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(75) Inventors: **Robert H. Versaw, JR.**, Muskegon, MI (US); **Richard W. Wright**, Grand Rapids, MI (US); **Robert L. Powney**, Rockford, MI (US)

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Correspondence Address:

VAN DYKE, GARDNER, LINN & BURKHART, LLP**SUITE 207, 2851 CHARLEVOIX DRIVE, S.E. GRAND RAPIDS, MI 49546 (US)**

(73) Assignee: **FUEL SYSTEMS, INC.**, Grand Rapids, MI (US)

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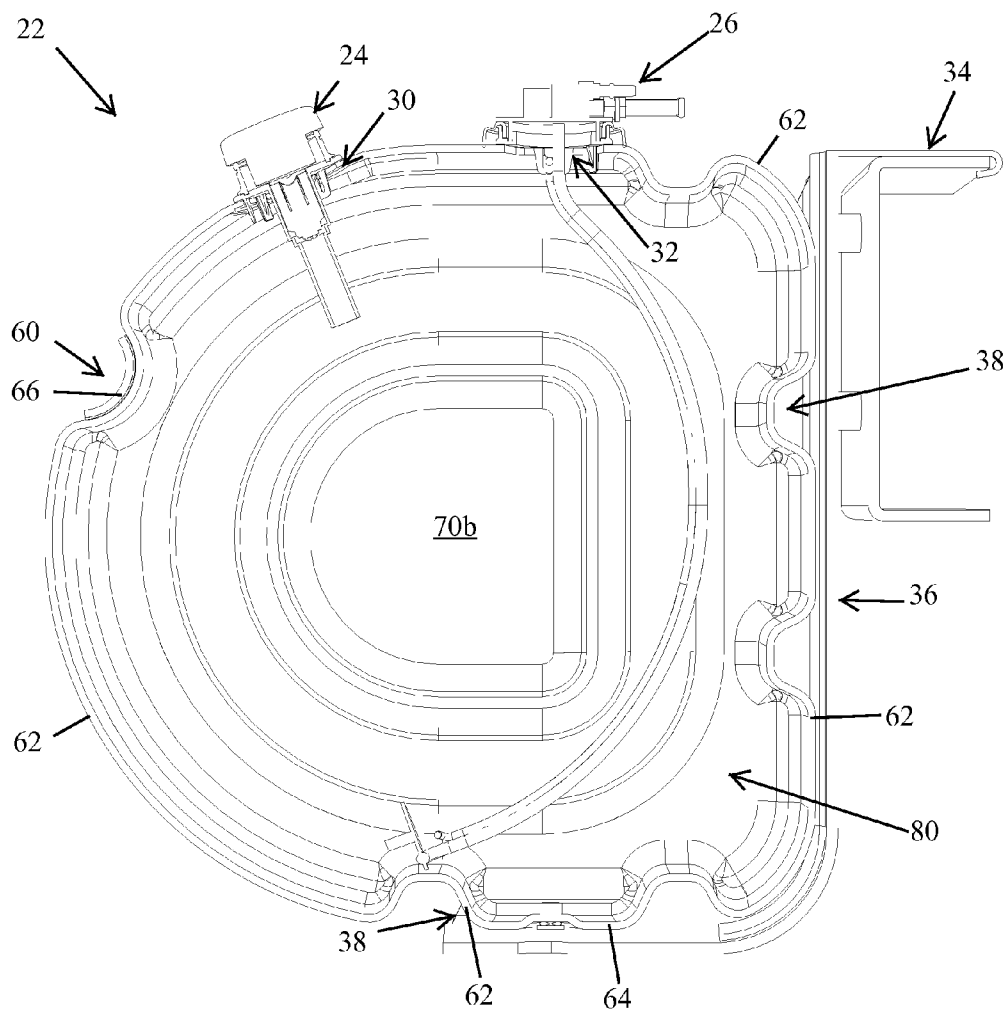
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Related U.S. Application Data

(60) Provisional application No. 61/012,484, filed on Dec. 10, 2007.

(57) **ABSTRACT**

A tank for storing urea solution and a tank assembly for storing disparate fluids, such as diesel fluid and urea solution, are disclosed. The tank may further include a filler assembly and/or a sensor assembly, either of which are adapted to be connected to the tank without the use of separate fasteners. The tank assembly may include a reservoir and a sensor for automatically diverting non-conforming urea solution to the reservoir. A recess may be defined in the tank body in order to accommodate a strap for securing the tank to the frame of vehicle. The tank may include parallel sidewalls that include a projection on one and a corresponding indentation on the other in order to allow the tanks to be easily stacked during assembly.



