greater just after release of the deforming force than it is when the recovery from that force is almost complete. Thus, the initial rate of recovery from a deformation of 50% is greater than from a deformation of only 25%. The preferred range of recovery times for flexible plastic foams useful in this invention is at least 3 times that of a steel spring when depressed to the same percentage of its free height.

Since these plastic foam materials have very low static load-carrying characteristics, the principal support according to the invention is provided in the form of compressed rubber or metal springs. A requirement of this principal support means, such as springs, is that they be prestressed by an amount to produce total spring force approximately equal to the total static weight of the container and contents, and also have a relatively low spring rate or constant, as defined by force per unit deflection. Thus, the static weight of the container will be supported without appreciable additional spring deflection. Also, if the container is tipped or dropped from any reasonable height, these springs further deform quite easily so that substantially the full impact load of the container and its contents is absorbed by the plastic foam material. After the container has sustained an impact on the shock absorbing structure, the container is returned to its normal position at a relatively slow rate principally by the minor fraction of the total impact energy which is now stored in the weak springs; the plastic foam material returns to its original shape and conditions at a slower rate and the major part of the total energy momentarily stored therein does not contribute appreciably to rebound. Thus, the compressed metal springs return to their original height more rapidly than the plastic foam pad and rather quickly provide a level base structure for the container to rest upon. The pad is preferably affixed as by gluing to either the upper or lower members of the base structure to minimize lateral shifting thereof, but may also be mechanically clamped in place.

The amount of shock-absorbance desired determines the thickness of plastic foam energy-absorbing material

used. Theoretically, it would be possible to design containers which would sustain drops from very great heights without damage, but of course with the one condition that the container would always land on the special base.

The expression "spring rate" as used herein means the total force in pounds necessary to deflect the resilient means, e.g. compressed helical metal springs, one inch, as defined by the following formula:

$$K=pn/d$$

where:

K =total spring rate, lb./inch of deflection.

p =force per spring, lb.

n =number of springs used.

d =deflection of spring, inches.

The desired spring rate is related to the weight and desirable stability of the container, and to the total force exerted by the springs when the base is deflected to its design value of, say, 30% of original thickness. The total spring rate may be calculated by the following generalized equation:

$$K=W(fG-R)/0.7T$$

where:

W =weight of container, lbs.

G =ratio of maximum allowable acceleration to gravity acceleration.

R =ratio of initial total spring compression to weight of container.

T =thickness of plastic pad, inches.

f =fraction of total impact force exerted on springs when base is at design deflection.

The invention will now be more fully described with reference to the accompanying drawings wherein like reference numerals refer to like parts. Referring more particularly to FIG. 1, container 10 may consist of outer shell wall 12 and inner vessel wall 14 and is preferably cylindrical in shape, but may be rectangular, hexagonal, curved, or any other desired shape such as spherical. Inner vessel 14 holds liquid or bulk product 16 and is positioned and retained within outer shell 12 by any desirable means such as load rods or a neck tube (not shown). The space between may be evacuated and/or filled with heat insulation.

Outer shell 12 is attached by any suitable means such as welding or bolting to an upper foot ring 18 which mates with lower foot ring 20. Upper foot ring 18 may be shaped as desired to fit the dish head of outer shell 12 and is preferably slightly larger and provided with a rim flange which slides outside the rim flange of lower foot ring 20. The static weight of container 10 and its contents is preferably borne entirely by at least three helical coil springs 22, preferably distributed around the circumference of the two mating base rings. The static weight is not supported by the pad of relatively-inelastic energy absorbing plastic foam material 24 located between foot rings 18 and 20. Supporting springs 22 are preferably loaded in compression and are guided by rods 26 having retaining pins 28, which are attached to lower foot ring 20 and also serve to hold the base assembly together. Rods 26 may be welded at their lower ends to the lower ring and pass through clearance holes in the upper ring to permit sliding. Alternately, adjustable nuts could be used instead of pins 28 for holding the mating parts together, and washers may be used under either the pins or nuts if desired. As stated previously, pad 24 is preferably held in position against lateral displacement as by gluing to either one of the members.

