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(54) PLASTICS DRUM

(71) We, SNYDER INDUSTRIES INC., of 4620 Fremont Street, P.O. Box 4583, Lincoln, Nebraska 68504, U.S.A., a Corporation organised and existing under the Laws of the State of Nebraska, U.S.A., do hereby declare the invention for which we pray that a Patent may be granted to us and the method by which it is performed to be particularly described in and by the following statement:-

The present invention relates to the provision of a molded plastics drum preferably made of cross-linked polyethylene e.g. a 55 gallon drum molded of cross-linked polyethylene suitable for shipment in interstate commerce on common carrier equipment.

Numerous attempts have been made to utilize synthetic polymeric materials in shipping containers for liquids and other substances. Polymeric materials, hereinafter called plastics, have certain potential advantages as shipping containers. Plastics are relatively resistant to many chemicals, such as acids and alkalis, which easily corrode most metals. In addition, because plastics are inherently lighter than metals, plastic drums have a lower shipping weight than conventional steel drums. Unfortunately, however, plastics by and large do not possess the necessary structural strength to withstand the rigors of use in common commercial carriers.

Before any plastics drum can be sold for common carrier usage in U.S.A. it must meet the rigorous federal regulations set forth in 49 CFR 178.19 governing polyethylene plastics containers. These regulations provide, inter alia, that plastics drums be able to withstand various compression loads based on the capacity of the drum. At the present time, these regulations only cover drums ranging in capacity from 2 1/2 gallons to 30 gallons, although a standard for 55 gallon plastics drums has recently been proposed. Prior to the present invention no drum has yet been manufactured which passes all the proposed U.S.A. federal regulations for 55 gallon plastics drums and, in addition, is capable of being handled by conventional drum handling equipment.

Attempts have been made to prepare plastics drums ranging up to 55 gallons in capacity. Such attempts have largely been unsuccessful because the drums either lacked the necessary compression strength, load temperature impact strength, or have been so difficult to handle using the ordinary drum handling equipment available to common carriers as to be commercially unacceptable.

U.S. Patent Nos. 3,927,790 to Chase et al and 3,940,011 to Dubois et al disclose proposals to manufacture various 55 gallon plastics drums capable of being handled by conventional drum handling equipment. These patents depict generally keg-shaped drums having a plurality of flat sides or slots adapted to be engaged by a conventional forklift. Similarly, U.S. Patent No. 3,889,939 to Simon et al discloses a plastics drum having slots on opposite sides of the drum engageable by a forklift and a ring or a slot on the top of the drum for handling by a standard handtruck.

All such keg-shaped or slotted drums, however, are not easily handled with conventional drum handling equipment because the handling equipment must be carefully positioned with respect to the drum so that the equipment will engage the flat sides, slots or other engaging paraphernalia. In practice, a worker using a forklift or a trolley will often be required to manually rotate the drum into the exact position necessary for handling before using the lift or handcart. Because a 55 gallon drum filled with liquid is extremely heavy and difficult to handle, such drums have not received great commercial acceptance because of the extra labor and time involved in orienting them to receive the drum handling equipment.

Furthermore, although attempts have been made to design plastics drums capable of being handled by a forklift and a trolley, to the best of our knowledge, no such plastics drum has ever been capable of also being handled by use of the device known in the cargo industry as the "parrot beak". "Parrot beak" equipment is drum handling equipment which lifts a conventional steel drum using a jaw-like device which attaches to the top chime or bead of the drum, the chime or bead thereby bearing virtually all the weight of the drum. Typical of "parrot beak" drum handling equipment is the LIFT-O-MATIC Model PTA-720 of Marvel Industries, Inc., Evanston, Illinois.

Various prior art plastics drums, such as that shown in U.S. 3,889,939 disclose polyethylene drums made by a process called "blow molding". Prior art plastics drums made by blow molding have been uneven in thickness and, being thicker in the ends and top and thinner at the rolling hoops, often fail in the compression testing mandate by the applicable government regulations. Moreover, when fully loaded blow molded drums are stacked on top of each other, the lower drums tend to cave in.

