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PACKAGING FOR SLURRY EXPLOSIVES

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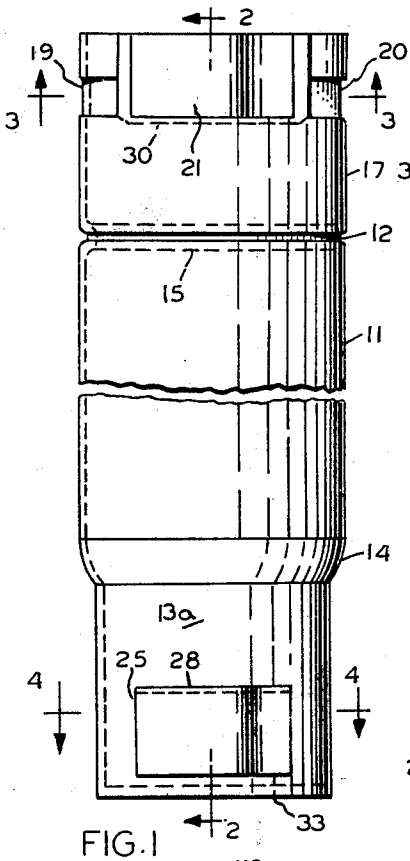


FIG. 1

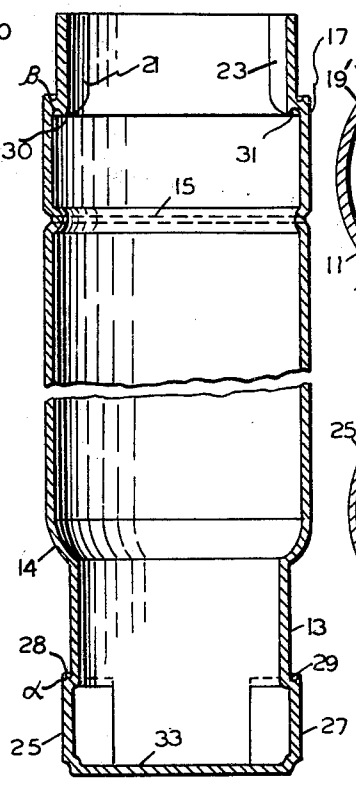


FIG. 2

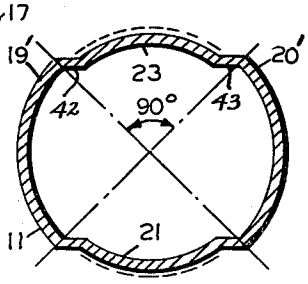


FIG. 3

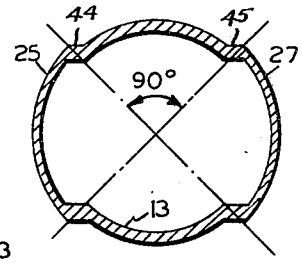


FIG. 4

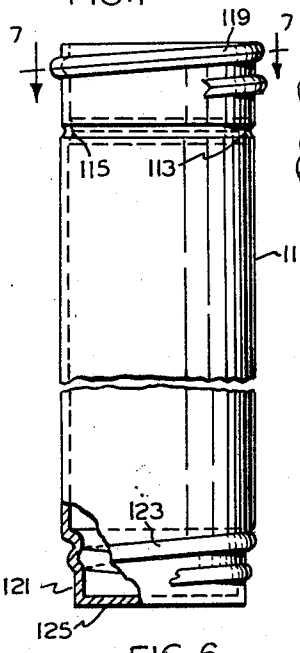


FIG. 6

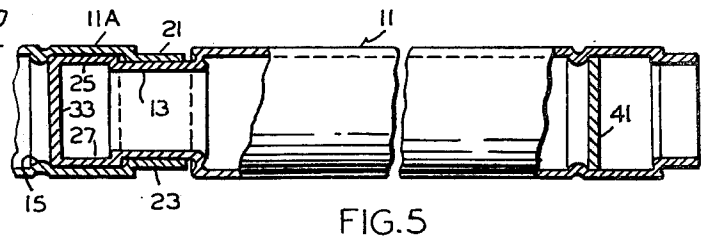


FIG. 5

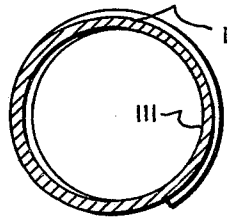


FIG. 7

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PACKAGING FOR SLURRY EXPLOSIVES

