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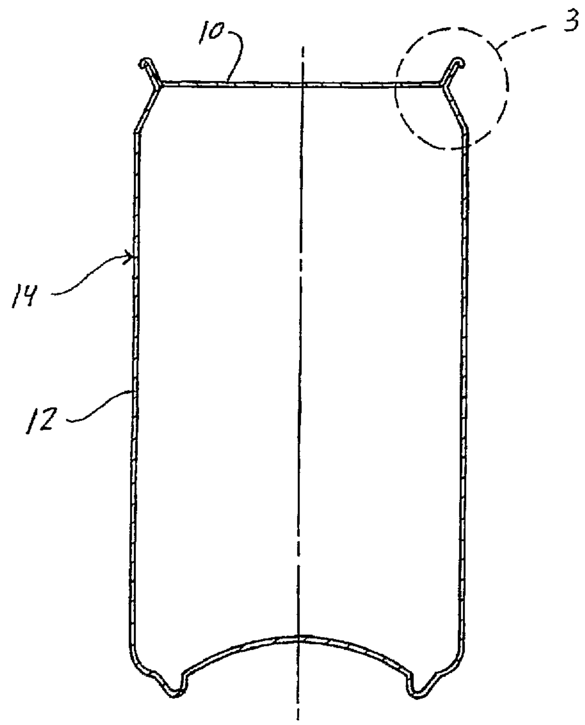
(54) Title: METALLIC CONTAINER HAVING IMPROVED JOINT



(57) Abstract: A metallic container includes a pre-formed lid portion that is generally disk shaped and includes a flange extending circumferentially thereabout that is angled between approximately five degrees and approximately seven degrees with respect to a longitudinal axis of the metallic container. A pre-formed body portion is generally cylindrically shaped and open at one end, and includes a flange extending circumferentially thereabout that is angled between approximately five degrees and approximately seven degrees with respect to a longitudinal axis of the metallic container. The lid portion includes an inner surface and the body portion includes an inner surface, portions of the flange of the inner surface of the lid portion are friction welded to portions of the inner surface of the flange of the body portion.

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METALLIC CONTAINER HAVING IMPROVED JOINT

BACKGROUND

[0001] The invention generally relates to metallic container, particularly a food container, that includes a lid portion that is friction welded onto a body portion.

[0002] Metallic containers, particularly those intended for food products, must be structurally robust, be made from materials compatible with food products, and generally incorporate internal coatings to make them suitable for food contents. Generally, metallic food containers, such as carbonated beverage cans, have a pre-formed body portion and a pre-formed lid portion that is attached to the body portion after the beverage is placed therein. The body portion is usually formed from a single piece of suitable metallic material, such as aluminum, and is shaped by stamping, drawing, ironing, and/or other suitable metal forming process. The lid portion is formed in much the same manner. The body portion can be very thin after forming, and therefore, the lid portion desirably contributes to the structural rigidity for the finished container. The lid portion can be made from a material that is relatively harder than the body portion.

[0003] One known method of attaching the lid portion onto the body portion of the metallic container involves rolling or curling parallel flange portions of the lid and the body portion onto each other to form a lip seam. This process generally provides a good seal, and does not compromise the integrity of any coatings that may be placed on the interior of the metallic container. A variety of coatings can be used on the interior surfaces of the lid portion and the body portion of the container, which are preferably satisfactory for food contact, to prevent corrosion of the inner surface of the metallic food container and to prevent the metal from contaminating the taste of the food placed therein. The coating can be any of the materials identified, for example, in U.S. Patent 5,739,215, which are hereby incorporated by reference. Typically, the body portion and the lid portion have the inner surfaces coated prior to the lid portion being attached to the body portion. Therefore, any attachment technique must account for and accommodate the coating.

[0004] By rolling the edges of the lid portion and the body portion onto one another, a tight seal is formed, and the coating is not compromised. However, this method of attachment requires extra metallic material to allow for portions to be rolled over onto one another in this manner. Additionally, typically in this process a vinyl seal or gasket can be placed between the edges of the lid portion and the body portion before they are rolled onto one another. This gasket material helps insure an adequate seal.

[0005] Other techniques can be used to reduce the amount of metallic material by directly connecting the edges by welding or soldering the edges together, by a process such as laser welding. This process will also provide a sealed attachment, however the temperatures necessary for this type of welding are high enough to compromise or destroy any coating placed on the inner surface of the body portion and the lid portion. This leaves an uncoated region immediately adjacent the area of the weld. Still other methods may use an intermediate material, with a lower melting point, between the lid portion and the body portion, to allow the lid portion and the body portion to be welded together, via the intermediate material, at a lower temperature.

[0006] Further, the processes discussed above, either rolling the edges of the lid portion and the body portion over onto one another, or welding the edges together require significant time to complete, thereby making the manufacture of these metallic containers more costly. The lid is generally attached to the body of the metallic container after the contents of the container have been placed therein. In the case of a carbonated beverage, as soon as a seal forms between the lid and the body of the metallic container, pressure will start to build within the container. This can cause carbonated beverage to be pushed between the lid and the body as the seal is being formed, thereby compromising the quality of the seal. Also, specifically with carbonated beverages, the portion of the beverage that leaks from within the container during the process of attachment makes a mess within the manufacturing facility.

[0007] Therefore, there is a need for a metallic food container that includes a lid portion that is attached to the body portion in such a way that the manufacturing of the metallic container is quick and reduces the amount of material used in forming the attachment, and does not compromise any food compatible coatings placed on the inner surfaces of the lid portion and the body portion.

SUMMARY

[0008] In one aspect, a metallic container of the present invention includes a pre-formed lid portion that is generally disk shaped and includes a flange extending circumferentially thereabout, and a pre-formed body portion that is generally cylindrically shaped and is open at one end, and includes a flange extending circumferentially thereabout. The flange of the lid portion is friction welded to the flange of the body portion by a metallic weld zone.

[0009] In another aspect, the flanges of the lid portion and the body portion are angled relative to a longitudinal axis of the metallic container. Furthermore, the flanges of the lid portion and the body portion are inwardly angled relative to the longitudinal axis of the metallic container.

[0010] In yet another aspect, the inner surfaces of the body portion and the lid portion include a coating material.

[0011] In still another aspect, the lid portion includes an inner surface and the body portion includes an inner surface, wherein portions of the inner surface of the flange of the lid portion are friction welded to portions of the inner surface of the flange of the body portion, thereby defining a metallic weld zone.

[0012] In yet another aspect, pockets of coating material are formed immediately adjacent the outer edges of the metallic weld zone, and the weld zone is free of any coating material between the inner surfaces of the flanges of the lid portion and the body portion.

DESCRIPTION OF THE DRAWINGS

[0013] The above, as well as other advantages of the present invention, will become readily apparent to those skilled in the art from the following detailed description of a preferred embodiment when considered in the light of the accompanying drawings.

[0014] Figure 1 is a perspective view of a metallic container in accordance with the present invention;

[0015] Figure 2 is a sectional view taken along line 2-2 of Figure 1;

[0016] Figure 3 is an enlarger view of a portion of Figure 2;

[0017] Figure 4 is a partial sectional view of an apparatus for attaching the lid portion and the body portion of the metallic container shown in Figure 1, wherein a sonotrode is in the fully retracted position;

[0018] Figure 5 is a view similar to Figure 4, wherein the sonotrode is moving downward toward the engaged position;

[0019] Figure 6 is a view similar to Figure 4, wherein the sonotrode is in the engaged position.

[0020] Figure 6A is a close up view of a portion of Figure 6 as indicated by the area labeled "6A" in Figure 6;

[0021] Figure 7 is a top view of the lid portion of a metallic container;

[0022] Figure 7A is a sectional view taken along line 7A-7A of Figure 7;

[0023] Figure 8 is a side sectional view of the body portion of a metallic container;

[0024] Figure 8A is an enlarged view of a portion of figure 8 as indicated by the area labeled "8A" in Figure 8;

[0025] Figure 9 is an enlarged view of a portion of Figure 6A as indicated by the area labeled "Fig. 9" in Figure 6A, prior to friction welding;

[0026] Figure 10 is a view similar to Figure 9, shown after friction welding;

[0027] Figure 11 is an enlarged portion of Figure 10 as indicated by the area labeled "11" in Figure 10;

[0028] Figure 12 is a perspective view of a portion of the support surface wherein the support surface has a criss-crossed knurl pattern formed thereon;

[0029] Figure 13 is a perspective view similar to Figure 12 wherein the friction surface has a diamond shaped knurl pattern formed thereon;

[0030] Figure 14 is a perspective view of a portion of the friction surface on the sonotrode wherein the friction surface has a vertically aligned knurl pattern formed thereon; and

[0031] Figure 15 is a perspective view of a portion of one of the friction surface and the support surface, wherein the surface has been grit blasted;

[0032] Figure 16 is a perspective view of a portion of one of the friction surface and the support surface, wherein the surface includes a raised serpentine ridge extending thereabout; and

[0033] Figure 17 is a sectional view taken along lines 17-17 of Figure 16.