Attempts have been made in the past to prepare drums using the rotational molding process. Such drums inherently have the same thickness throughout and, when properly designed, do not fail in compression. One such drum currently being marketed comprises a multilayer laminate having a thin skin of cross-linked, high density polyethylene, a foam core of a second plastics material and an inner skin of a different material. However, this multilayer drum is not designed for easy handling using forklift or trolley equipment and cannot be handled by "parrot beak" equipment.

Drums have also been prepared using a single thickness of rotationally molded, cross-linked, high density polyethylene. However, drums prepared in this way have proved unsatisfactory, in particular bunghole threads in drums formed by the rotational molding process, although useable, are somewhat pitted and rough generally not as precise as desired.

It is an object of the present invention to overcome the above-noted disadvantages of the prior art by providing an improved plasic drum which is closable by a threaded bung which smoothly engages mating threads of a drum opening. According to the present invention there is provided a plastics drum having an integrally molded threaded opening therein, a polygonal recess formed in the outer surface of the drum surrounding the opening, and an internally and externally threaded insert having a transversely extending polygonal portion, the outer threads being capable of being screwed into the opening until the insert is locked against rotation with it polygonal portion in the recess, the inner threads defining a bunghole which is capable of receiving a threaded bung to close the bunghole. The invention also includes a drum molded of cross-linked, high density polyethylene, said drum comprising (a) a body having a continuous substantially cylindrical wall of cross-lined polyethylene closed at its top and bottom ends, respectively, by top and bottom end pieces of cross-linked polyethylene molded and formed integrally with said continuous wall; (b) an annular lead-bearing chime of cross-linked polyethylene extending around the circumference of said cylinder and above the surface of said top end piece, said chime being integrally molded and formed with and connecting the top of said wall with said top end piece, said chime being capable of being lifted and supported by parrot-beak type drum handling equipment; (c) at least one rolling hoop formed integrally with said continuous wall and located in the body of said drum between said annular chime and said bottom end piece, said hoop extending circumferentially around said continuous wall and capable of being engaged by the forks of a forklift regardless of the orientation of said cylinder relative to the forklift, said hoop further extending outwardly from said continuous wall a sufficient distance to support a fully loaded drum when said hoop is engaged by the forks of the forklift; (d) a threaded opening formed in said top end piece, the top surface of the top end piece having a polygonal recess formed therein surround the opening, at least a portion of said opening being raised above the top surface of said top end piece by a flange integrally molded with said top end piece and containing said opening and said recess, said flange being capable of absorbing expansion between said opening and said top end piece when the pressure of the contents of said drum is increased; and (e) an internally and externally threaded insert having a transversely extending polygonal portion, the outer threads adapted to be screwed into said opening until the insert is locked against rotation with its polygonal portion in said recess, the inner threads defining a bunghole which is adapted to receive a threaded bung to close the bunghole. It should be mentioned that our co-pending British Patent Application No. 29462/77 (Serial No. 1586484) (from which the present application is divided) describes and claims a drum molded of cross linked, high density polyethylene, said drum comprising (a) a body having a continuous substantially cylindrical wall of cross-linked polyethylene closed at its top and bottom ends, respectively, by top and bottom end pieces of cross-linked polyethylene molded and formed integrally with said continuous wall; (b) a hollow load bearing lifting chime of cross-linked polyethylene integrally molded and formed with and conecting the top of said wall with said top end piece, said chime extending above the surface of said top end piece, and comprising in radial cross-section a substantially arcuate first wall, integral with and connected to the top of said continuous wall by a short radially outwardly flared section of said continuous wall, and a second wall connected between said first wall and said top end piece, whereby said chime can be engaged and the drum lifted by parrot-beak type drum handling equipment; (c) at least one rolling and lifting hoop formed integrally with said continuous wall and located in the body of said drum between said chime and said bottom end piece, said hoop extending circumferentially around and outwardly from said continuous wall whereby said hoop can be engaged and the drum lifted by the forks of a forklift regardless of the orientation of the drum when standing upright on one of its ends; (d) a plurality of vertical ribs formed integrally with said continuous wall at spaced circumferential positions and extending inwardly therefrom and (e) at least one bunghole integrally molded in the top end piece.