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Continuation-in-part of application Ser. No. 330,861, Dec. 16, 1963. This application Sept. 24, 1965, Ser. No. 497,587

Int. Cl. F42b 1/02, 3/18

U.S. Cl. 102—24 1 Claim

This application is a continuation in part of Ser. No. 330,861, filed Dec. 16, 1963, and now abandoned.

The present invention relates to improvements in packaging for plastic explosives. It has particular application to the packaging of slurry type explosives which are pourable or which flow as viscous liquids under ordinary temperature conditions.

In the prior art, numerous proposals have been made for the packaging of explosives in such a way that multiple units could be connected and used together. For example, in U.S. Patent 2,238,939, a proposal was made for packaging explosives, ordinarily of the solid type such as ammonium nitrate-TNT, dry compositions, in water tight metal cans. These cans were shown as being so constructed that they could be inter-connected for multiple or series use, for example, in a long borehole. However, the cans described in said patent are relatively costly. Each of them is sealed individually and they comprise complex and expensive structures. Each can is prefilled and sealed, certain ones are fitted with boosters, and thereafter there is no possibility of making as versatile an assembly of multiple units as is desirable.

In other cases, as in U.S. Patent 2,383,542, a paper package has been proposed for explosives, such as dynamite. In this case, the respective ends of each package were proposed to be fitted with male and female screw threads so that they could be inter-connected to make a long series of solid explosive units, e.g., dynamite sticks. Such containers, however, are not well suited for the packaging of fluid, especially water-containing or slurry-type explosives.

More recently, further efforts have been made to package various types of explosives for multiple unit assembly. An example is U.S. Patent 3,013,492 which describes impervious steel cylindrical containers having female thread elements at one end and male thread elements at the other so that they can be connected in series fashion. Such units are proposed, for example, for use in oil and water wells or for similar employment. At each joint there are two thicknesses of barrier metal between explosive charges. Such structures are relatively expensive and they have end seams larger in diameter than the cans which interfere with efficient insertion of charges into boreholes, particularly where efficient filling of the borehole is important.

None of the foregoing packages is particularly designed or entirely suitable for the inexpensive packaging on a large scale of a flowable plastic or slurry-type explosive. Explosives of the latter type comprising aqueous solutions of ammonium nitrate with sensitizer for example, have come into relatively wide use in recent years. One reason is that the explosive material can be field mixed and pumped or poured into containers for convenient handling and dropping into boreholes at the point of use. The present invention makes possible more convenient and efficient filling of the borehole. In some situations the flowable slurry can be mixed and pumped directly into the borehole. In other cases, however, it is not convenient or feasible to pump the flowable plastic explosive directly into the bore hole and it is preferable to premix and package in individual unit packages for insertion in series into

boreholes, wells, etc. The packaged explosves of this invention may be prepared in long sections, i.e. multiples. For such uses, it is desirable to have sectional packages that can be assembled in chain or series fashion with maximum explosive continuity to provide charges of multiple length and still make efficient use of bore hole space. There is, therefore, a real need for improved packaging to make it possible to assemble long sections of such explosives quickly and conveniently in the field.

It is thus an object of the present invention to make available improved but economical unit packages for liquid slurry type explosives, which packages can be used individually or in series, i.e. in multiple units or assembled in tandem by simple insertion of the closed end of one unit into the open end of the next, followed by locking rotation through a small angle, i.e., desirably not more than about 2½ turns of relative rotation, preferably not more than one turn. A further, though less important, object is to design such packages so that they either may be pre-filled, or may be filled, if desired, after inter-connection of two or more units, filling being accomplished preferably by a suitable pumping or other plastic flowing supply means.