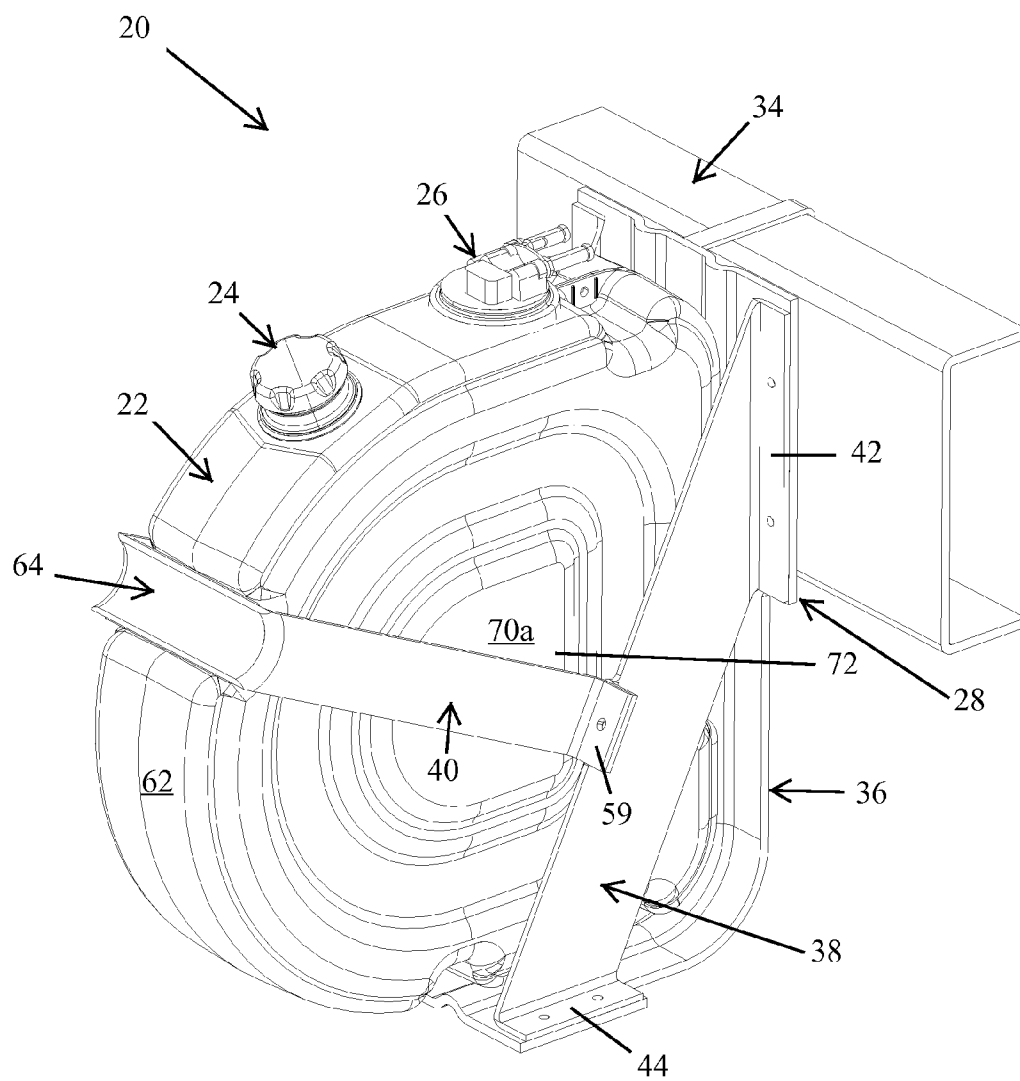


FIG. 1

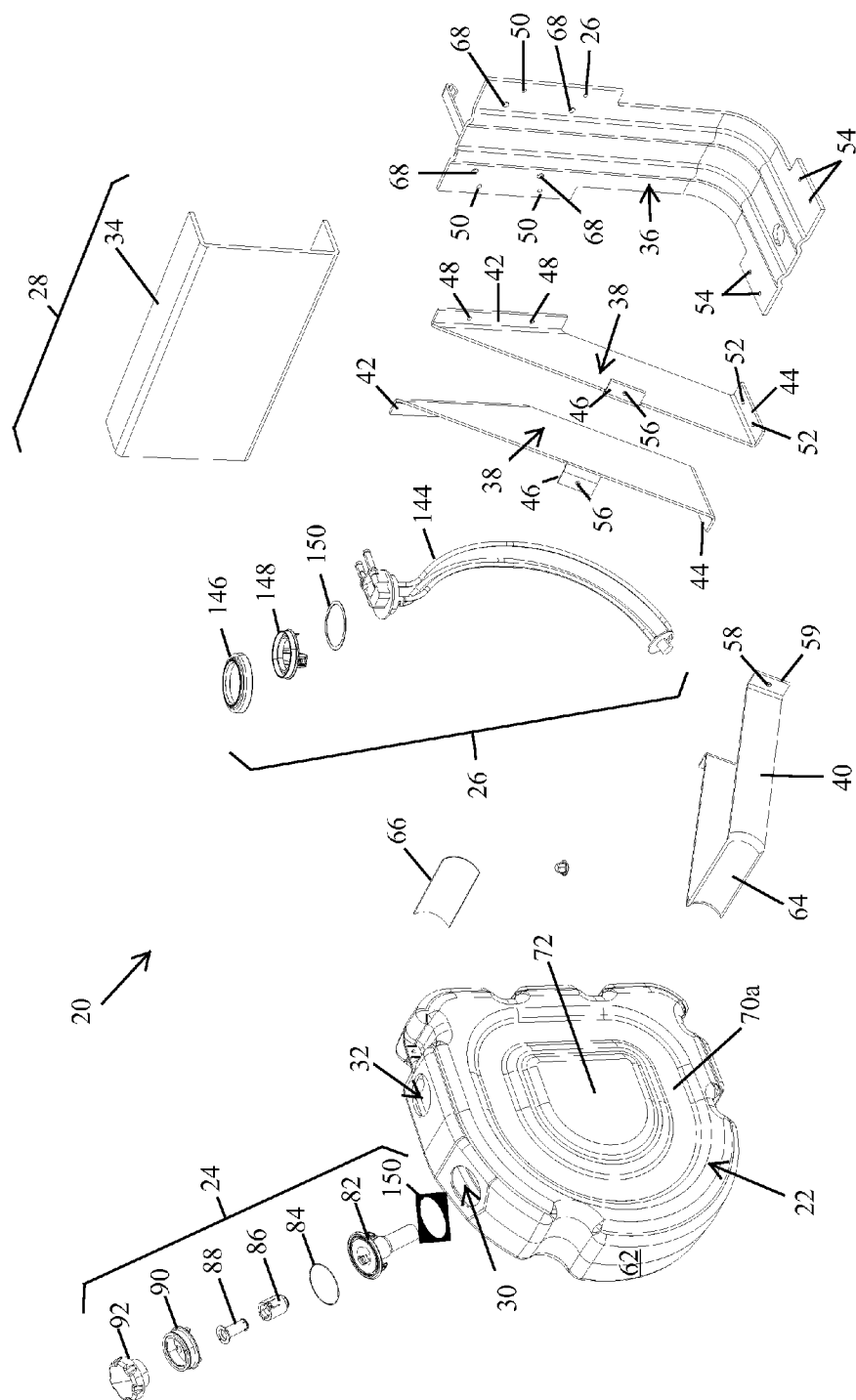