DESCRIPTION OF THE EMBODIMENTS

[0034] Referring to Figures 1, 2, and 3, a metallic container in accordance with the teachings of the present invention is shown generally at 14. The metallic container includes a pre-formed lid portion 10 that is generally disk shaped and includes a flange 38 extending circumferentially thereabout. The lid portion 10 is positioned on top of a pre-formed body portion 12 that is generally cylindrically shaped and is open at one end. The body portion 12 also includes a flange 20 extending circumferentially thereabout. The flange 38 of the lid portion 10 and the flange 20 of the body portion 12 are friction welded to one another, thereby forming the metallic container 14.

[0035] Referring to Figure 4, an apparatus suitable for manufacturing such a metallic container 14 is shown generally at 16. The apparatus 16 includes a base 18 that is adapted to support the body portion 12 of the metallic container 14 when placed thereon. Referring to Figures 8 and 8A, the body portion 12 of the metallic container 14 is generally cylindrically shaped and open at one end. The open end includes an angled flange 20 extending circumferentially thereabout. A support assembly 22 is movable relative to the base 18 and includes a support surface 24 adapted to support an outer surface 26 of the flange 20.

[0036] The support assembly 22 includes a frame 28 and a clamshell anvil 30. The clamshell anvil 30 includes two halves 30A, 30B that are pivotally mounted onto opposing portions of the frame 28. The two halves 30A, 30B of the clamshell anvil 30 pivot between an open position and a closed position. Referring again to Figure 4, in the open position, the support surface 24 is pivoted away from the flange 20 of the body portion 12, thereby allowing the body portion 12 to be loaded and unloaded from the base 18. Referring to Figures 6 and 6A, in the closed position, the two halves of the clamshell anvil 30 are pivoted inward such that the support surface 24 contacts and supports the outer surface 26 of the flange 20 of the body portion 12.

[0037] A vertically moveable sonotrode 32 is mounted vertically above the base 18. The sonotrode 32 includes a friction surface 34 that can have a variety of shapes and sizes, some of which are shown in the later figures. The sonotrode 32 is moveable linearly, along a longitudinal axis 36, relative to the support assembly 22 between a retracted position, shown in Figure 1, and an engaged position, shown in Figure 3. Referring to Figure 1, in the retracted position, the sonotrode 32 is positioned vertically above the base 18 as well as the body portion 12 and lid portion 10 of the metallic container 14 situated on the base 18. Referring to Figure 6 and 6A, after the support assembly 22 engages the outer surface 26 of the flange 20 of the body 12 of the metallic container 14, the sonotrode 32 is moved to the engaged position, wherein the friction surface 34 of the sonotrode 32 contacts the lid portion 10 of the metallic container 14.

[0038] Referring to Figures 7 and 7A, the lid portion 10 of the metallic container 14 is generally disk shaped and can include an angled flange 38 extending circumferentially around the disk perimeter. The angle 40 of the flange 20 on the body portion 12 is approximately equal to the angle 40 of the flange 38 on the lid portion 10 of the metallic container 14, such that when the lid portion 10 is placed onto the body portion 12, an inner surface 42 of the flange 38 on the lid portion 10 contacts a confronting inner surface 44 of the flange 20 on the body portion 12. The flange 38 on the lid portion 10 can include a curled lip 46 which curls outward such that when the lid portion 10 is placed onto the body portion 12, the curled lip 46 engages the distal end of the flange 20 on the body portion 12. The angled flanges 20 and 38 on the lid and the body portions 10 and 12, and the curled lip 46 of the flange 38 on the lid portion 10 make loading the lid portion 10 to the body portion 12 quick and simple. Furthermore, the lid portion 10 and the body portion 12 are self-centering with one another so that additional tooling is not necessary to keep the components 10 and 12 centered during the welding process.

[0039] When the sonotrode 32 is moved to the engaged position, the friction surface 34 contacts an outer surface 48 of the flange 38 on the lid portion 10. When the sonotrode 32 is in the engaged position, the flange 38 on the lid portion 10 and the flange 20 on the body portion 12 are held in contact with one another between the support surface 24 of the support assembly 22 and the friction surface 34 of the sonotrode 32, as best shown in Figure 6A.

[0040] An actuator 50 moves the sonotrode 32 between the engaged position and the retracted position. The actuator 50 pushes the sonotrode 32 downward such that when the sonotrode 32 is moved to the engaged position, the sonotrode 32 exerts a downward force to hold the flanges 20 and 38 of the lid and the body portions 10 and 12 of the metallic container 14 in contact with one another between the support surface 24 of the support assembly 22 and the friction surface 34 of the sonotrode 32. A motor 52 is adapted to reciprocate the sonotrode 32 relative to the support assembly 22 at a high frequency. Reciprocal movement of the sonotrode 32 relative to the support assembly 22 moves the lid portion 10 relative to the body portion 12. The motor 52 is adapted to reciprocate the sonotrode 32 at a rate of between 15 KHz and 25 KHz. Preferably, the sonotrode 32 is reciprocated at a frequency of approximately 20 KHz. This reciprocal movement can create frictional wear necessary to wipe out any protective coating on the surfaces 42 and 44, and can create heat between the flanges 20, 38 of the lid portion 10 and the body portion 12, such that a metallic friction weld is formed between the flanges 20, 38 of the lid portion 10 and the body portion 12 of the metallic container 14.

[0041] When the sonotrode 32 is moved to the engaged position, the actuator 50 can move the sonotrode 32 downward in stages such that the sonotrode 32 exerts an initial downward force to hold flange 20 and 38 of the lid 10 and the body 12 of the metallic container 14 in contact with one another between the support surface 24 of the support assembly 22 and the friction surface 34 of the sonotrode 32, while the coating materials on the contacting surfaces 42 and 44 are wiped out. Following the wipe out of the coating materials, the downward force can be increased to create the friction weld between the metallic materials forming the lid portion 10 and the body portion 12 of the container 14. The actuator 50 is adapted to provide a downward force between approximately 1300 N and approximately 7200 N. Preferably, the downward force applied during the welding of the surfaces 42 and 44 is approximately 2200 N.

[0042] Preferably, the sonotrode 32 is made from powered metal, and may be tuned using sound waves to control the amplitude of the reciprocal motion at the point of contact between the friction surface 34 and the flange 38 of the lid portion 10. The amplitude of the reciprocation is important and dependant upon several factors, including, but not limited to, the diameter at the point of contact between the flange 38 of the lid portion 10 and the friction surface 34 of the sonotrode 32, the magnitude of the downward force on the sonotrode 32, the thickness of the flanges 20, 38 of the lid portion 10 and the body portion 12, the mode of vibration, etc. The sonotrode 32 can be vibrationally rotated back and forth about the longitudinal axis. The sonotrode 32 can also be vibrated parallel to the longitudinal axis. The vibrational motion can also be a combination of such motions such as orbital or random. The amplitude of the vibrational motion in all modes is small. For example, the amplitude of reciprocal rotation for a typical carbonated beverage container would be on the scale of approximately 5×10^{-3} cm or about 0.1° of arc.

[0043] The sonotrode 32 is supported on a shaft 54 extending between the motor 52 and the sonotrode 32. The shaft 54 can have a cammed outer surface 56. Portions of the pivotally mounted clamshell anvil halves 30A, 30B can engage the cammed outer surface 56. Referring to Figures 4-6, each half 30A, 30B of the clamshell anvil 30 can include a rolling contact 58. The support assembly 22 can include springs 60 that bias the halves 30A, 30B of the clamshell anvil 30 away from the closed position to keep the rolling contacts 58 held against the cammed outer surface 56 of the shaft 54. When the sonotrode 32 is in the retracted position, the rolling contacts 58 engage the shaft 54 at a narrow point in the shaft 54, wherein the rolling contacts 58 can move inward and the springs 60 bias the halves 30A, 30B of the clamshell anvil 30 to the open position, as shown in Figure 4.

[0044] As the sonotrode 32 begins to move downward, as shown in Figure 5, the rolling contacts 58 follow the cammed outer surface 56 of the shaft 54 and are pushed outward against the biasing springs 60 of the support assembly 22. As the sonotrode 32 moves downward, the rolling contacts 58 are contacting portions of the shaft 54 that are gradually increasing in diameter, such that the rolling contacts 58 are pushed outward, the halves 30A, 30B of the clamshell anvil 30 are pivoted against the biasing springs 60 and begin to pivot to the closed position.

[0045] Finally, as the sonotrode 32 and the shaft 54 continue to move downward, the rolling contacts 58 reach a point on the shaft 54 where the diameter of the shaft 54 pushes the rolling contacts 58 outward to a point where the halves 30A, 30B of the clamshell anvil 30 are pivoted to the closed position, as shown in Figure 3. The rolling contacts 58 reach the point on the shaft 54 where the diameter of the shaft 54 pushes the rolling contacts 58 outward such that the halves 30A, 30B of the clamshell anvil 30 are pivoted to the closed position before the sonotrode 32 contacts the lid portion 10 of the metallic container 14. Specifically, the two halves 30A, 30B of the clamshell anvil 30 reach the closed position and the support surface 24 contacts the outer surface 26 of the flange 20 on the body portion 12 of the metallic container 14 prior to the friction surface 34 of the sonotrode 32 contacting the flange 38 on the lid portion 10 of the metallic container 14, thus resulting in some lost motion.