A further object is to utilize as container material, substances such as molded or blown thin wall polyolefin plastics which have definite fuel value to add to the explosive effect. For this purpose, the container material should be of appropriate texture and wall thickness. Other objects include use of combustible and energy-contributing plastic package material of about 2 to 100 mils, preferably 4 to 50 mils in wall thickness, which are sufficiently strong to withstand filling and packaging in columns as long as 20 feet or more and still not so thick as to reduce seriously the efficiency of hole filling by the blasting agent. The design and construction are such that the propagation of the detonation wave is not substantially interrupted by end closure material. The preferably single transverse thickness of end closure material is a definite improvement in this respect. Additional objects are the design and fabrication of unit package elements that may be assembled interchangeably, that are suitable for fluid slurry or gel compositions, especially those which remain somewhat fluid in use, or for compositions which flow at moderately elevated temperatures and solidify, or substantially solidify, under conditions of use; the package units are also suitable for non-liquid but fluent compositions, such as "prills and oil," i.e. granular solids to which a non-slurrying amount of oil has been added, e.g. 4 to 8% of oil and 92 to 96% of ammonium nitrate. Other objects and advantages will appear more fully as this description proceeds. Hence, reference will next be made to the accompanying drawing wherein—

FIGURE 1 is an elevational view of a single unit container representing a preferred embodiment of this invention;

FIGURES 2, 3 and 4 respectively, represent a vertical and two transverse cross sectional views of the structure of FIGURE 1, taken respectively on the lines 2—2, 3—3 and 4—4, of said figure, in each case looking in the direction of the arrows;

FIGURE 5 is a front view, partly in section, of a pair of connected unit containers of the type shown in FIGURES 1 to 4;

FIGURE 6 is an elevational view of a modified unit container having a somewhat different inter-connection;

FIGURE 7 is a transverse sectional view of the structure of FIGURE 6, taken substantially along the line 7—7.

Referring now to the drawings and first to FIGURES 1 to 4 inclusive, there is shown a cylindrical unit container made, preferably, of a combustible thermoplastic

polymeric or moldable material such as polyethylene, polypropylene, or similar substance. It is important that that this material have adequate strength and yet have some flexibility. In a typical unit the tube may have a length of one to several feet or more and an internal diameter of one to six or more inches. In large blasting operations, tubes may be as large as eight or nine inches in diameter. A typical unit of convenient size, for example, may have an internal diameter of about four inches and a length of about four feet. However, proportions as well as absolute sizes may vary considerably. In general, the length will be several times the diameter, preferably at least four times in most cases. Polyethylene is presently a particularly suitable material for manufacturing such tubes since it has some fuel value and has adequate tensile strength, in the wall thickness preferred (4 to 50 mils or so), and can readily be extruded or blow molded and formed in the desired shape. It is also highly water repellent. The latter property makes it very suitable for insertion into bore holes in the earth where water is frequently abundant and troublesome. Polypropylene, copolymers of C_2 and C_3 olefins, and other related materials may be used in lieu of simple polyethylene with or, without reinforcing fibers, plasticizers and other modifiers known in the art.

As shown, the unit container comprises an elongated cylindrical body section **11** which is provided with a reduced end element, which also includes a transverse closure element, in its preferred form. For interlocking purposes, the closure end may be considered the male locking element and the non-closure end the female locking element when units are to be assembled in multiples. Assembly is to be effected by forcibly inserting the male closed element into the open end of the next unit and then rotating one unit with respect to the other to effect interlocking with the transverse end of the male element compressing the explosive in said next unit. This male element in FIGURES 1, 2 and 5, is shown as an end portion **13** of smaller diameter than the main body, joining the main cylindrical section **11** with a short tapered section **14**. At its other, or upper, end a female socket or receiver element **17** is formed, being joined to the body by an inwardly formed rib or shoulder, **15**. This annular shoulder **15** is defined by an outer groove **12** located between the body **11** and the socket or female joint section **17**. The latter is designed to fit and receive internally the element **13** of reduced diameter. The parts fit smoothly for convenient but reasonably snug assembly.