FIG 2

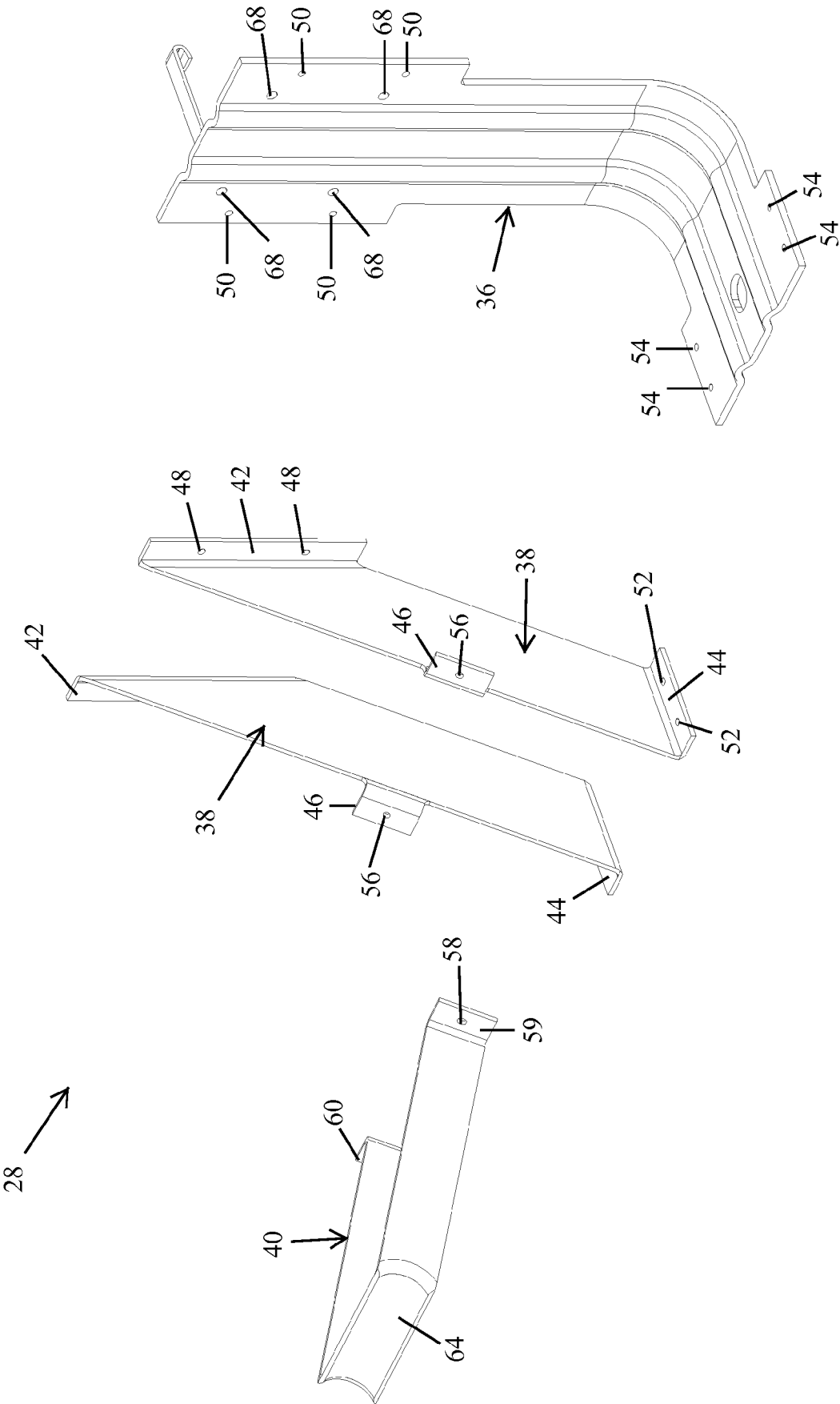


FIG. 3

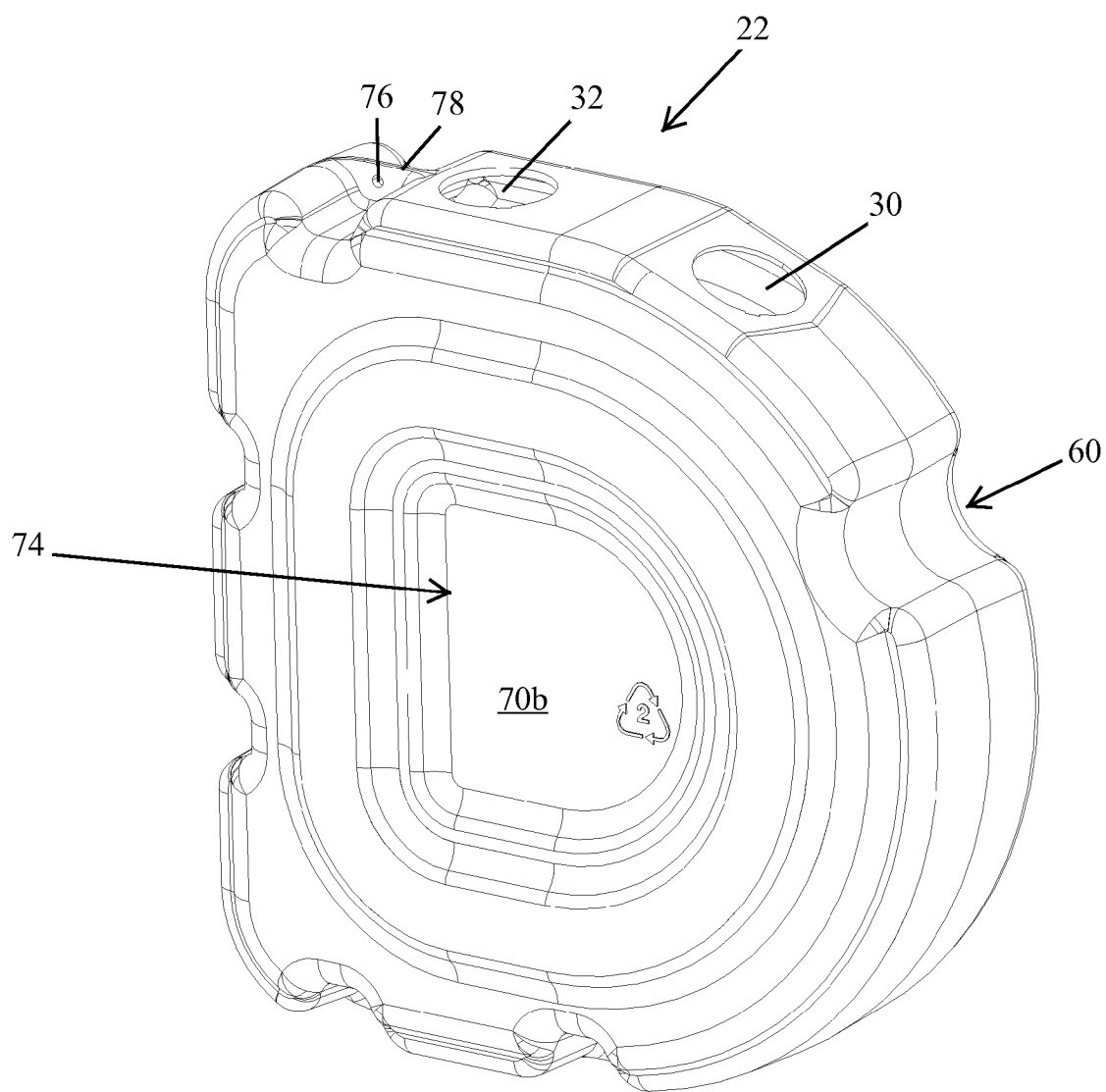