Whenever container 10 is accidentally or intentionally dropped through a reasonable height up to, say, 4 ft. (for example from a truck bed) onto a rigid surface so that lower foot ring 20 strikes first, the impact or shock load jointly by springs 22 and plastic foam pad 24. However, springs 22 will easily deflect due to the low spring

rate so that a major part of the impact load is then resisted by plastic pad 24. Due to its particular physical characteristics, the pad will deform appreciably at a slow rate to an amount necessary to absorb the principal portion of the energy of impact. This relatively large deflection per unit thickness of pad 24 coupled with its good energy absorption characteristics result in relatively low impact forces being transmitted to the container, and thus serves to cushion the inner parts of the container and thereby prevent structural damage to the container and/or its contents. After the impact load is absorbed and the corresponding deflection of the pad has occurred, the container is relatively slowly returned to its normal position or height by action of the coil springs 22 due to their low spring rate after which the plastic foam material 24 returns slowly to its original height or thickness.

The general requirement for designing a supporting base structure of this type is to absorb the energy produced at the required or greatest expected drop height by having the resulting impact force less than the strength of the weakest component of the container. This requirement of limiting the impact force may be met by properly sizing the area and thickness of the plastic foam pad, since the amount of energy absorbed will then be generally proportional to the thickness of the pad. For good results and most economical use of the plastic foam material, the pad should be designed for a maximum loading of about 50 p.s.i. occurring at about 70% deflection (to 30% of original thickness) of the pad material. These figures are for Ensolite #266 and might vary slightly for other plastic foam materials. Dimensions of the mating foot rings of the base assembly should be selected to achieve this loading and deflection. In general, the energy absorbing performance of the plastic pad for a particular application is essentially a function of the volume of material used. The pad may be varied in both diameter and/or thickness to provide the degree of energy absorption desired to adequately protect the various parts of the container and/or its contents from damage. However, no performance detriment is incurred in using greater material thickness than required.

The basis for selecting the total spring rate and preloading of the compression springs sufficiently is to give a desirable amount of stability to the container when standing and for routine handling, and yet not compress the plastic foam material. Excessive preloading of the springs or use of a high spring rate results in the springs absorbing an undesirably large share of the impact load, which would cause inferior shock-absorbing performance, excessive rebound and mechanical resonance of the container. To limit rebound and for best results, the springs should absorb only about 10-20% of the total impact force when the flexible plastic foam is deflected to its design value, or to say about 30% of original thickness. It is undesirable to have any initial compression of the plastic foam material since that portion which is so compressed would be wasted with regard to providing shock or impact-energy absorption.

The helical springs should be at least 3 in number and are preferably located and spaced around the outer circumference or periphery of the base in order for them to provide the maximum stability to the container.

One desirable modification of the invention is shown in FIG. 2. In this design, both the upper and lower foot rings 18 and 20 are attached to the cylinder by bolts, the bolt holes in the lower ring 20 being sized to permit sliding along the bolts which do not additionally serve as spring guides as in FIG. 1. The plastic pad is retained and shaped to the general contour of the container by the two mating foot ring pieces, and may occupy the full inside diameter of the upper foot ring if desired. In this embodiment, the pad is restrained from lateral motion by the skirt on upper member 18 wherein gluing of the pad to one of the members is not necessary. The coil springs are retained in position and guided

by suitably formed depressions 23 in the lower foot ring and also by suitable perforations in the pad material. This design is especially adapted to containers of greater height/diameter ratio and also having greater weight/diameter ratio and greater impact force/diameter ratio than required for FIG. 1.

This base design is particularly effective in absorbing impact loads applied either axially or at relatively small angles with the vertical axis of the container. Impact loads from the side may also be effectively resisted by using a ring of the plastic energy absorbing material between the vertical flanged mating surfaces or aprons of the foot rings.