[0046] This lost motion allows the sonotrode 32 to retract from the lid portion 10 prior to the halves 30A, 30B of the clamshell anvil 30 opening. Referring to Figure 6A, at least one of the clamshell anvil halves 30A, 30B includes a stop 62 extending from an inner surface 64 of the clamshell anvil half 30A, 30B. The stop 62 is positioned vertically above the support surface 24, such that when the sonotrode 32 retracts from the lid portion 10 of the metallic container 14 after welding, if the lid portion 10 of the metallic container 14 sticks to the friction surface 34 of the sonotrode 32, the stop 62 will contact the lid portion 10, thereby holding the metallic container 14 down as the sonotrode 32 retracts upward.

[0047] If the halves 30A, 30B of the clamshell anvil 30 open immediately upon motion of the sonotrode 32, then the halves 30A, 30B of the clamshell anvil 30 would pivot away from the metallic container 14, and the metallic container 14 could become stuck to the friction surface 34 of the sonotrode 32, requiring manual removal by an operator of the apparatus 16.

[0048] The risk of the lid portion 10 sticking to the friction surface 34 of the sonotrode 32 is a real concern, because in order for the friction surface 34 of the sonotrode 32 to grip the flange 38 on the lid portion 10, the friction surface 34 of the sonotrode 32 is rough. In one embodiment, the friction surface 34 of the sonotrode 32 has a knurled pattern formed therein. The friction surface 34 can be planar or a continuous arc from the side to the lower end of the sonotrode 32. In order to assist in the removal of the sonotrode 32 from the lid portion 10 after welding, the knurled surface of the friction surface 34 could have a vertically oriented knurl 66 formed therein, such as that shown in Figure 14. Alternatively, a downward pointing triangular shaped knurl pattern 68, such as the one shown in Figure 13, could be used. These knurl patterns 66, 68, would more readily allow the friction surface 34 of the sonotrode 32 to retract from the lid portion 10 with a reduced chance of the lid portion 10 sticking to the friction surface 34.

[0049] Likewise, the support surface 24 of the support assembly 22 also has a rough surface. This rough surface allows the support surface 24 to grip the outer surface 26 of the flange 20 on the body portion 12 to prevent sliding movement of the flange 20 of the body portion 12 relative to the support surface 24. As the support surface 24 retracts radially from the outer surface 26 of the body portion 12, the risk of the body portion 12 sticking to the support surface 24 is not as important as with the sonotrode 32 and the lid portion 10, therefore a conventional criss-cross knurl pattern 70 can be used, such as that shown in Figure 12.

[0050] The depth of the knurl patterns 66, 68, 70 on the friction surface 34 of the sonotrode 32 and the support surface 24 of the support assembly 22 is calibrated according to the thickness of the flanges 20, 38 of the lid portion 10 and the body portion 12 and the downward pressure of the sonotrode 32. If the depth of the knurl pattern 66, 68, 70 is too deep, the downward pressure could push the knurl substantially or completely through the flanges 20, 38 of the lid portion 10 and the body portion 12. Therefore, the thickness of the knurl is carefully calibrated to allow the knurl pattern to press into the flanges 20, 38 of the lid portion 10 and the body portion 12 sufficiently enough to engage and frictionally grip the flanges 20, 38, without sinking deep enough into the thickness of the flanges 20, 38 to compromise the structural integrity of the weld. Typically the depth of the knurl pattern 66, 68, 70 is calibrated as a small percentage of the thickness of the flanges 20, 38 of the lid portion 10 and the body portion 12.

[0051] In another embodiment, the support surface 24 of the support assembly 22 and the friction surface 34 of the sonotrode 32 have a textured surface rather than a knurled surface. Referring to Figure 15, the support surface 24 of the support assembly 22 and the friction surface 34 of the sonotrode 32 can be sand-blasted or grit-blasted, thereby creating a textured surface 80. In still another embodiment, the support surface 24 of the support assembly 22 and the friction surface 34 of the sonotrode 32 can each include a raised ridge 82 extending thereabout. Referring to Figures 16 and 17, the raised ridge 82 extends around the support surface 24 and the friction surface 34 in a serpentine manner. When the friction surface 34 of the sonotrode 32 contacts the lid portion 10 and the flanges 20, 38 of the lid portion 10 and the body portion 12 are held between the friction surface 34 and the support surface 24, the raised ridges 82 on the friction surface 34 and support surface 24 will create pressure points against the flanges 20, 38. Other embodiments can be envisioned wherein the support surface 24 of the support assembly 22 and the friction surface 34 of the sonotrode 32 each include a raised ridge 82 extending thereabout in a serpentine manner, and include portions that are grit blasted or sand blasted to increase the frictional grip of those portions.

[0052] Preferably, the interior surfaces 42, 44 of the lid portion 10 and the body portion 12 are coated with a food compatible coating 72 prior to being assembled. These coatings 72 are typically organic coatings. A variety of coatings can be used on the interior surfaces of the lid portion and the body portion of the container, which are preferably satisfactory for food contact, to prevent corrosion of the inner surface of the metallic food container and to prevent the metal from contaminating the taste of the food placed therein. The coating can be any of the materials identified, for example, in U.S. Patent 5,739,215, which are hereby incorporated by reference. Typically, the body portion and the lid portion have the inner surfaces coated prior to the lid portion being attached to the body portion. It is important that any process used to attach the lid portion 10 to the body portion 12 does not compromise the integrity of any coatings 72 placed thereon.

[0053] The downward force that the sonotrode 32 places on the lid portion 10 presses the flange 38 of the lid portion 10 and the flange 20 of the body portion 12 together. That downward force and the frequency of the reciprocal movement of the sonotrode 32 are carefully calibrated such that the frictional heat generated from the reciprocal relative motion between the lid portion 10 and the body portion 12 is sufficient to initially wipe out the coating between the lid portion 10 and the body portion 12 of the metallic container 14. There after, the downward force of the sonotrode 32 can be increased such that the frictional heat generated from the reciprocal relative motion between the lid portion 10 and the body portion 12 is create a friction weld between the lid portion 10 and the body portion 12 of the metallic container 14, while being sufficiently low enough to prevent break-down of the coating 72 inwardly adjacent to the weld area.

[0054] This allows the formation of a weld zone 74 between the inner surfaces 42, 44 of the flanges 20, 38 of the lid portion 10 and the body portion 12 while maintaining the integrity of the coating 72 on these surfaces 42, 44. Referring to Figure 9, a close up view shows the flange 38 of the lid portion 10 and the flange 20 of the body portion 12 prior to welding. The inner surface 42 of the flange 38 on the lid portion 10 has a coating 72 placed thereon and the inner surface 44 of the flange 20 on the body portion 12 has a coating 72 placed thereon. The coatings 72, as well as protecting the contents of the metallic container 14, after the lid portion 10 is attached to the body portion 12, also assist in the friction welding.

[0055] Thermoplastic coatings 72 can provide lubrication between the lid portion 10 and the body portion 12 to more easily allow relative motion between the two as the sonotrode 32 begins to move back and forth. As the frictional heat increases, the thermoplastic coatings 72 can become more fluid, thereby acting as a lubricant. After a short time, the heat begins to build up, and the downward pressure of the sonotrode 32 pushes the heated coating 72 away from the area directly between the friction surface 34 of the sonotrode 32 and the support surface 24 of the support assembly 22, or specifically, the weld zone 74. In the embodiment including raised serpentine ridges 82 on the friction surface 34 and the support surface 24, the pressure points created by the raised ridges 82 will push against the outer surfaces 26, 48 of the flanges 20, 38 thereby defining flow paths between the inner surfaces 42, 44 of the flanges 20, 38. The liquefied coating material 72 will flow, via the flow paths, outward, away from the weld zone 74. In this way, the raised serpentine ridges 82 assist in removing the coating material 72 from between the flanges 20, 38, thereby helping to insure a contaminant free weld zone 74. Coatings 72 formed of thermoset resins are observed to quickly become powdered and expelled outward from the weld zone 74.

[0056] Referring to Figures 10 and 11, once the coatings 72 are wiped out from the weld zone 74, the flange 38 of the lid portion 10 and the flange 20 of the body portion 12 are in direct contact within the weld zone 74. As reciprocal motion continues, the heat eventually builds up and forms a friction weld between the lid portion 10 and the body portion 12 within this weld zone 74. Referring specifically to Figure 11, the weld zone 74 is the area wherein the lid portion 10 and the body portion 12 are actually welded to one another. The coating material 72 that was wiped out of the weld zone 74 can form pockets 76 of coating material 72 immediately adjacent each side of the weld zone 74. These pockets 76 of coating material 72 help insure that there are no gaps in the coating material 72 at the point of welding.

[0057] Referring again to Figure 6A, the friction surface 34 of the sonotrode 32 and the support surface 24 of the support assembly 22 are oriented at an angle 40 relative to the longitudinal axis 36 of the apparatus, along which the sonotrode 32 moves. Preferably, the friction surface 34 of the sonotrode 32 and the support surface 24 of the support assembly 22 are inwardly angled. The flanges 20, 38 on the lid portion 10 and the body portion 12 are correspondingly angled, as discussed previously. The angled orientation means that the downward force of the sonotrode 32 will provide a force to directly keep the flange 38 of the lid portion 10 and the flange 20 of the body portion 12 held together. This force will also act to push downward on the lid portion 10 relative to the body portion 12. This means that as the weld zone 74 is forming, the downward force pushing on the lid portion 10 will cause the weld zone 74 to smear radially inward. This increases the size of the weld zone 74 and the depth of the weld between the lid portion 10 and the body portion 12.