FIG. 4

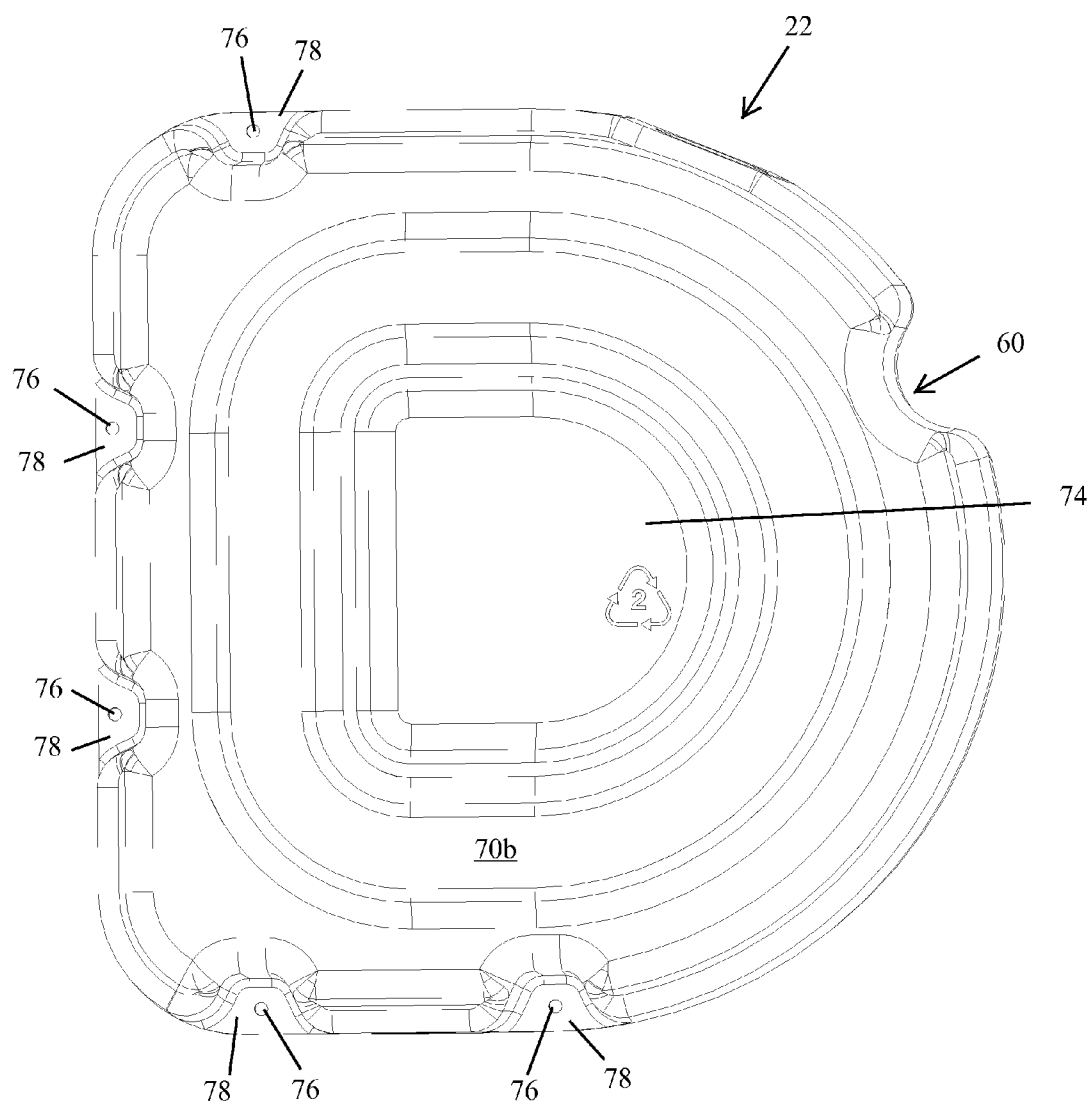


FIG. 5