Figure 1 is a partial cross-sectional side elevation view of a drum in accordance with our aforementioned copending application;

Figure 2 is a top view of the drum in Figure 1;

Figure 3 is a bottom view of the drum in Figure 1;

Figure 4 is a cross-sectional view taken along line 4-4 of Figure 1;

Figure 5 is a top view of the bunghole for the drum of the present invention;

Figure 6 is a cross-sectional side elevation view taken along line 6-6 of Figure 5; and

Figure 7 is a side elevational view of a drum according to the instant invention engaged by a "parrot beak" device.

Figures 1 to 4, although relating to our copending application, are included for a better understanding of the present invention and therefore, referring to Figures 1-4, a drum 2 preferably a 55 gallon drum, comprises substantially a cylinder having a continuous substantially vertical wall 4. As depicted in Figure 1, the diameter of the drum 2 at its lower end may be nominally greater than the diameter at its top end to provide additional capacity without increasing the height of the drum. The drum 2 is preferably rotationally molded and is made from a high density, cross-lined polyethylene plastics material as will be described in more detail hereafter. The height and width of the drum may vary, however, we have found a drum 35-37 inches high and 23-24 inches wide will hold 55 gallons and is not so high as to preclude the use of conventional automatic filling equipment.

A U-shaped annular lower support chime 6 is integrally formed with the vertical wall 4 and is connected to the lower end of wall 4. The support chime 6 comprises an upper wall 8, an outer wall 10 spaced outside the curved plane of the wall 4, a horizontal bottom wall 12 and an inner wall 14. The bottom wall 12 of the support chime 6 is adapted to rest on the ground to thereby support the weight of the drum 2 and its contents. The bottom of the drum 2 is closed by a circular bottom end piece 16, integrally formed with the continuous wall 4 and the support chime 6 and connected to the inner wall 14 of the support chime 6 as shown in Figure 1.

Similarly, a hollow annular upper load bearing lifting chime 18 is also molded integrally with the vertical wall 4 and is connectred to the upper end of the wall, the upper lifting chime therefore connects the top of the wall 4 with a top end piece or head 26. The chime 18 extends above the surface of the top end piece and comprises in radial cross-section a substantially arcuate first wall 22 integral with and connected to the top of the continuous vertical wall 4 by a short radially outwardly flared section 20 of the wall 4 and a second wall 24 connected between the first wall 22 and the top end piece, whereby the chime 18 can be engaged and the drum lifted by "parrot-beak" type drum handling equipment. The first wall 22 of the chime 18 is convexly curved and is spaced at least $\frac{1}{4}$ of an inch and preferably $\frac{1}{2}$ of an inch outwardly from the vertical wall by the short radially outwardly flared section of the wall 4. The second wall 24 has an uppermost portion which is essentially vertical and a lower portion that is concavely curved to form a bearing surface for engagement by a "parrot-beak" device used on conventional drum handling equipment. The top of the drum is closed by the circular top end piece or head 26 which is molded integrally with the wall 4 and upper chime 18 and is connected to the second wall 24 of chime 18 as shown in Figure 1. It has been found that although the flared section 20 and the lower portion of the first wall 22 are substantially at right angles to each other the rotational molding process used to mold the drum in the illustrated embodiment imparts a slight curve to the junctures. This is true of virtually all junctures of the drum.

Because of the rotational molding process all of the previously described components of the drum, i.e., the vertical wall 4, the support chime 6, etc., hve approximately the same thickness.

The circular top end piece or head 26, shown more particularly in Figure 2, serves as a top cover for the drum 2. The top end piece 26 has a plurality of raised portions 28 hereinafter called lands which are circumferentially spaced about the periphery of the top end piece 26. These lands 28 extend inwardly from the outer edge of the top end piece 26 and terminate at a constant radius from the centre of the top end piece 26. The lands 28 are separated by flat areas 30 which are, in effect, merely at the same level as the center of the top end piece 26. Similarly, the bottom end piece 16, shown in Figure 3, has a plurality of lands 32 circumferentially spaced about the periphery of the bottom end piece 16 in a manner similar to the lands 28 in the top end piece 26.