[0058] The method of forming a metallic container 14 includes the steps of providing a pre-formed body portion 12, providing a pre-formed lid portion 10, placing the lid portion 10 onto the body portion 12 and applying a force to keep portions of the lid portion 10 and the body portion 12 held in contact with one another, and reciprocally rotating the lid portion 10 with respect to the body portion 12, thereby generating frictional heat between the lid portion 10 and the body portion 12 such that a friction weld is formed therebetween.

[0059] Referring to Figures 7, 7A, 8, and 8A, preferably, the body portion 12 is generally cylindrically shaped and open at one end, the open end having an angled flange 20 extending circumferentially around the open end. A coating 72 is placed on the inner surface 44 of the body portion 12. The lid portion 10 is generally disk shaped and includes an angled flange 38 extending circumferentially around the disk perimeter. The angle 40 of the flange 20 on the body portion 12 being approximately equal to the angle 40 of the flange 38 on the lid portion 10. The lid portion 10 has a coating 72 placed on the inner surface 42 as well.

[0060] Preferably, the lid portion 10 and the body portion 12 are cold formed from a metallic material such as aluminum. It is to be understood that the metallic container 14 can be made from any suitable metallic material, and aluminum is being described here as one example of such a metallic material. The lid portion 10 is coated prior to the lid portion 10 being cold formed into pre-formed shape, and the body portion 12 is coated after being cold formed into the pre-formed shape.

[0061] The lid portion 10 and the body portion 12 are be placed together such that the inner surface 42 of the flange 38 of the lid portion 10 contacts the inner surface 44 of the flange 20 on the body portion 12. The force applied to keep the inner surface 42 of the flange 38 on the lid portion 10 held in contact with the inner surface 44 of the flange 20 on the body portion 12 should be between approximately 1800 N and approximately 2700 N. Preferably, the force is approximately 2250 N. The lid portion 10 can be rotated or otherwise moved reciprocally relative to the body portion 12 at a rate between 15 KHz and 25 KHz. Preferably, the lid portion 10 is vibrated at a frequency of approximately 20 KHz.

[0062] Preferably all steps are performed by providing an apparatus 16 such as that described above. The body portion 12 of the metallic container 14, generally filled with suitable contents such as a food or beverage, is placed onto the base 18 of the apparatus 16. The lid portion 10 of the metallic container 14 is then placed onto the body portion 12 of the metallic container 14.

[0063] The actuator 50 is activated and begins to move the sonotrode 32 downward toward the metallic container 14. As the sonotrode 32 and the shaft 54 on which the sonotrode 32 is mounted, begin to move downward, the rolling contacts 58 on the two halves 30A, 30B of the clamshell anvil 30 follow the cammed outer surface 56 of the shaft 54, thereby pushing the rolling contacts 58 outward and causing the two halves 30A, 30B of the clamshell anvil 30 to pivot against the biasing springs 60 mounted onto the support assembly 22.

[0064] When the rolling contacts 58 reach a point on the cammed outer surface 56 of the shaft 54 wherein the two halves 30A, 30B of the clamshell anvil 30 are pivoted to the closed position, the support surface 24 of the clamshell anvil 30 contacts the outer surface 26 of the flange 20 on the body portion 12 of the metallic container 14. The sonotrode 32 continues to move downward to the engaged position, wherein the friction surface 34 of the sonotrode 32 contacts the flange 38 on the lid portion 10 of the metallic container 14.

[0065] The actuator 50 pushes the sonotrode 32 downward with a force of approximately 2250 N. After the sonotrode 32 reaches the engaged position, and the friction surface 34 of the sonotrode 32 is in contact with the flange 38 of the lid portion 10 and the support surface 24 of the support assembly 22 is in contact with the flange 20 of the body portion 12, the motor 52 begins to reciprocate the sonotrode 32. The sonotrode 32 reciprocates relative to the support assembly 22, thereby reciprocating the lid portion 10 relative to the body portion 12 of the metallic container 14. The motor 52 reciprocates the sonotrode 32 at a frequency of approximately 20 KHz, thereby generating sufficient frictional heat to wipe out the coating 72 on the inner surfaces 42, 44 of the body portion 12 and the lid portion 10 to the sides of the weld zone 74 and forming a friction weld between the flanges 20, 38 of the lid portion 10 and the body portion 12 within the weld zone.

[0066] Alternatively, the actuator 50 moves the sonotrode 32 to the engaged position, and pushes the sonotrode 32 downward with a first downward force. The motor 52 is activated, and the sonotrode 32 is reciprocally rotated at a first frequency for a first predetermined amount of time. Specifically, the sonotrode 32 exerts sufficient force (first downward force) and the motor 52 reciprocally rotates the sonotrode 32 at a frequency (first frequency) until any thermoplastic coating material 72 placed on the inner surfaces 42, 44 of the flanges 20, 38 is allowed to melt, and become liquid. The first downward force and the first frequency are sufficient to create frictional heat to melt the coating material 72, however not sufficient to create enough frictional heat to form a weld. This melted coating material 72 acts as a lubricant to allow continued movement between the flanges 20, 38. However, the coating materials 72 could compromise the integrity of the weld formed between the flanges 20, 38, so the downward force and the frequency of rotation are held at the first downward force and the first frequency until the melted thermoplastic coating material 72 has migrated away from the weld zone 74. It is possible, to use the frictions surface 34 and support surface 24 illustrated in Figures 16 and 17 to assist in this migration.

[0067] The support surface 24 and the friction surface 34 can each have a raised ridge 82 extending therearound in a serpentine pattern such that when the friction surface 34 of the sonotrode 32 contacts the lid portion 10 and the flanges 20, 38 of the lid portion 10 and the body portion 12 are held between the friction surface 34 and the support surface 24, the raised ridges 82 on the friction surface 34 and support surface 24 will create pressure points against the flanges 20, 38. The first downward pressure is adapted to apply sufficient pressure, such that the raised serpentine ridges 82 on the friction surface 34 and the support surface 24 create pressure points against the outer surfaces 26, 48 of the flanges 20, 38, thereby defining flow paths between the inner surfaces 42, 44 of the flanges 20, 38. The flow paths will allow the melted thermoplastic coating material 72 to more readily flow from within the weld zone 74, and the reciprocal rotation of the sonotrode 32 will help push the melted thermoplastic coating material 72 through these flow passages. Similar flow patterns are observed for powdered non-thermoplastic coatings.

[0068] Typically, when applied to a typical carbonated beverage can, it takes approximately two to six hundredths of a second to wipe out the coatings 72 from the weld zone 74. Once the coating material has been wiped out, the downward pressure of the sonotrode 32 can be increased to a second downward force and the frequency of reciprocal motion of the sonotrode 32 is increased to second frequency. The downward pressure and the frequency are increased to levels appropriate to create sufficient heat and pressure to form a friction weld between the flanges 20, 38, and held at those levels until the friction weld is formed. When applied to a typical carbonated beverage can, this portion of the process takes approximately one to two tenths of a second.

[0069] When used in connection with a rotational sonotrode 32, the first downward force and the first frequency are between approximately sixty percent and approximately seventy percent of the second downward force and the second frequency. As previously discussed, the downward force and the frequency are application dependant. The downward force and the frequency of reciprocal rotation, depend on the thickness of the flanges 20, 38, the material that is being welded, the diameter of the sonotrode 32, and other factors. For example, in a particular application, the downward pressure and frequency of reciprocal rotation necessary to create a friction weld between the flanges 20, 38 of the lid portion 10 and the body portion 12 are 2250 N and 20 KHz, respectively. These are the second downward force and the second frequency. The first downward force and the first frequency would be sixty to seventy percent of the second downward force and second frequency, or between 1350 N and 2200 N and between 12 and 14 KHz, respectively.

[0070] The method and apparatus 16 described above provide a technique of attaching the lid portion 10 to the body portion 12 of a metallic container 14 that creates a solid metal seal between the lid portion 10 and the body portion 12, while maintaining the integrity of any coatings 72 placed on the inner surfaces 42, 44 of either component. The process is quicker than any known prior processes, and eliminates additional material necessary for rolling the edges of the lid portion 10 and the body portion 12 onto one another. Furthermore, no intermediate material is necessary between the flanges 20, 38 of the lid portion 10 and the body portion 12. The method and apparatus 16 described herein create a weld directly between the flanges 20, 38 of the lid portion 10 and the body portion 12 with no intermediate material or gaskets of any kind necessary. The temperatures of the process described above remain relatively low compared to prior art processes, thereby making it possible to maintain a food suitable coating 72 the inner surfaces 42, 44 of the components.

[0071] In accordance with the provisions of the patent statutes, the present invention has been described in what is considered to represent its preferred embodiment. However, it should be noted that the invention can be practiced otherwise than as specifically illustrated and described.

WHAT IS CLAIMED IS:

1. A metallic container including:

a pre-formed lid portion that is generally disk shaped and includes a flange extending circumferentially thereabout;

a pre-formed body portion that is generally cylindrically shaped and open at one end, and includes a flange extending circumferentially thereabout;

the flange of the lid portion being friction welded to create a metallic weld to the flange of the body portion.

2. The metallic container of claim 1, wherein the flanges of the lid portion and the body portion are angled relative to a longitudinal axis of the metallic container.

3. The metallic container of claim 1, wherein the inner surfaces of the body portion and the lid portion include a coating material.