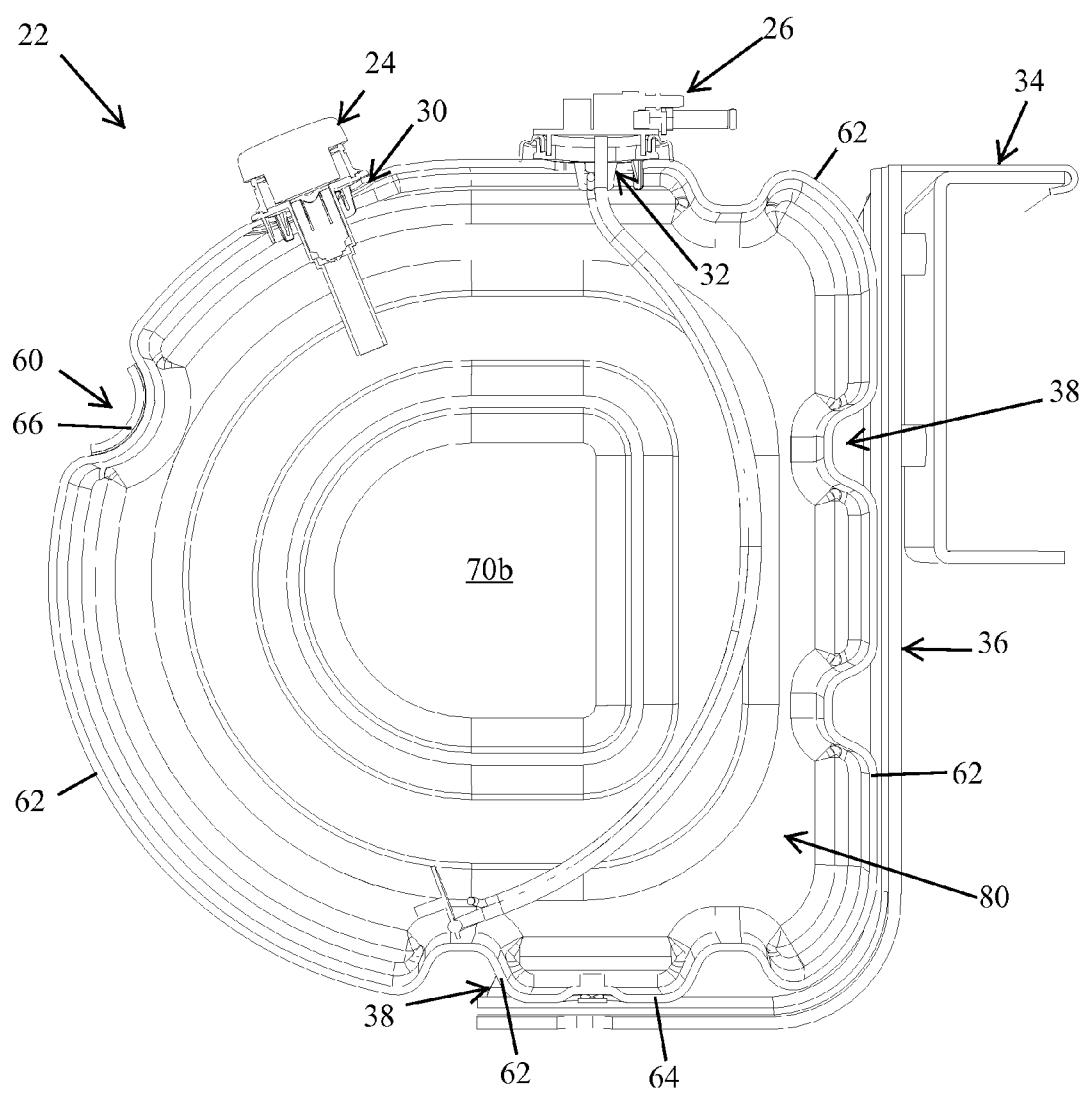


FIG. 6

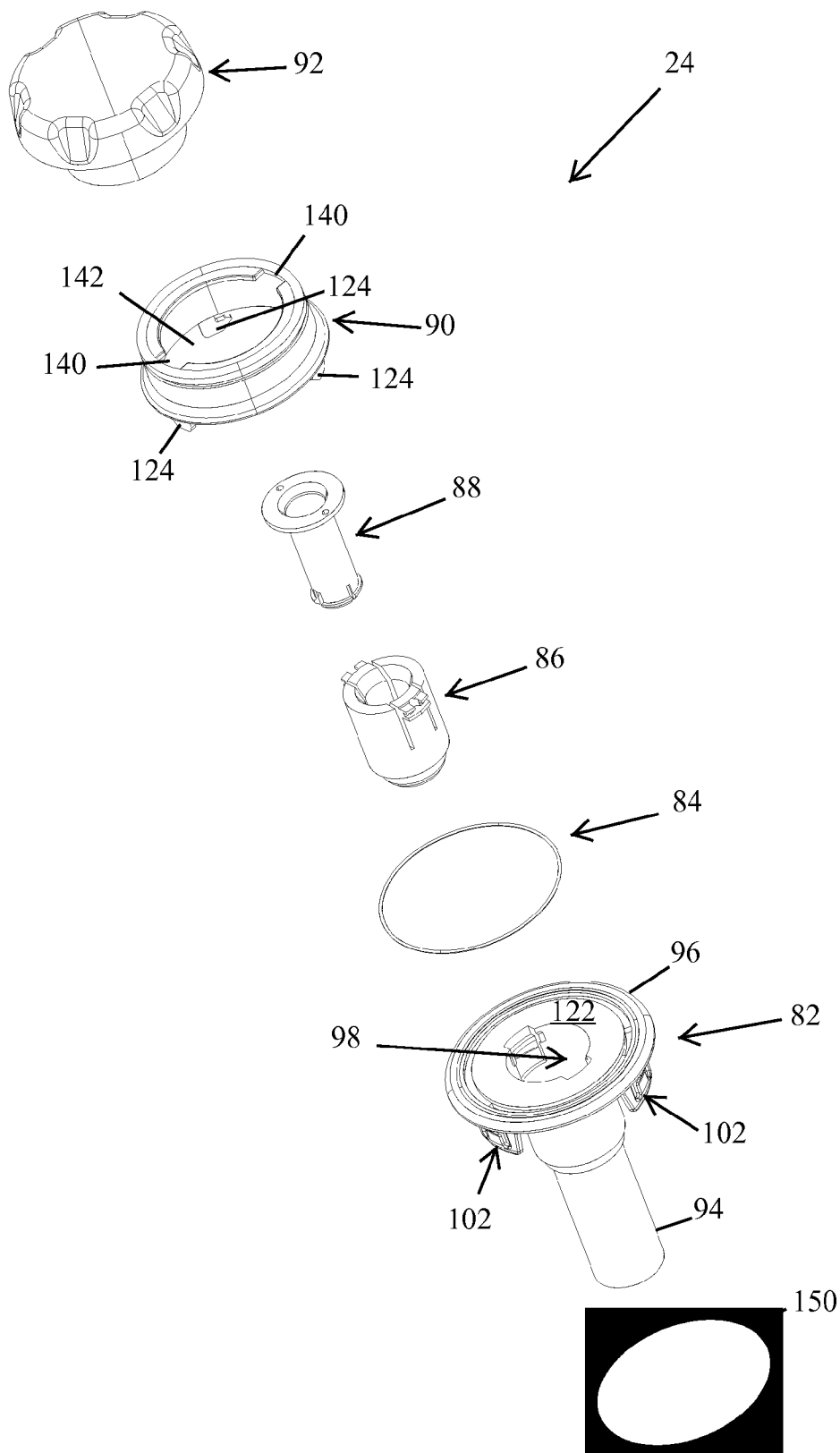