Another refinement of the arrangement of FIG. 1 is to replace the retaining pins 28 in FIG. 1 by some adjustable means such as threaded nuts by which the amount of preloading of the springs can be controlled as desired, based upon the weight of the container and/or its contents. However, for a still further improvement, this adjustment may be made in such a manner that this preloading of the springs is controllable independently of the thickness of the plastic foam material as shown by FIG. 1a. The amount of compression of spring 22 may be changed by a threaded and notched rotatable spring retainer plate 21 using a suitable tool inserted through openings provided in lower foot ring 20. Rod 26 is welded to the lower plate and passes through a clearance hole in the upper plate. Other means of accomplishing this spring adjustment may alternatively be used, allowing adjustment to be made either from the top or from underneath the base. In this manner, the initial total spring force can be adjusted as desired to provide the required stability and yet have the container positioned so that it just contacts the plastic foam material without undesirable pre-compression of the plastic material. Such an adjustment feature is also useful in making any adjustments desired after extended use of the support. Alternately, the total spring rate may be changed by increasing or decreasing the number of individual supporting springs, or by substituting other springs for the initially used springs. A further refinement of FIGS. 1 and 2 is to use helical tension springs to replace the helical compression springs described. With appropriate revision of the spring attachments and guides, tension springs may be used to perform in essentially a similar manner as compression springs. An advantage of tension springs is that they would not "bottom" under higher-than-expected impact loads by reaching their solid compressed height as compression springs do.

Another modification designed to withstand both vertical and transverse loads is illustrated in FIG. 3. Here the spring guide rods 26 are mounted on pivots at their lower ends. As shown, these pivots merely comprise an enlarged opening in lower member 20 and a flanged portion 27 at the lower end of rod 26, or may have a curved seating surface. This arrangement at the upper end of the rod is substantially the same wherein the nut 28 takes the place of flange 27 at the lower end. The rods can alternatively be mounted in rubber grommets which are in turn mounted in the hole through member 20 with substantially the same results. Other suitable arrangements allowing limited axial and pivotal movement are also possible. With the resilient means so disposed at an angle to the vertical, they provide a limited amount of protection against lateral blows. Other equivalent modifications of FIG. 3 are also possible.

Another modification replaces the helical coil springs with pieces of an elastomer material such as natural or synthetic rubber having circular, annular, or other suitable cross-section and pre-compressed by the desired amount. This modification is exemplified by FIGS. 4 and 5 wherein the numerals 122 and 124 designates the rubber springs and the foam plastic energy-absorbing material respectively. In this embodiment of the invention, the rubber springs would be chosen to have a low spring

rate as set forth with respect to the helical metal springs above. They could either be used with guide rods as with the helical springs or simply attached to the upper and lower members 18 and 20 with a suitable adhesive. However, in the latter case little or no pre-compression of the springs would be possible. If the mounting means of this embodiment were used as a shock absorbing support for liquefied gas containers as shown in FIGS. 1 and 2, the rubber springs would be at least 3 in number and preferably located around the outer circumference or periphery of the base in order to provide the maximum stability.

FIG. 4 shows a compressed rubber spring member of desired cross-section enclosed within flexible plastic foam material.

FIG. 5 shows a piece of plastic foam material of any desired cross-section, enclosed with compressed rubber.

FIGS. 6a and b show embodiments wherein a piece of flexible plastic foam material of any desired cross-section is enclosed within a coiled helical spring having a small initial compression load as provided by a retaining and guide rod 26.

FIGS. 7a and b show two embodiments wherein a piece of flexible plastic foam material of any desired cross-section, preferably annular, encloses a coiled helical spring having a small initial compression load as provided by a retaining rod.

It is also to be understood that air bags could be used as the elastic spring members with only slight modification. For example, in FIG. 1 an annular air bag could be positioned between the upper and lower members in the space where the springs 22 are located.

For each of the constructions shown in FIGS. 4 through 7b, the location or type of guide or tension rod 26 is optional. If the general cross-sectional shape of the particular support member of these figures is assumed to be triangular or pie-shaped, it could become a segment of a circular base construction as illustrated by FIG. 1. Additionally, the units can be placed at different angles in a combination use designed to absorb both vertical and lateral loads, in a manner similar to that of the resilient member in FIG. 3.