4. The metallic container of claim 3, wherein the lid portion includes an inner surface and the body portion includes an inner surface, wherein portions of the inner surface of the flange of the lid portion are friction welded to portions of the inner surface of the flange of the body portion, thereby defining a weld zone.

5. The metallic container of claim 4, further including pockets of coating material formed immediately adjacent the outer edges of the weld zone.

6. The metallic container of claim 5, wherein the weld zone is free of any coating material between the inner surfaces of the flanges of the lid portion and the body portion.

7. A metallic container including:

a pre-formed lid portion that is generally disk shaped and includes a flange extending circumferentially thereabout, the flange being angled between approximately five degrees and approximately seven degrees with respect to a longitudinal axis of the metallic container;

a pre-formed body portion that is generally cylindrically shaped and open at one end, and includes a flange extending circumferentially thereabout; the flange being angled between approximately five degrees and approximately seven degrees with respect to a longitudinal axis of the metallic container;

the lid portion including an inner surface and the body portion including an inner surface, portions of the flange of the inner surface of the lid portion being friction welded to portions of the inner surface of the flange of the body portion, thereby defining a metallic weld zone;

the inner surfaces of the body portion and the lid portion including a coating material, wherein the metallic weld zone is free of any coating material between the inner surfaces of the flanges of the lid portion and the body portion, and pockets of coating material are positioned immediately adjacent outer edges of the weld zone.