FIG. 7

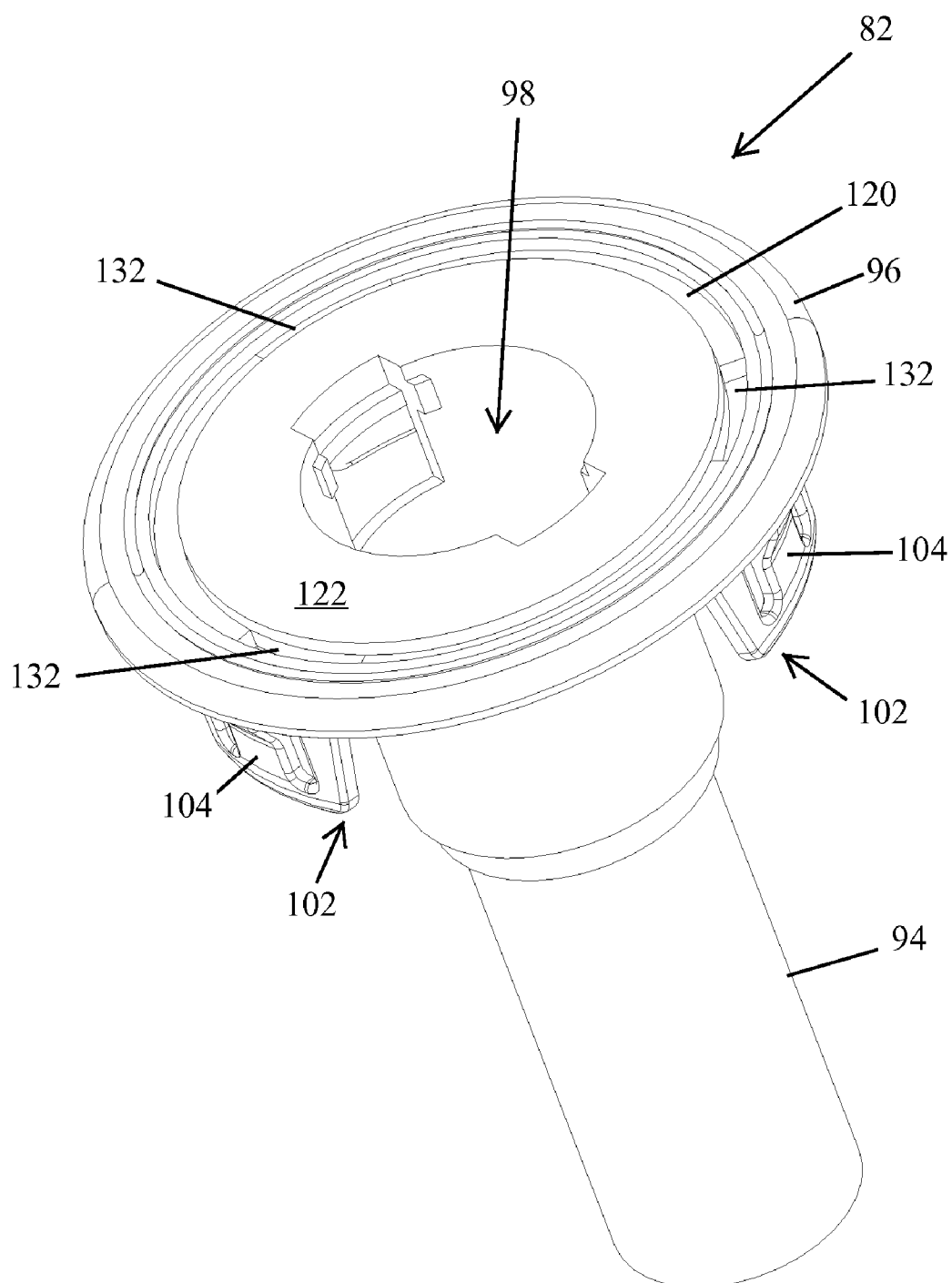


FIG. 8

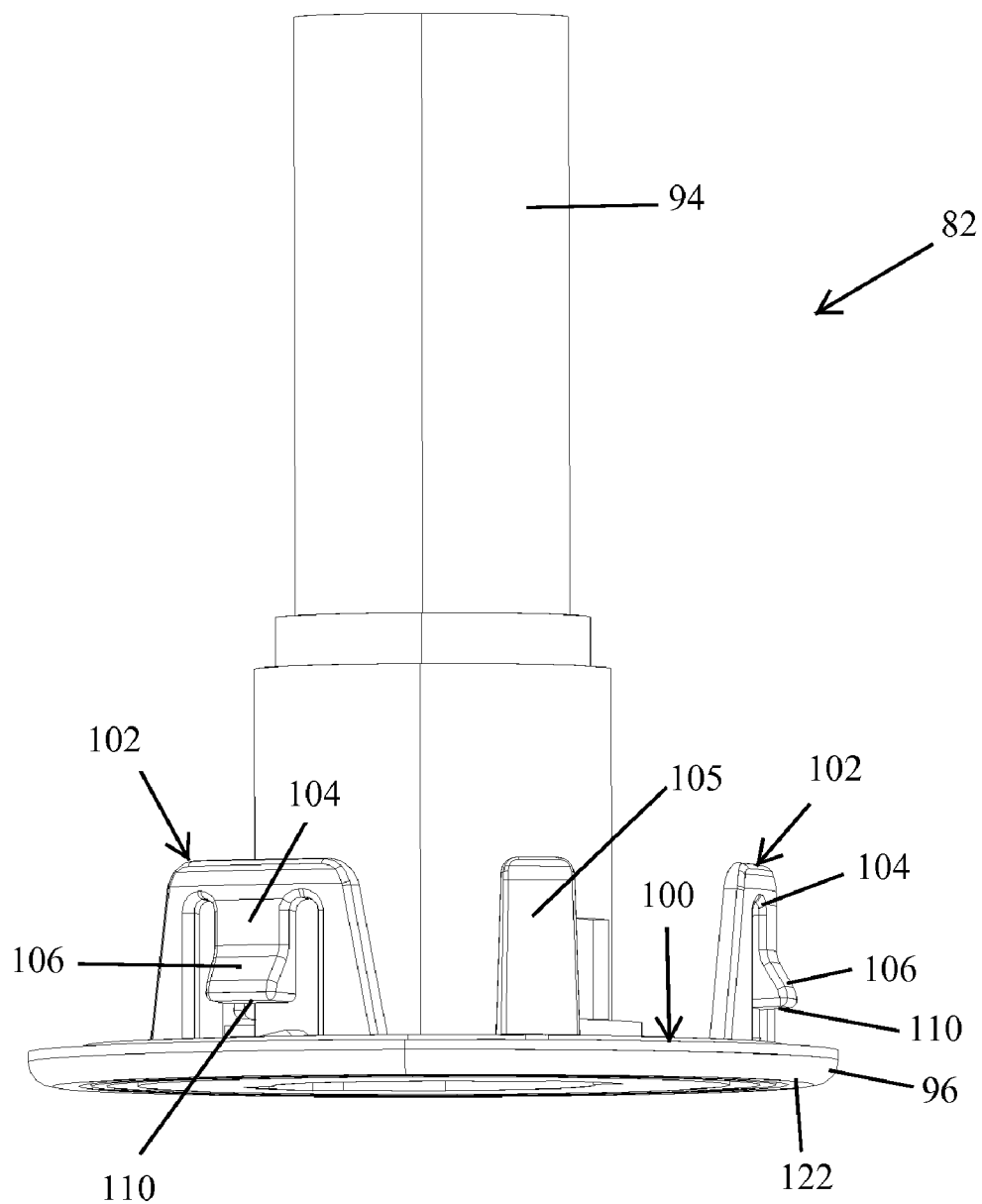