The drum 2 is provided with horizontal rolling hoops 34 which are integrally formed in the wall 4 of the drum 2 at spaced locations thereof. Each rolling hoop 34 is preferably 2 inches wide and comprises a section 36 spaced outwardly from the curved plane of the wall 4 by substantially horizontal top and bottom surfaces 38 and 40, respectively. The distance by which the hoops 34 are spaced outwardly from the wall 4 must be such that the forks of a forklift truck can engage the bottom surface 40 of at least the upper hoop 34 and support the weight of a 55 gallon drum loaded with water. This distance may, of course, be varied; however, for a plastics drum made of a high density, cross-linked polyethylene with a capacity of 55 gallons, it has been found that hoops 34 spaced outwardly from the wall a distance of 1/2 inch will be sufficient to support the drum 2 when filled and under ordinary conditions of use.

The hoops 34 extend around the circumference of the drum 2 but need not be continuous since they may be broken by a plurality of continuous, inwardly projecting vertical ribs 42 integrally formed in wall 4 circumferentially spaced locations. When used, ribs 42 extend along substantially the entire length of wall 4 between top closure 26 and bottom closure 16. It is preferred to provide approximately six ribs 42 having a width of 1 1/2 inches because the ribs strengthen the drum in compression and prevent bulging of the drum walls when fully loaded drums are stacked upon each other. Needless to say, ribs 42 may not be needed when the drum 2 is manufactured in smaller sizes or when the thickness of the material forming the drum 2 is such that no bulging of the drum would occur under normal conditions of use. Use of the ribs 42, however, decreases the amount of material and the wall thickness needed in the drum 2.

As best seen in Figures 1 and 2, top end piece 26 is provided with at least one bunghole 44 to serve as a means of filling and/or emptying the drum. Preferably two bungholes are provided. The bungholes 44 are integrally molded in top end piece 26 and are preferably placed 180° apart in the flat areas 30 in the top end piece 26. The bungholes are ultimately designed to accommodate a conventional bung. In one embodiment of this invention, bungholes 44 comprise a top surface 48, a threaded vertical wall 50, and a bottom surface 52 with an opening 54 therein. The threads in the vertical wall 50 of the bunghole 44 are integrally molded therein and are preferably the standard NPS threads used in conventional drums.

Preferably the top surface of each of the bungholes 44 is raised above the surface of the top end piece 26 by means of a connecting flange 56 and the opening 54 in the bottom surface 52 of each bunghole 44 is approximately coplanar with or slightly below the top end piece 26. The connecting flange 56 should be short enough so that a bung 46 contained in a bunghole 44 does not protrude above top chime 18.

Connecting flange 56 is particularly important because it provides for absorption of a limited, but necessary, degree of expansion between the bunghole 44 and the top closure 26. When a liquid material stored in plastic drums is set out in the sun, a vapor pressure will be built up inside the drum due to the evaporation of the liquid. This vapor pressure tends to cause the top and bottom closures of the drum to bow outwardly along the unsupported portions of the closures. When the bunghole is indented or molded flat with the top end piece, the bunghole assumes the bowed shape of the top end piece under pressure and depending upon the extent of the bow can cause leakage around the bung in the bunghole. However, when the top surface of each bunghole is raised, there is no leakage around the bunghole 44 since the bunghole 44 can expand to a limited degree relative to the top end piece 26 to accommodate the vapor pressure built up inside the drum.

We have found that the threads formed in the rotational molding process, although usable, are somewhat pitted and rough and generally not as precise as desired. Therefore having described the main features of plastics drum attention is now directed Figures 5 and 6 which illustrate the inventive features of the present invention.

Figures 5 and 6 depict the preferred arrangement of this invention wherein a threaded bunghole 64 having a top surface 68, a threaded sidewall 70, and a bottom surface 72 with an opening 74 therein is integrally molded into the top end piece 26 in a raised position in the same manner as the bungholes 44 shown in Figures 1 and 2. However, the top surface 68 of the bunghole 64 is provided with a polygonal, preferably hexagonal, shaped recess 76.