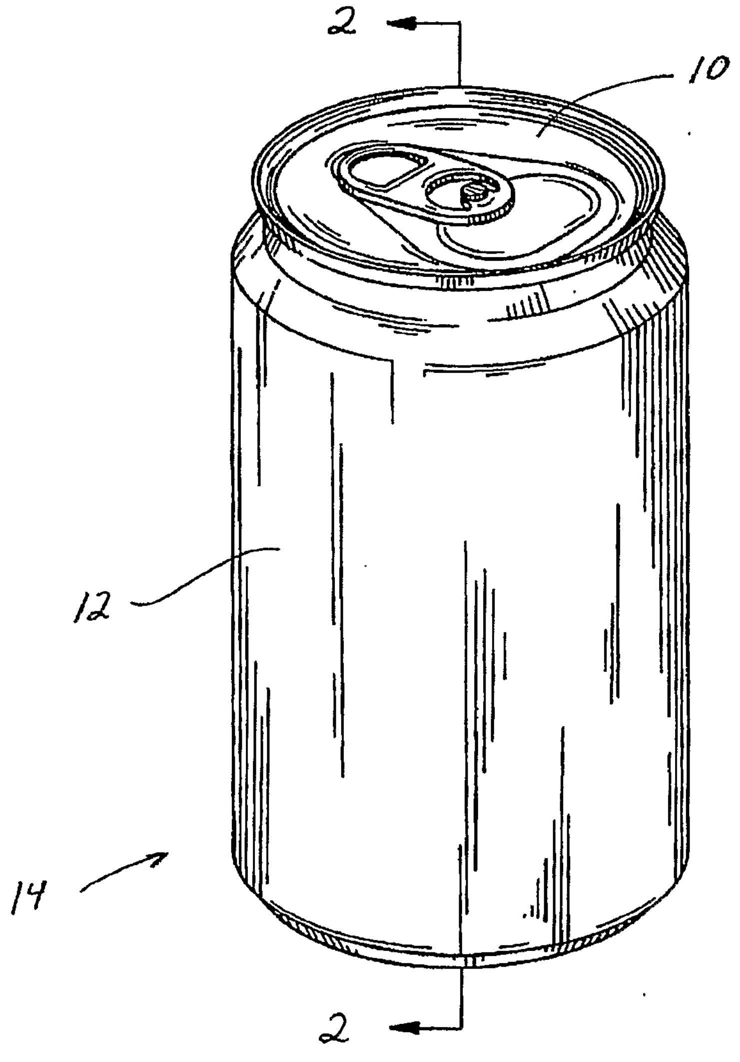

Fig. 1

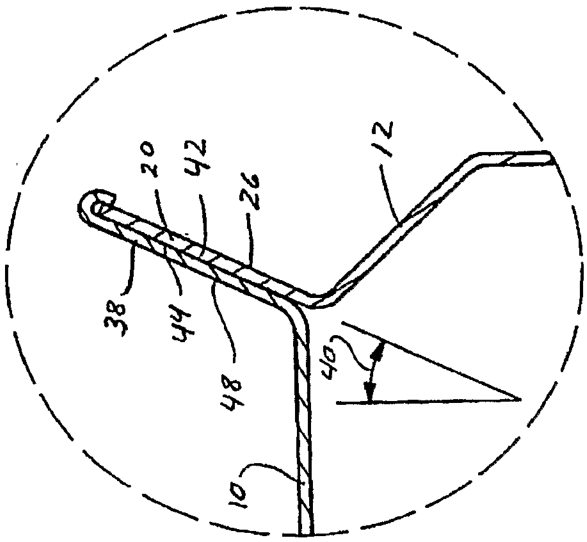

Fig. 3

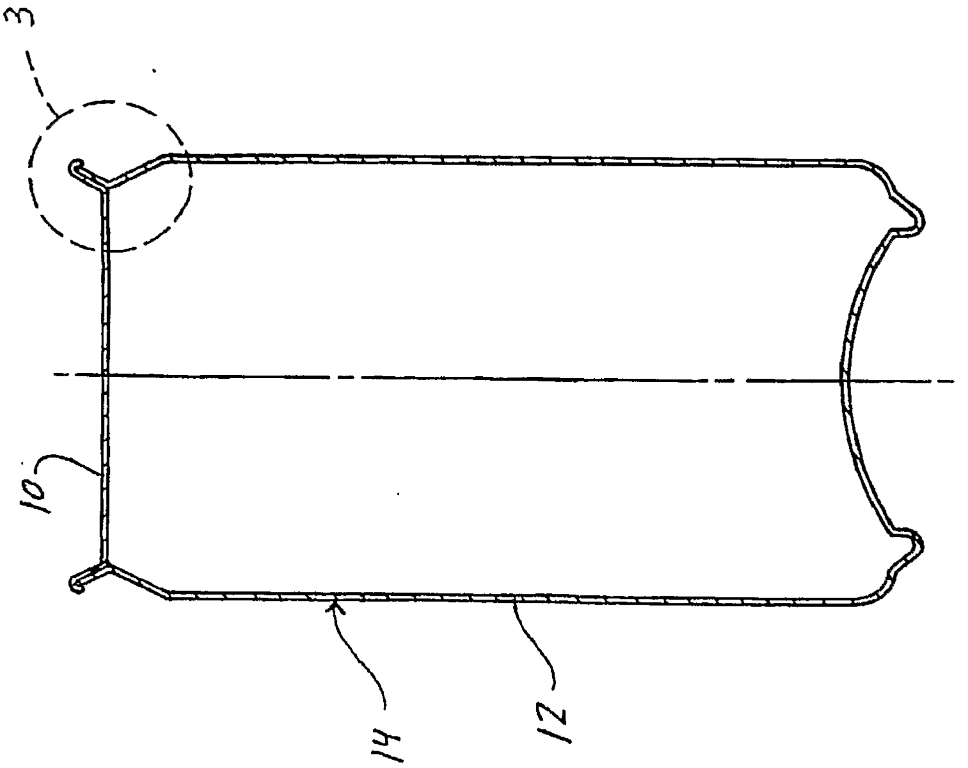

Fig. 2

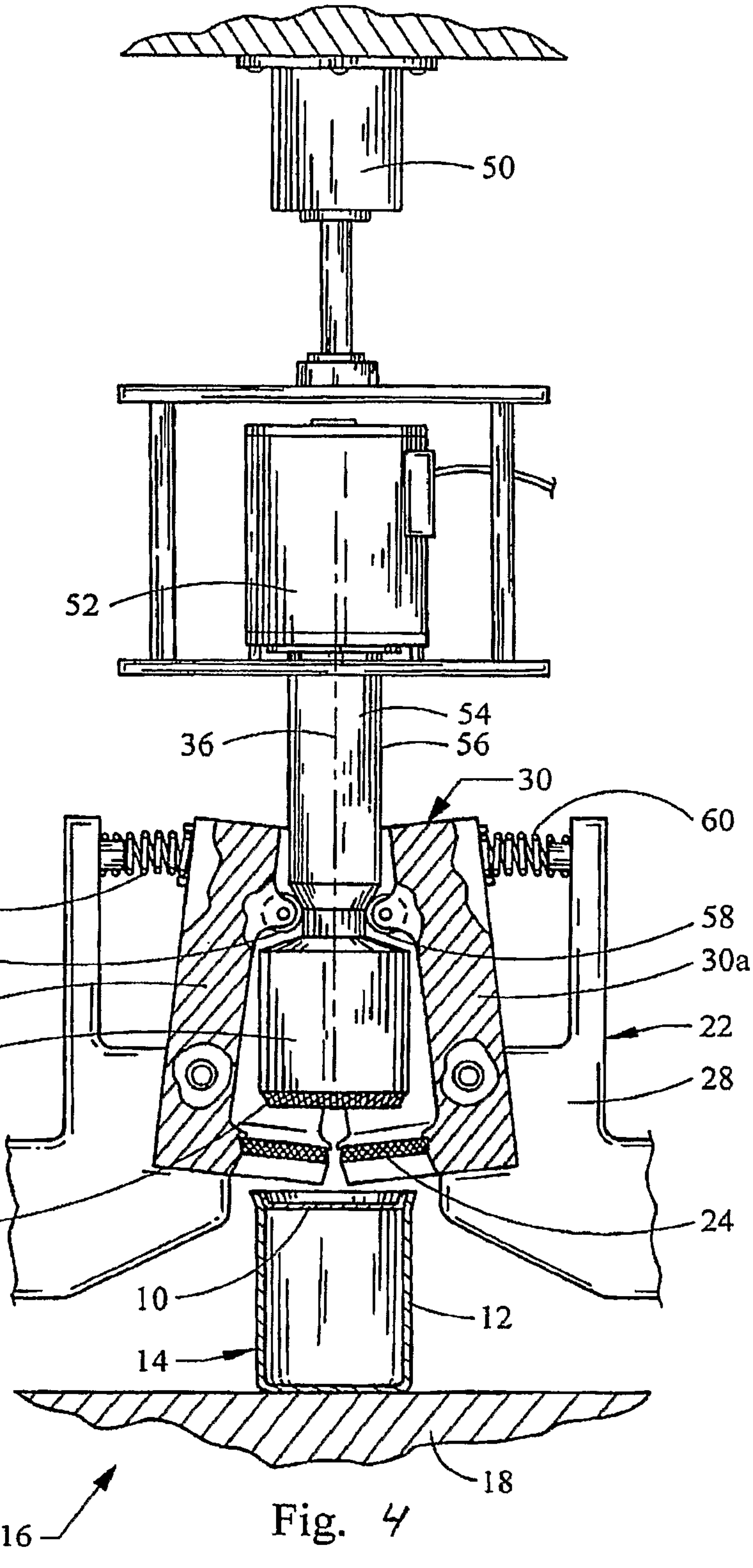

Fig. 4

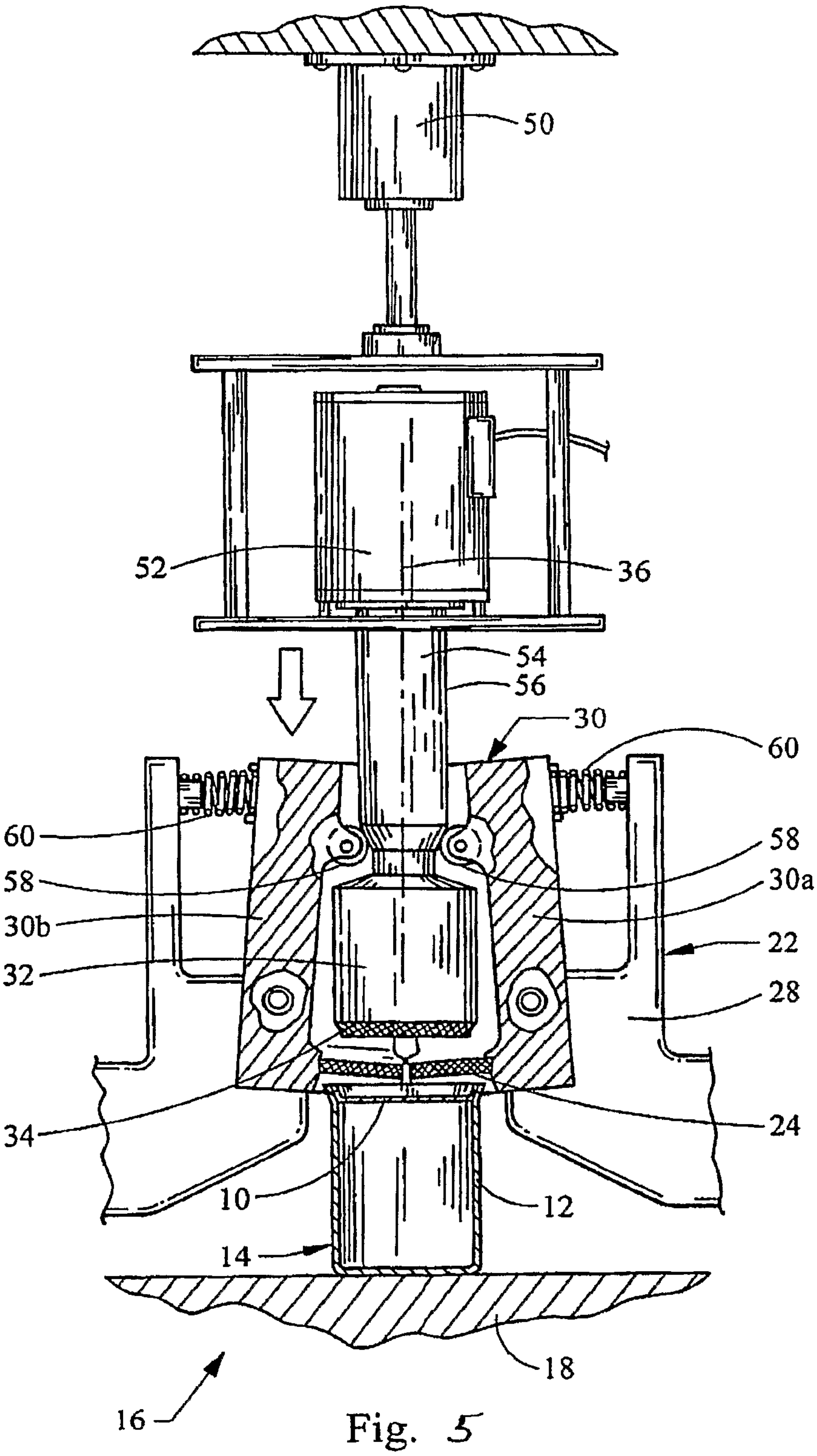

Fig. 5

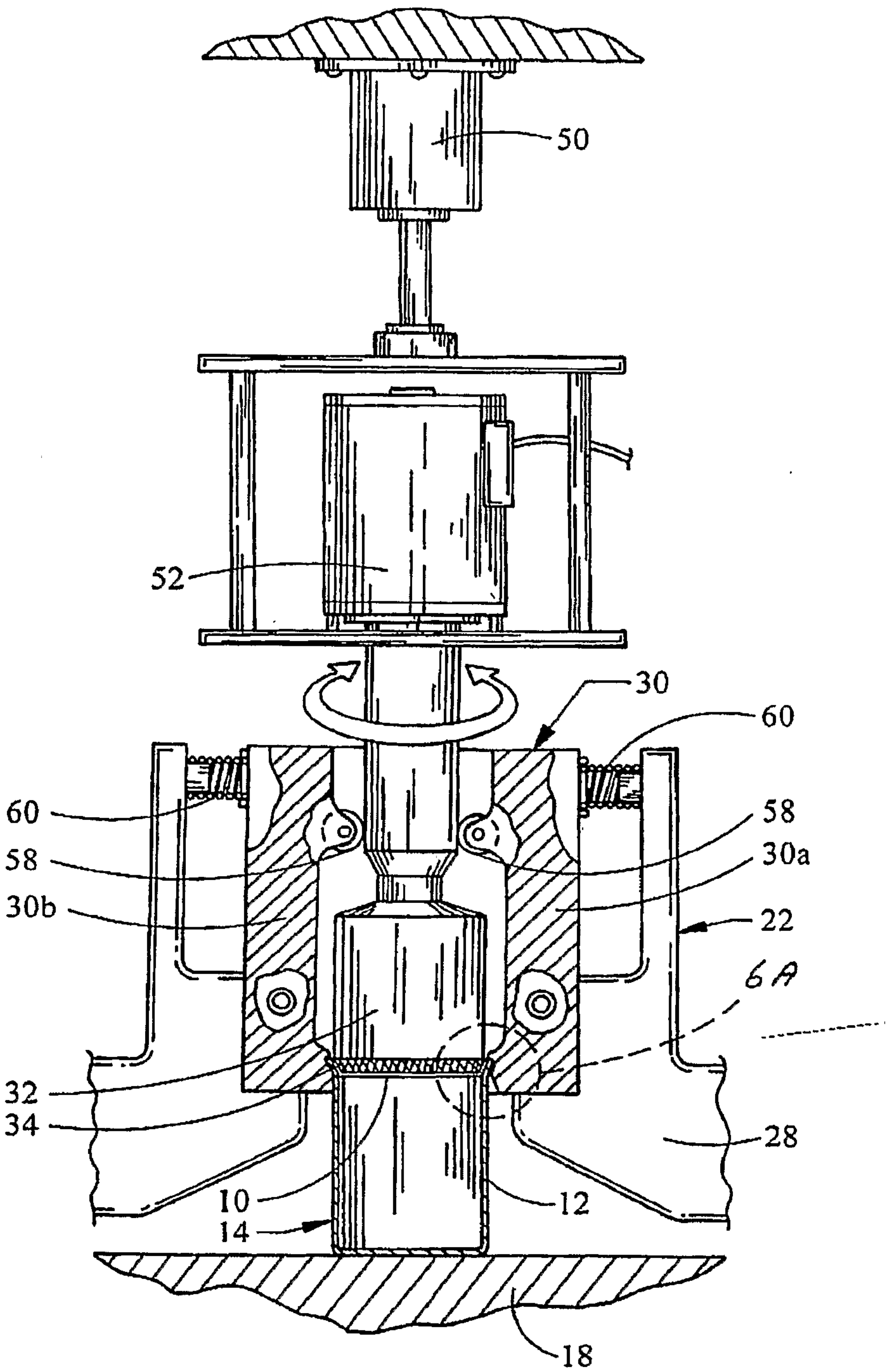

Fig. 6

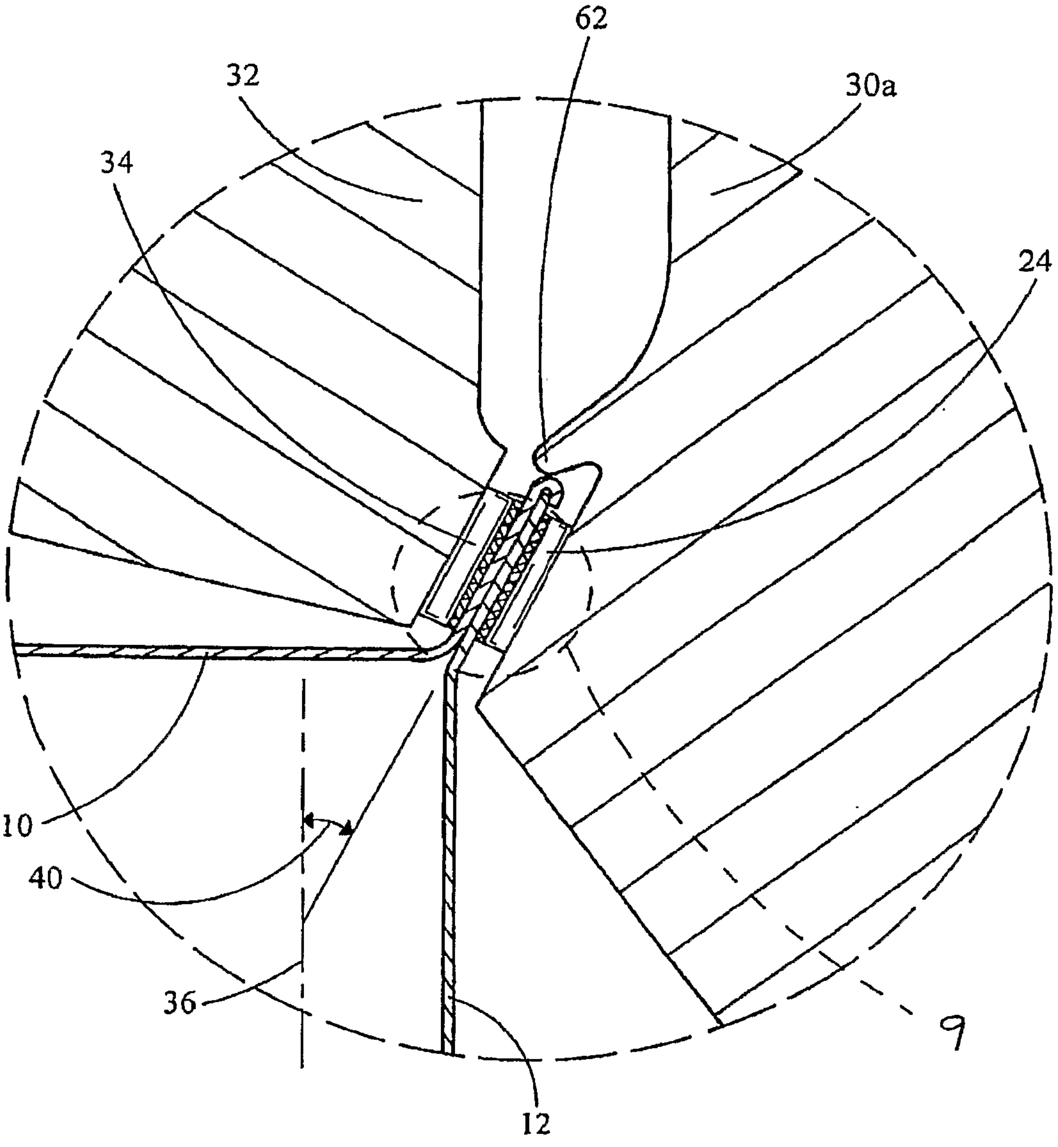

Fig. 6A

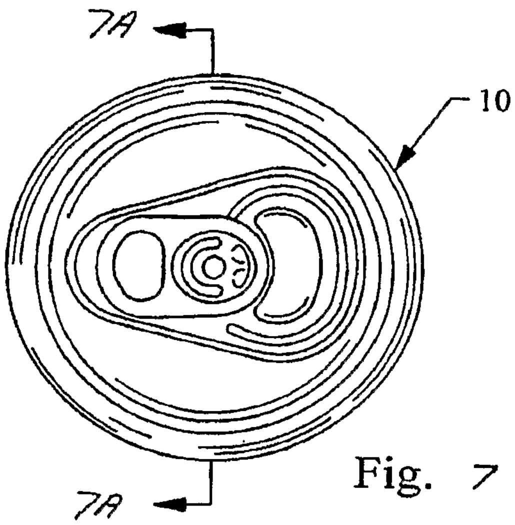

Fig. 7

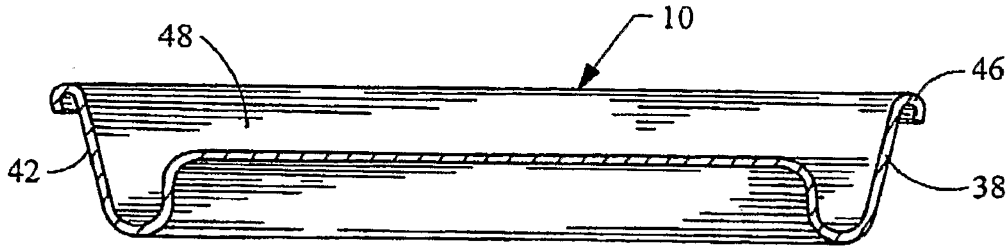

Fig. 7A

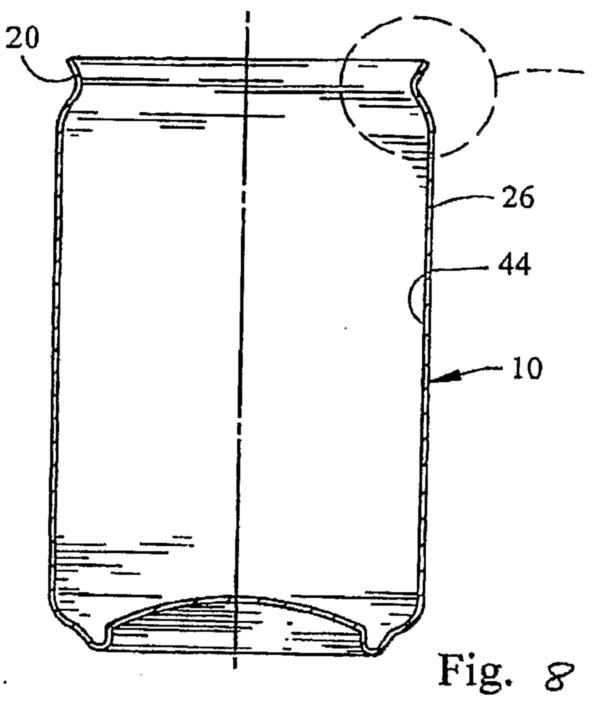

Fig. 8

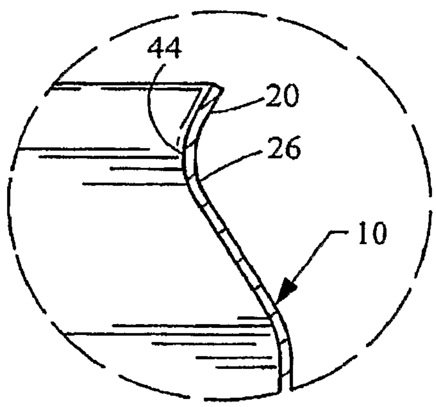

Fig. 8A

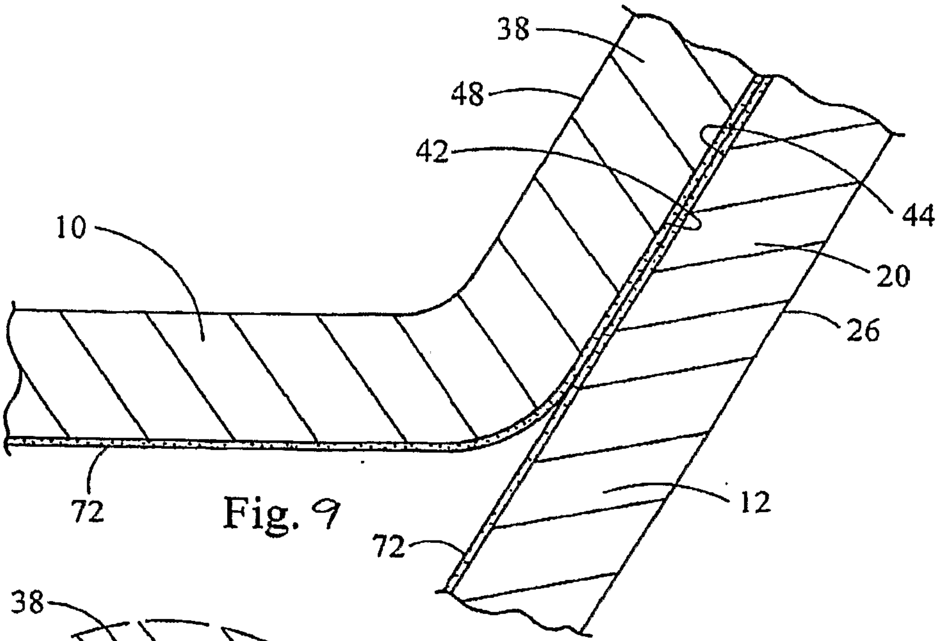

Fig. 9

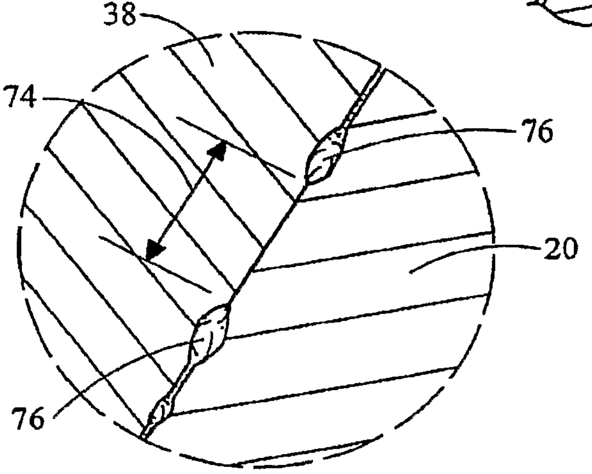

Fig. 11

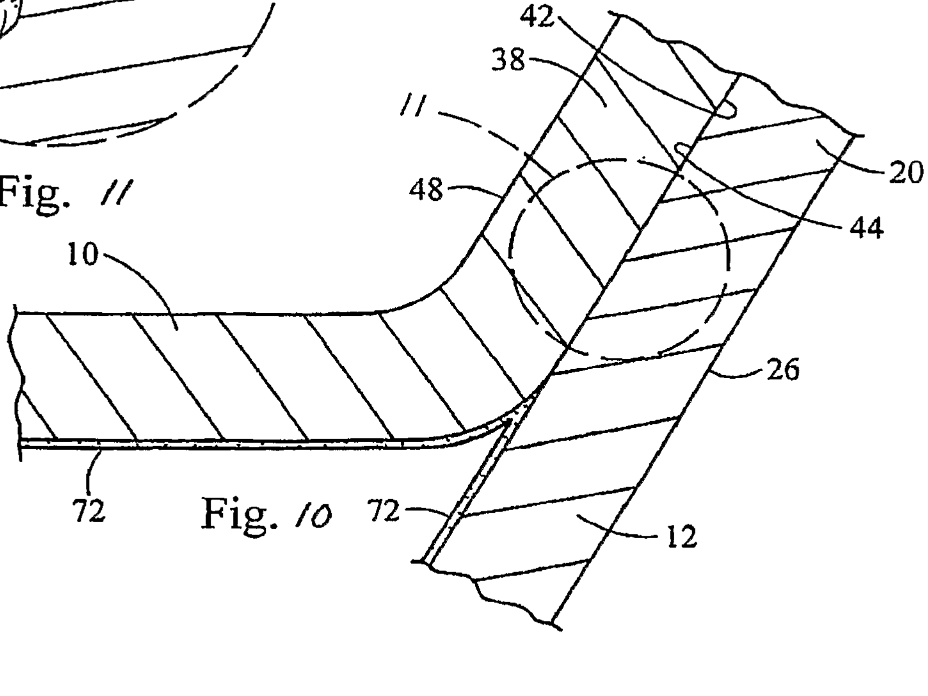

Fig. 10

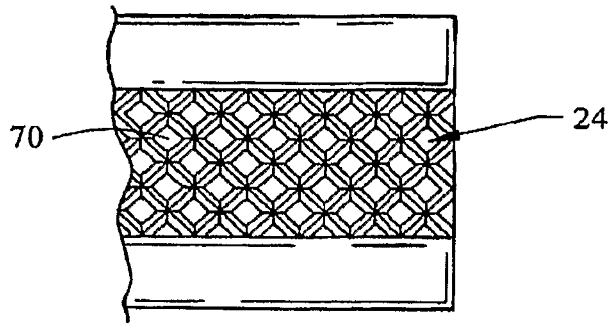

Fig. 12