FIG. 9

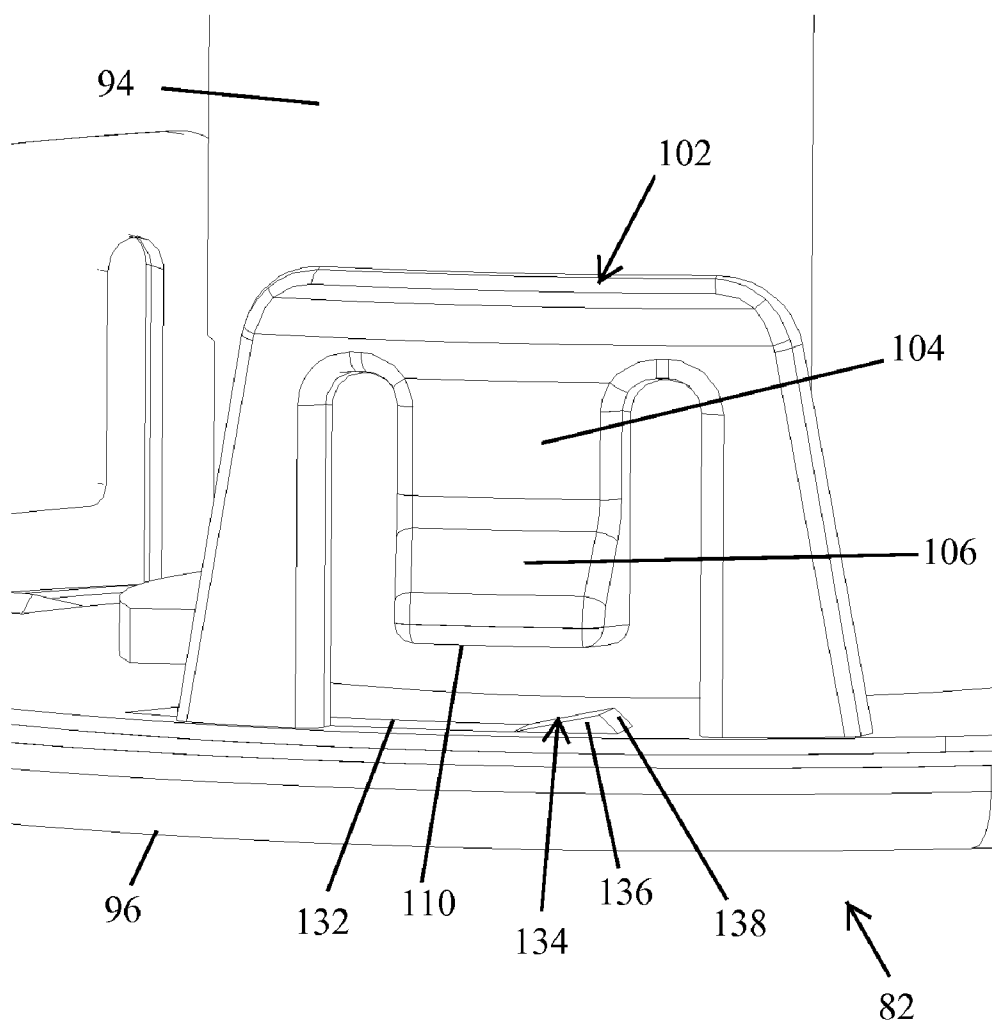


FIG. 10