While the body of the container is shown in the drawings as being circular in cross section, and this is normally preferred, it may not always be absolutely circular. Thus, it may be polygonal and/or bear reinforcing ribs or struts, if desired. The receiver section or socket **17**, shown at the upper end, is provided with impressed, e.g. molded, internal locking or female bayonet interlocking elements, indicated at **21, 23**. See also FIGURES 2 and 3. Shallow indented partially annular depressions or channel portions **19** and **20** are formed in the open end section of socket **17**. These extend around the full diameter portion of socket **17**, in effect connecting between the inwardly extending locking or bayonet elements **21, 23**.

The section **17** is of full diameter i.e. equal to that of the body, as indicated at **11**, FIGURE 3. One purpose of the shallow indentations **19, 20**, is to insure a good friction hold and a reasonably snug fit when two sections or joints are fastened together. This will be explained further.

The other, or lower end of the container **11** has the restricted neck or male element portion **13** proviously mentioned above the transverse closure element and the male interlocking elements to be described below. This neck **13** preferably is primarily of circular configuration in section as indicated in FIGURE 3, i.e. except for the locking elements **25, 27** which are adapted to coact with elements **21, 23**. The surfaces of the latter are essentially concentric with the container axis. Near its other or lower extremity the necked-down portion **13** is expanded in form to provide the interlocking or bayonet type male locking elements **25, 27**, mentioned above. These are best shown in FIGURES 2 and 4. These locking sections are preferably formed at their tops with relatively sharp interlocking or mutually interengaging shoulder elements **28, 29**. These form an angle α of at most 90°, and preferably less, with the vertical face of the element **25** or **27**. See FIGURE 2. A corresponding angle β is formed on inside surfaces of the locking elements **20, 23**, to insure a good, tight and secure interlock when the parts are assembled. That is to say, the angle is such as to withstand the longitudinal tension of assembly with explosive under compression.

At the extreme lower part of the unit container, and just below the interlocking portions **25, 27** the container is closed with the transverse bottom member **33** mentioned above. This member or element is formed integrally with the side wall and is relatively thin so as to give minimal interference with the transmisison of the detonation wave when the charge is exploded. The unit container can be filled with liquid or flowable slurried explosive, or with a relatively stiff slurry or gel, or with granular prills and oil, up to the internal shoulder **15** which supports the bottom of the next section when two or more units are assembled. The containers are fitted together by inserting the reduced closed male end **13** of one unit into the open and larger or full diameter receiving end of female socket **17** of the preceding unit. Then, by pressing the parts together axially and rotating one section about a quarter of a turn, with this particular design, the interlocking elements **25, 27** fit snugly under the elements **21, 23** respectively. Due to the sharp shoulder construction there is no tendency for the parts to jam or slip. By careful design, including the slightly indented channels or depressions **19, 20**, a substantially liquid tight joint may be formed if desired. A locking collar or band of metal or of reinforced fiber, reinforced plastic, etc., may be placed and tightened around the outer tube, fitting in channel elements **19** and **20**, if desired. These elements provide a good seat for such a collar (not shown). On tightening, this band or collar will compress the outer wall elements of the female section to snugly embrace the inner elements. The water repellency of the wall material, especially when made of polyethylene or polypropylene, aids in making the joint leakproof when the parts are carefully fabricated or fitted together with liquid sealing in mind. Liquid sealing is not always essential but is a special feature of the invention that can be employed when desired.

Materials such as polyethylene and polypropylene, their copolymers, and the like, with or without reinforcing strands, e.g. of fiberglass or equivalent material, lend themselves to fabrication by economical blow molding. They also may be made by other common techniques such as simple extrusion and other dieforming practices well known in the art. At moderately elevated temperatures, straight stock cylindrical tubing of substantially the desired diameter may be used as starting material. Such tubing may be cut to appropriate lengths and then deformed by heating and pressing, or blow-molding, e.g., at its ends to produce the inter-locking male elements **25, 27**, and the female elements **21, 23** and groove **12** (corresponding to internal rib **15**) shown at the top of FIGURE 1. The transverse bottom element **33** is normally and preferably formed as an integral part of the tube wall. However, in some cases, it may be made of a separate piece of material. It preferably is formed by molding at the same time that the side-wall material is shaped. Due to the water-repellent characteristics of the preferred materials, i.e., polyolefinic plastics, especially polyethylene, the joint elements **15, 33** when fitted together with reasonable tightness, will not only hold aqueous materials quite well but will also exclude external water. The joints are quite effec-