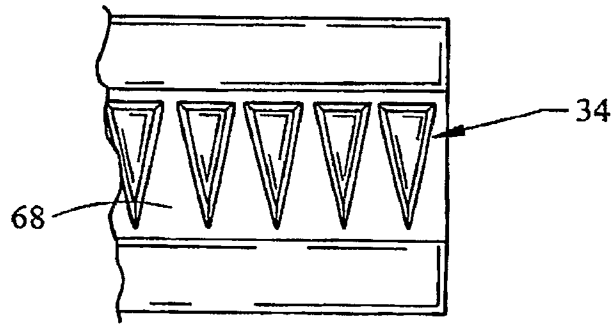

Fig. 13

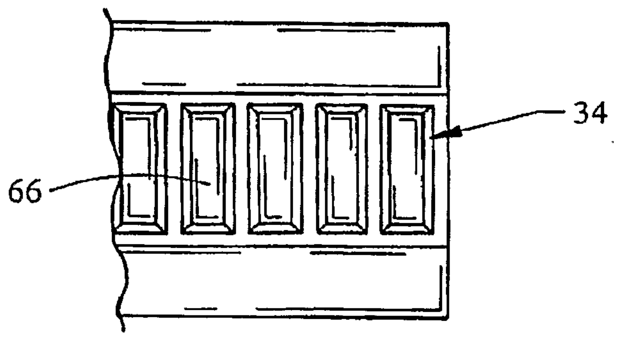

Fig. 14

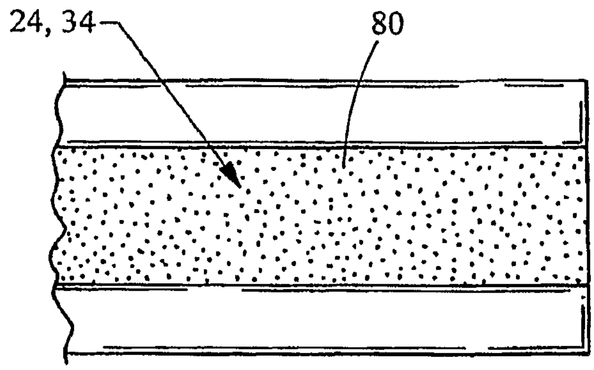

Fig. 15

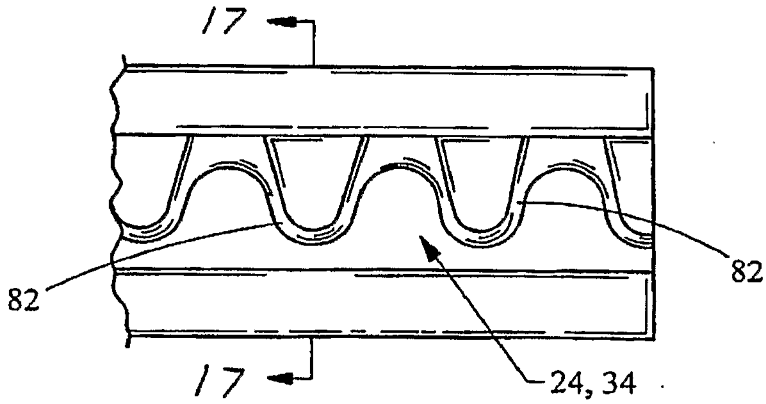

Fig. 16

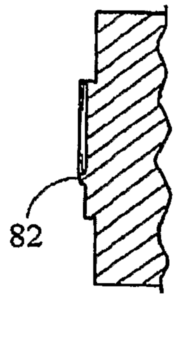

Fig. 17

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2006/048206

A. CLASSIFICATION OF SUBJECT MATTER
INV. B65D6/32 B65D17/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B65D B23K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2003/113416 A1 (WYCLIFFE PAUL ANTHONY [CA] ET AL) 19 June 2003 (2003-06-19) page 4, paragraph 43 - paragraph 45; figures 1-11	1-7
Y	FR 1 320 632 A (AMERICAN MACH & FOUNDRY) 8 March 1963 (1963-03-08) page 1, column 2, last paragraph - page 3, column 1, last paragraph; figures 1-10	1-7
A	US 4 892 227 A (MACLAUGHLIN DONALD N [US]) 9 January 1990 (1990-01-09) column 3, line 30 - column 4, line 49; figures 1,2	1-7
A	WO 02/42196 A (RAPTOR CONSULTING INC [US]; WILLIAMSON JAMES T [US]; VER VAECKE TIMOTH) 30 May 2002 (2002-05-30) page 5, line 20 - page 7, line 2; figure 2	1-7

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 May 2007	21/05/2007

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Derrien, Yannick

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2006/048206

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 2003113416	A1	19-06-2003	AU	2002350314 A1	30-06-2003
			WO	03051725 A1	26-06-2003
FR 1320632	A	08-03-1963	NONE		
US 4892227	A	09-01-1990	NONE		
WO 0242196	A	30-05-2002	AU	1785802 A	03-06-2002