In addition, the threads 71 provided on the sidewall 70 of the bunghole 64 are threads having a considerably larger pitch than the standard NPS threads. Threads with a large pitch, such as the preferred Acme or Modified Acme threads, may be precisely formed in the rotational molding process used to mold the drum.

A polygonal insert 78 which is shaped to match the polygonal recess 76 in the top surface 68 of the bunghole 64 may be formed of a plastics material such as nylon which is amenable to conventional injection molding processes. The polygonal insert 78 has an outer surface 80 provided with Acme-type threads 81 designed to mate with threads 71 of bunghole 64. In practice, polygonal insert 78 is screwed into the bunghole 64 until the insert 78 locks itself into the corresponding polygonal recess 76 provided in the top surface of bunghole 64.

Bunghole insert 78 also has a threaded opening 82 adapted to receive a standard bung 46 conventionally used to close bungholes (see Figures 1 and 2). Because insert 78 may be injection molded, threaded opening 82 carries sharp, precise and durable standard NPS threads. An O-ring 84 may be placed between the polygonal insert 78 and the bunghole 64 to assist in sealing the drum.

Preferably a hexagon shape is used for polygonal recess 76 and insert 78 because the hexagon shape provides sides which are short enough to permit screwing insert 78 into bunghole 64 but long enough to provide locking engagement when insert 78 is seated in recess 76. If a polygon having too many sides is chosen for the polygonal recess and insert, then the shape of the recess begins to approximate a circle and will not firmly lock insert 78 when it is seated therein. For example, an octagon-shaped polygonal insert does not work as well as a hexagon-shaped insert.

As mentioned previously, the chime 18 of the drum 2 has been specially designed so that it can be handled by what is known as a "parrot beak". As seen in Figure 7, a "parrot beak" 86 is utilized on a piece of conventional drum handing equipment 88 and comprises a lower flange 90 and a pivotally mounted top hook 92. The lower flange 90 is adapted to engage underneath the shoulder of upper chime 18 formed by the wall 20 connecting chime 18 to wall 4. Top hook 92 fits over arcuate outer surface 22 of chime 18 and engages inner wall 24 of chime 18. The "parrot beak" 86 is usually held open as the drum handling equipment 88 approaches a drum and its closing is automatically triggered by the presence of the chime.

We have discovered that the convex arcuate shape of the outer wall 22 of the chime 18 in the preferred embodiment prevents premature triggering of the "parrot beak". We have also discovered that it is necessary to provide a sufficient distance between the top of the chime and the surface of top end piece 26 to permit engagement by the "parrot beak". Preferably the distance is 9/16 of an inch and at least 3/8 of an inch. It was highly surprising that a hollow chime 18 formed of a cross-linked polyethylene could be gripped and lifted by a "parrot beak" and still support the weight of the drum without collapsing or otherwise damaging upper chime 18.

Drum 2 and its component parts, i.e., wall 4, top and bottom end pieces 26 and 16, the chime, etc., are all integrally molded in a single operation from a high density, cross-linked polyethylene. We have evaluated numerous thermoplastic practicals and have discovered that only high density, cross-linked polyethylene yields a drum capable of meeting the proposed U.S.A. government standards for 55 gallon drums. Typical polyethylenes which may be used are Marlex CL-50 and Marlex-CL-100 cross-linked, high density polyethylenes sold by Phillip Petroleum Company.

Typically, the drums may be molded as follows: (a) the molds for the drum are first sprayed with a release agent and wiped dry; preferably the release agent is a fluorocarbon such as FREKOTE 33 (Registered Trade Mark) manufactured by Frekote, Inc., of Indianapolis, Indiana; (b) approximately 25 pounds of high density, cross-linked polyethylene powder ground to 35 mesh is charged into the mold. The actual amount of material charged into the mold may be varied depending upon the thickness desired in the finished drum. In practice 25 pounds of powder will yield a 55 gallon drum having walls with a thickness of about 3/16 of an inch; (c) after the mold has been charged, it is placed inside the oven of a conventional rotational molding machine, such as the McNeil 1000-64 "Autocast" machine. The oven is preheated to a temperature of about 580°F. The mold is then rotated inside the oven for 17 minutes. The damper of the oven is preferably opened for the first five minutes of the seventeen minute cycle to allow a rapid warmup of the mold, but is closed for the remainder of the cycle to prevent overheating of the mold; (d) at the conclusion of the oven cycle, the mold is cooled for 15 minutes as follows: five minutes of cooling under ambient air, five minutes of cooling under a water spray and five minutes of cooling under an air blast.