A most significant improvement which the combination of relatively-inelastic plastic foam material and an elastic material or member offers over other elastic shock-absorbing systems such as coil springs, rubber in shear, etc. is that the plastic foam provides essentially a constant resistive force more or less independent of deflection to about 30% of original height. This means that with "maximum allowable force to be absorbed" used as the design criterion, the plastic foam material used alone will absorb almost twice as much energy as a linear spring for the same deflection. This is because the plastic foam will deflect with nearly a constant load for essentially the full deflection, whereas an elastic spring system is deflected with the load increasing proportionally to deflection. Also, a spring is essentially an energy storing member rather than an energy absorbing or dissipation member which causes many rebounding cycles before the impact energy is dissipated. Springs give very rapid energy return, whereas plastic foams and the like useful in this invention have much slower energy return times and are inherently more dampening.

In the present invention, the use of the plastic foam and springs are combined in such a manner as to use each part most effectively to achieve the desired result. For example, the springs are selected to be relatively soft by having a low spring rate or constant, and support the container and its contents with perhaps a 1/2 in. initial deflection at 1G loading. Thus, for an impact loading of 5G's, deflection of the spring alone would need to be about 5 times the original deflection, or increase by an amount usually greater than the required thickness of the foamed plastic material. It may be seen that the effect of the springs upon the energy absorbing characteristics

of the base structure is quite minor. Thus, the design avoids the excessive flexibility or resiliency inherent in all spring-base support systems designed for low impact force.

The properties of Ensolute 266 are approximately as follows: During shock it deflects with almost a uniform pressure of 50 p.s.i. to about 30% of its initial thickness and has low rebound. It also has low density, low moisture absorption, is inert to oils and grease and is combustion resistant.

It is to be noted that although the plastic foams mentioned herein are referred to as inelastic, they do have the property of plastic memory or will return to their original shape when the deforming force is removed, although the action is sufficiently slow that they are not considered resilient or elastic when compared with metal springs, rubber, etc. As portable liquefied gas containers are usually designed for shock loadings of 10-40G's, this invention is most useful for that range of applications. However, it also has utility for mounting portable delicate equipment requiring shock protection for lower loadings such as 2-10G's. While certain preferred embodiments of the invention have been shown and described, it is to be understood that other modifications and changes could be made by a person skilled in the art without departing from the spirit and scope thereof.

The shock-absorbing support means of this invention may additionally be applied to the lateral sides of a container for supporting delicate equipment, for example a shipping container. FIGURE 8 shows a container 10 normally positioned uprightly and having an inner container 12 enclosed with an outer enclosure 20. Shock-absorbing means are provided within the outer enclosure and comprises resilient means for static loading used in combination with foamed plastic energy absorbing material for energy absorption. The lower end of the container employs shock-absorbing means preferably comprising (a) at least three prestressed helical compression springs 22 located near the periphery of the base enclosure to withstand the static load and provide stability, and (b) one or more conveniently located foamed plastic shock absorbing pads 24. The upper end of the container is open to receive the article to be protected during storage or shipment.

Lateral shock absorption for the inner container is provided for preferably by two separated rings 30 and 32 of foamed plastic energy absorbing material which are preferably located near each end of the container, and by at least three torsion springs 34. These torsion springs are located between the inner and outer enclosure and are prestressed by a desired amount prior to assembly so as to withstand the static loading without further deformation if the container is placed on its side, and are positioned to just touch the outer container when no load is applied. Thus, an impact to the container in any lateral direction will place a torsional stress on these springs followed by deflection of the plastic foam rings 30 and 32 by an amount as determined by the magnitude of the load applied as previously described. For short containers, only one ring of foamed plastic might be required for adequate lateral shock absorption. If desired, the rings of foamed plastic may comprise multiple separated pads instead of one continuous strip of material.

Also for the shock absorbent structure of FIGURE 8, the plastic foam rings 30 and 32 and the torsion springs 34 combine to provide a suitable centering and guidance means for vertically applied loads. For laterally applied loads, the multiple helical compression springs located at the lower end of the container similarly provide suitable centering and guidance means for the inner container.