tive for the latter purpose even when not strictly liquid tight. By any reasonable care in fabrication, joint elements **15, 33**, etc., may be made sufficiently liquid tight to retain non-aqueous liquids or slurries, or coated solids such as prills and oil. As noted above, an alternative embodiment of the invention is the filling of the tube with flowable through non-liquid material of this general type. Even with generous manufacturing tolerances, the packages are normally adequate to retain slurry material of fairly high water content without loss through the joint. This includes slurries which are readily pourable. Hence, with reasonable care in making the interfitting joints at elements **15, 33**, loss of either oil-type or water-type slurry explosive or its liquid components, due either to leakage or to leaching by external water is prevented or minimized. The structures of the invention exclude entrance of extraneous water to any extent that would unduly dilute the slurry. It is particularly important that external water be excluded from ammonium nitrate-oil mixes.

Instead of starting with tube stock, containers also may be molded from unformed material, e.g., powdered or granular by appropriate and known techniques. The transverse closure elements **33** may be formed separately and cemented or otherwise secured in place within the tubes if desired. These transverse closures may sometimes be omitted, if desired. e.g., where plural sections are to be joined before filling. However, the structure shown is normally preferred.

The invention also contemplates using the lower part of the package unit, i.e., from about the bottom of tapered section **14** down, FIGURES 1 and 2, to hold a booster. The booster, e.g. of tetryl or other cap sensitive explosive or the like, may be cast or pressed into this part, with provision for a detonating cap or fuse, and the part then assembled with other sections just as any full section would be.

At the final or upper end of an assembly or series of connected containers **11, 11A**, etc., FIGURE 5, an end closure **41** is introduced as indicated in FIGURE 5. This preferably is a simple flat disc which fits into the tube against the shoulder **15**. Liquid tight closure is thus provided in substantially the same fashion as is typical with common plastic or paper cups or disposable type, fitted with removable lids. The disc **41**, which can also be used at the intermediate joints if desired, may be made of polyethylene or polypropylene or it may more economically be made of wax-coated paper or other suitable material, since no particular structural strength is normally needed at this position. The fitted disc tends to remain in place due to friction. It prevents inadvertent loss of the explosive during handling of the tube or assembly, i.e., it keeps the tube full of explosive.

The interlocking bayonet elements **21** and **23**, FIGURE 3, and **25, 27** FIGURE 4, are preferably formed with essentially parallel land portions **42, 43** and **44, 45**, respectively. These arcuate elements are secant internally into the smaller arcuate sections (**21, 23** of FIGURE 3 or **13** of FIGURE 4) and secant externally through the larger arcuate sections (**19', 20'** FIGURE 3 or **25, 27** FIGURE 4). All these arcuate sections are essentially concentric about the axis of the container, as shown in FIGURE 4 especially. The construction is such that the container contents add strength and rigidity to the multiple unit package by combining the compressive strength of the contents with the tensile strength of the package wall material. This is particularly true when the contents are solidified or packed tightly to place the joints under tension.