We have evaluated the 55 gallon drums of this invention and determined that they pass all the physical tests in Federal Regulation 49 CFR 178. 19-7. In this test, the proposed compression test for 55 gallon drums is 2,400 pounds.

WHAT WE CLAIM IS:

1. A plastics drum having an integrally molded threaded opening therein, a polygonal recess formed in the outer surface of the drum surrounding the opening, and an internally and externally threaded insert having a transversely extending polygonal portion, the outer threads being capable of being screwed into the opening until the insert is locked against rotation with its polygonal portion in the recess, the inner threads defining a bunghole which is capable of receiving a threaded bung to close the bunghole.

2. A drum according to Claim 1 further comprising a seal capable of preventing leakage placed between the insert and the opening.

3. A drum according to Claim 1 wherein said opening is formed in an end piece of the drum.

4. A drum according to Claim 3 wherein at least a portion of said opening is raised above the top surface of said top end piece by a flange integrally molded with said top end piece and containing said opening and said recess, said flange being capable of absorbing expansion between said opening and said top end piece when the pressure of the contents of said drum is increased.

5. A drum molded of cross-linked, high density polyethylene, said drum comprising:

(a) a body having a continuous substantially cylindrical wall of cross-linked polyethylene closed at its top and bottom ends, respectively, by top and bottom end pieces of cross-linked polyethylene molded and formed integrally with said continuous wall;

(b) an annular load-bearing chime of cross-linked polyethylene extending around the circumference of said cylinder and above the surface of said top end piece, said chime being integrally molded and formed with and connecting the top of said wall with said top end piece, said chime being capable of being lifted and supported by parrot-beak type drum handling equipment;

(c) at least one rolling hoop formed integrally with said continuous wall and located in the body of said drum between said annular chime and said bottom end piece, said hoop extending circumferentially around said continuous wall and capable of being engaged by the forks of a forklift regardless of the orientation of said cylinder relative to the forklift, said hoop further extending outwardly from said continuous wall a sufficient distance to support a fully loaded drum when said hoop is engaged by the forks of the forklift;

(d) a threaded opening formed in said top end piece, the top surface of the top end piece having a polygonal recess formed therein surrounding the opening, at least a portion of said opening being raised above the top surface of said top end piece by a flange integrally molded with said top end piece and containing said opening and said recess, said flange being capable of absorbing expansion between said opening and said top end piece when the pressure of the contents of said drum is increased; and

(e) an internally and externally threaded insert having a transversely extending polygonal portion, the outer threads adapted to be screwed into said opening until the insert is locked against rotation with its polygonal portion in said recess, the inner threads defining a bunghole which is adapted to receive a threaded bung to close the bunghole.

6. A drum according to Claim 5 further comprising a seal capable of preventing leakage placed between said insert and said opening.

7. A drum according to Claims 3, 5 or 6 wherein said polygonal recess and said polygonal portion are hexagon shaped.

8. A drum according to Claim 3 further comprising a seal capable preventing leakage placed between said insert and said opening.

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1586485 COMPLETE SPECIFICATION