Another embodiment of this invention is illustrated by FIGURE 9, wherein the upper end of the container may also have one or more prestressed helical compression springs 22 used in combination with one or more suitably located pads 24 of foamed plastic energy absorbing material in order that the container may be inverted if desired. If desired, a separate plate may be provided at each end

with adjustable tie bolts for precompressing the axial support springs. Similarly, lateral loads and shock absorption is provided for preferably by two rings 30 and 32 (or separated multiple pads) of foamed plastic material located near each end of the container and used in combination with one or more prestressed tension springs. Such tension springs are connected between the inner and outer enclosure in a polygon pattern, i.e., having at least three equal sides.

FIGURE 9 shows one or more helical tension springs 34 connected in a preferred triangular pattern at each end of the container, and utilizes metal tube 36 attached to the inner container with tension spring 34 being attached by flexible means such as cables 40 at three equally spaced points on a rigid circular ring 41 which is slidably attached to the outer container as shown by FIGURE 9. The spring is retained within the tube by adjustable washers 42 located at each end of tube 36 and which permit tension loads to be applied to either end of the prestressed spring 34 by the cables 40. If only one tension spring is used, the cables 40 must be able to slide relative to their points of attachment to the circular ring. If the same number of tension springs are used as attachment points, the cables may simply be attached rigidly to the circular ring without any provision for sliding of the cable within the attachment means. In this manner, the inner container is held concentric with the outer enclosure under static conditions.

Thus, an impact to the container in any lateral direction will place a tension load on the cables and prestressed spring(s), followed by deflection of the plastic foam rings 30 and 32 by an amount determined by the applied load as previously described. Similarly as for the shock absorbent structure of FIGURE 8, the plastic foam rings 30 and 32 and the tension springs 34 provide a suitable centering and guidance means for axially applied loads. For laterally applied loads, the multiple helical compression springs located at each end of the container provide suitable centering and guidance means for the inner container.

What is claimed is:

1. A shock-absorbing support structure for a storage container comprising in combination a base member having a vertically upwardly extending skirt and a container supporting member having a vertically depending skirt laterally displaced from the base member skirt sufficiently to permit relative vertical movement between the two members but only slight relative lateral movement therebetween; resilient means comprising at least three helical springs interposed between the two members for supporting the static weight of said storage container and said upper member and characterized by having low energy dissipation and a low spring constant; foamed plastic energy absorbing material contiguously interposed between the two members and characterized by having high energy dissipation and a return rate less than that of said resilient means such that the substantial majority of the dynamic energy imparted to said shock-absorbing support structure by an impact thereon will be absorbed by said foamed plastic energy absorbing material; guide rods interposed between the two members axially of said resilient means and connected to said base member at one end and adapted to slide in guide holes

in said upper member; and means on the other end of said guide rods for limiting the amount of vertical separation between the two members.

2. A support means as set forth in claim 1 wherein at least about 75% of the dynamic energy imparted to the shock-absorbing support structure by an impact thereon will be absorbed by the foamed plastic energy absorbing material.

3. A shock-absorbing support structure for a device comprising in combination a base member; an upper device-supporting member movable with respect to said base member; resilient means interposed between the two members for supporting the static weight of the device and the upper member and characterized by having low energy dissipation and a low spring constant; foamed plastic energy absorbing material contiguously interposed between the two members and characterized by having high energy dissipation and a return rate less than that of said resilient means such that the substantial majority of the dynamic energy imparted to said shock-absorbing support structure by an impact thereon will be absorbed by said foamed plastic energy absorbing material; and guide means permitting relative vertical movement between the two members but only slight relative lateral movement, said guide means comprising a lateral shock-absorbing support as a first member, a second member movable with respect to said first member, resilient means interposed between the two members capable of laterally supporting the device and characterized by having low energy dissipation and a low spring constant, and foamed plastic energy absorbing material contiguously interposed between the two members and characterized by having high energy dissipation and a return rate less than that of said resilient means such that the substantial majority of the dynamic energy imparted to said lateral shock-absorbing support by an impact thereon will be absorbed by said foamed plastic energy absorbing material.

4. A shock-absorbing support structure according to claim 3 in which at least one torsion spring comprises the resilient means of said guide means.

5. A shock-absorbing support structure according to claim 3 in which the resilient means of said guide means comprises at least one tension spring connected to said second member and with the ends thereof attached to flexible means connected to said first member at least at three equi-spaced points.

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