Referring now to FIGURE 6, there is shown a modified container having generally the same characteristics and utilities as that of FIGURES 1 to 5 inclusive with somewhat different inter-connecting elements. This container has a cylindrical wall **111** provided with a slightly reduced neck **113** to provide an inner shoulder or rib **115**. Suitably impressed in the open end of the container unit is an outer or female thread element or portion **119** at the upper end of the section. The design preferably is such that the locking elements do not substantially protrude outside the main tube outer cylindrical surface. A reduced or indrawn neck or male portion **121** is provided at the opposite end. This male interlocking element is provided with suitably formed male thread element **123** adapted to interlock snugly with threaded female locking element **119**. These thread elements are of the quick-locking or short turn type. Preferably, complete interlock is accomplished in not more than about one turn—in any case, not more than about 2½ turns. For this purpose, the threads may be, and preferably are, of multiple helix type. Hence, by inserting a reduced end portion **121** of one container within the large end of another and twisting to interlock the female thread elements **119** and the external male thread element **123**, the joint can be quickly and tightly made. An assembly of these particular forms of container is not shown but is generally similar to that indicated in FIGURE 5. Two or more such tubes or containers **111** may be connected after filling to the level of shoulder **115**. The male end closure **125** puts the filled explosive under compression. The preferred extent of the threads is between about ½ and 1½ turns, a single turn being very satisfactory as experience has shown. However, this may be varied from as little as a quarter revolution or slightly less to somewhat more than 1½ revolutions, if desired. For quick assembly and assurance of a tight seal, the angle afforded by about one single full turn of thread appears to give about the best results with polyethylene containers. As in the case of the embodiment of FIGURE 1, the internal annular shoulder **115** may be utilized also to receive an end closure, not shown, but like element **41**, FIGURE 5, when a series of containers **111** are assembled. When threads are used, the stress surfaces are preferably substantially normal to the axis of the thread helix so that good tension can be applied to the joint, i.e. so that the explosive is under some compression axially.

The other or male end of each section or unit preferably is fitted or formed with an end closure **125** as already noted. As described above, the latter is preferably integral but it may be made separately and cemented in place. Also, when it is desired to fill plural sections at one operation, the closure **125** can be omitted from the upper and/or any intermediate sections. The same is true of the structure of FIGURE 1. Alternatively, a seal disc like **41**, FIGURE 5, can be inserted so that when the parts are forced together, by relative twisting, the male end element **125** presses the seal disc into the explosive behind it.

In use, any number of sections of either type may be filled one by one and assembled as they are pushed into place. In this manner, a relatively rigid container, filled essentially completely from end to end and packed to a desired tightness and tension with the slurry, can be inserted into bore holes at much in the same way as solid explosive. Except for the very minor gaps formed by the end closures **33** or **125** (and **41**, if used), the slurry explosive is continuous from one end of the assembly to the other and there is no problem of propagation of the detonation wave. In many structures of the prior art, this feature, which is often critical with slurry explosives, has not been available because the structures proposed for assembly have, in many cases allowed or necessitated subtantial gaps in explosive filler. The containers of this invention are quite firm and solid when filled with the explosive under compression and the wall elements under axial tension, but they are slightly deformable and are thus often capable of being pushed past minor obstructions where a solid metal container of similar diameter might be blocked.

As previously noted, another advantage of this invention resides in the fact that the preferred container material itself is combustible, i.e., it has a certain fuel value which adds somewhat to the power of the explosive. De-

pending on the thickness of the container wall, which may range from 2 to 90 mils or more, normally between 2 and 50 mils, the combustible container material, preferably polymeric, may be only slightly consumed or many be rather substantially consumed. In any case it can contribute energy in some degree, especially when hydrocarbon materials such as olefines, for example, form its main ingredients.

It will be understood that various modifications may be made in the packaging arrangements described without departing from the spirit or purpose of this invention. For example, the container need not necessarily be a circular cylinder in form and may be octagonal, hexagonal or other polygonal in cross section if desired. The cylindrical cross section is normally preferred.

What is claimed is:

1. A blow molded plastic container capable of being assembled with other like containers to form an elongated assembly, said container comprising an elongated tube of uniform outside diameter throughout most of its length, said tube having a male coupling on one end and a female coupling on the other end, and adapted to be filled with explosive between said couplings, said female coupling being of the same overall outside diameter as the tube and

the male coupling being enough smaller to fit within a female coupling on another like tube, interengageable locking means on the inside of the female coupling and on the outside of the male coupling, the arrangement being such that on assembly of filled plural like containers, the male coupling will tightly press upon and pack the explosive in the adjacent container, whereby a substantially rigid and continuous explosive column of explosive may be assembled, the tubular walls being slightly deformable when filled to make possible insertion past minor obstacles into boreholes of essentially the same diameter as said outside diameter.

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