4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

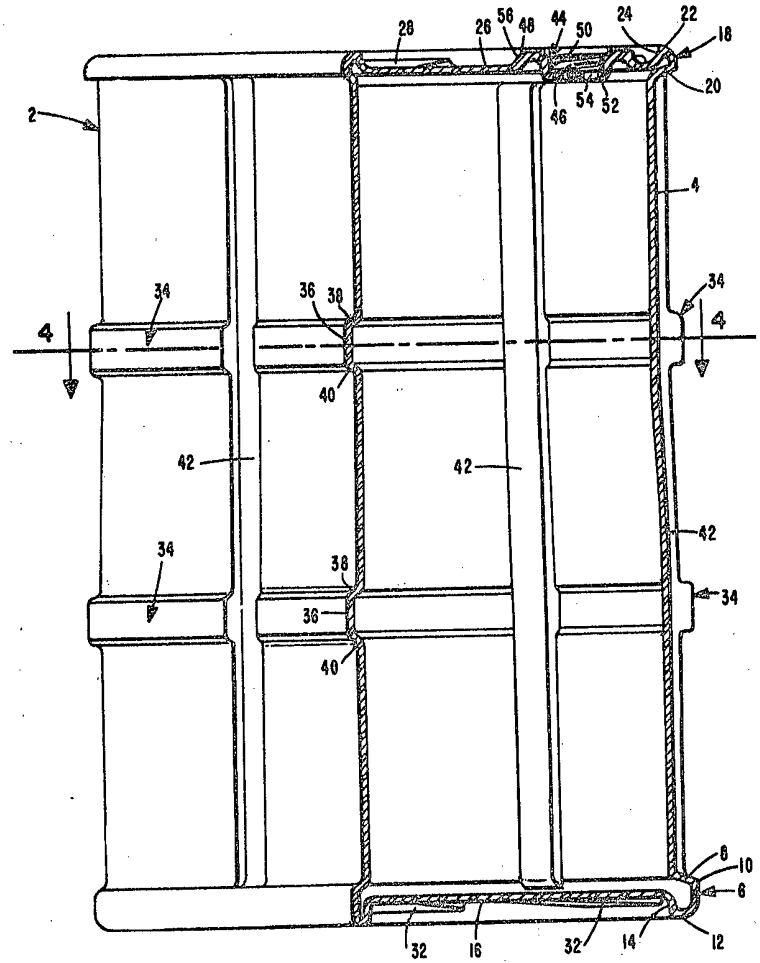

FIG. 1

1586485 COMPLETE SPECIFICATION

4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

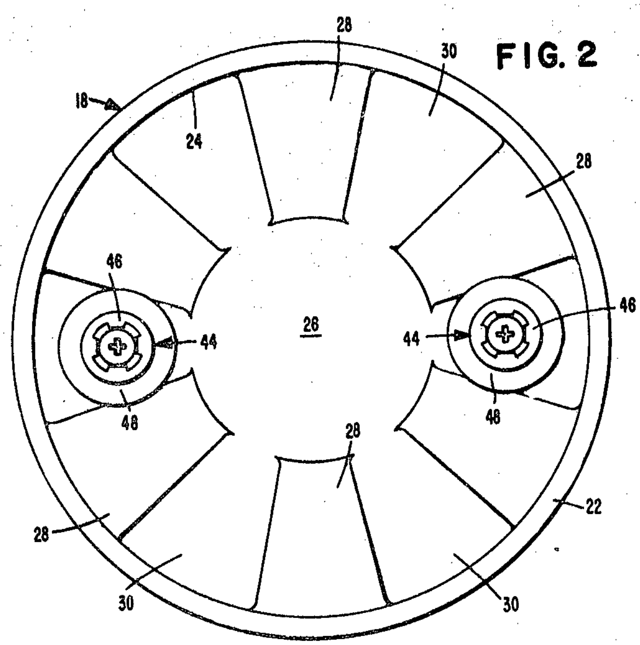

FIG. 2

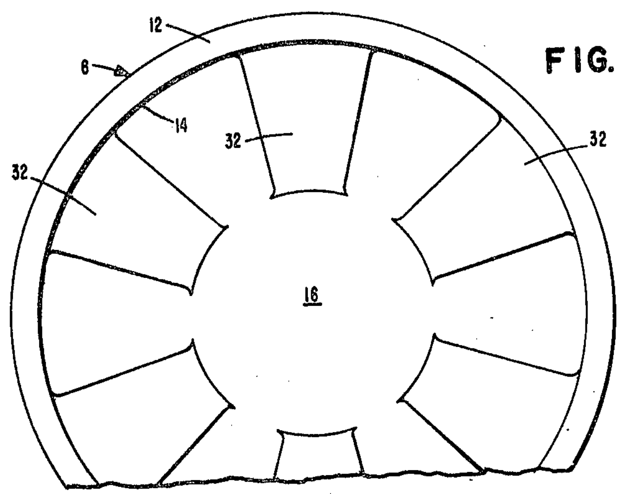

FIG. 3

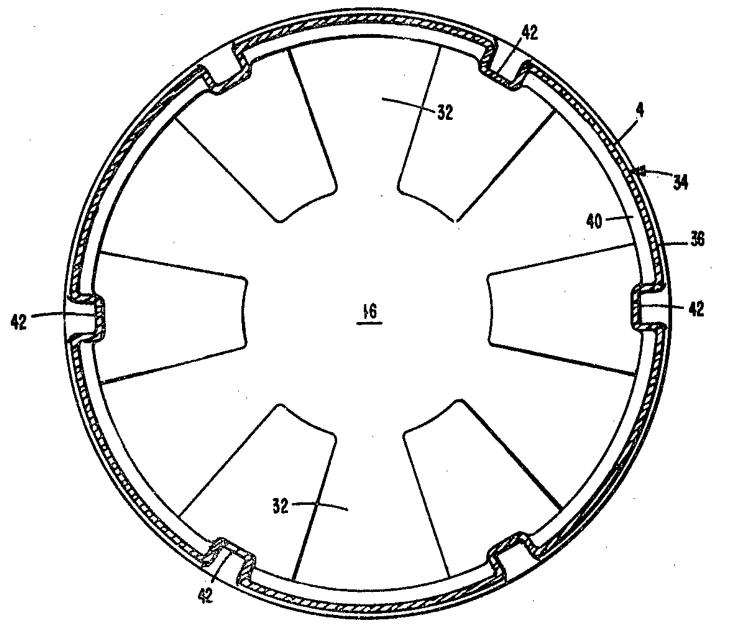

FIG. 4

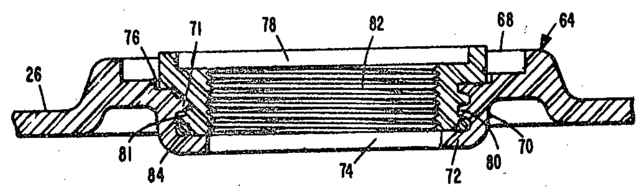

FIG. 6

1586485 COMPLETE SPECIFICATION

4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 4

FIG. 5

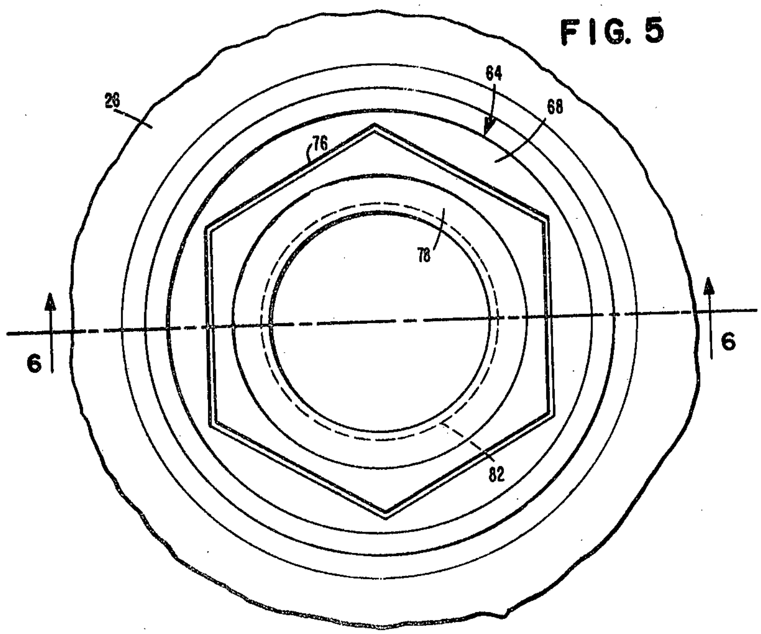

FIG. 7