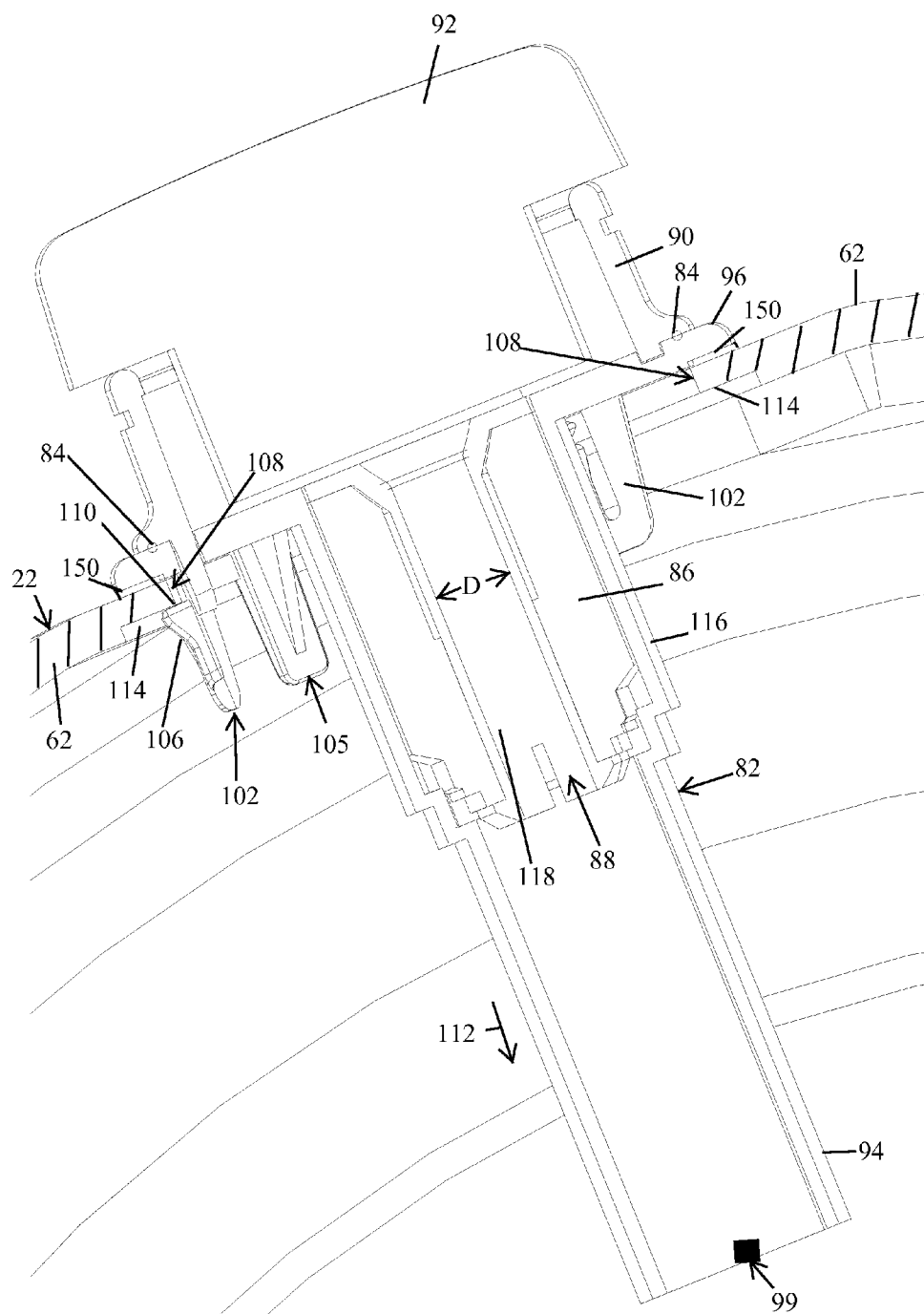


FIG. 11

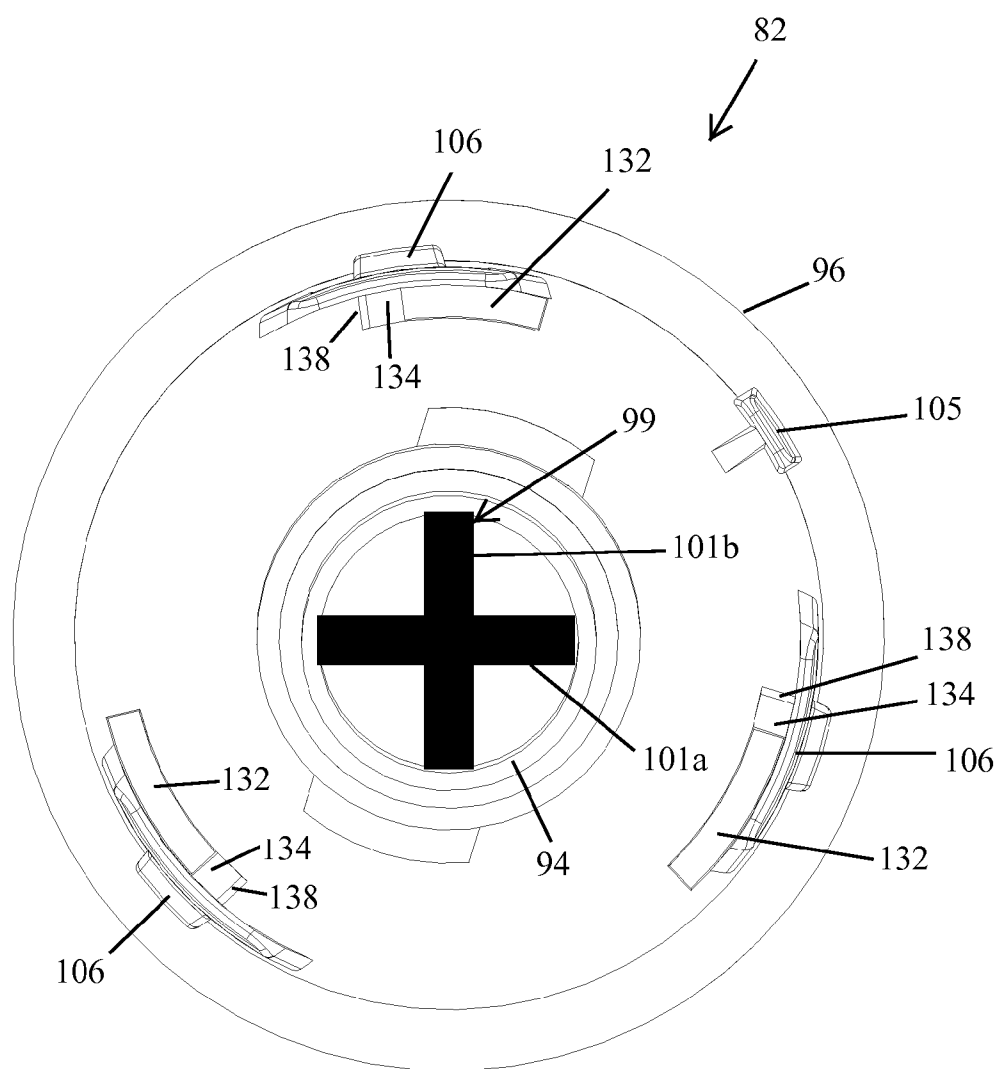


FIG. 11A

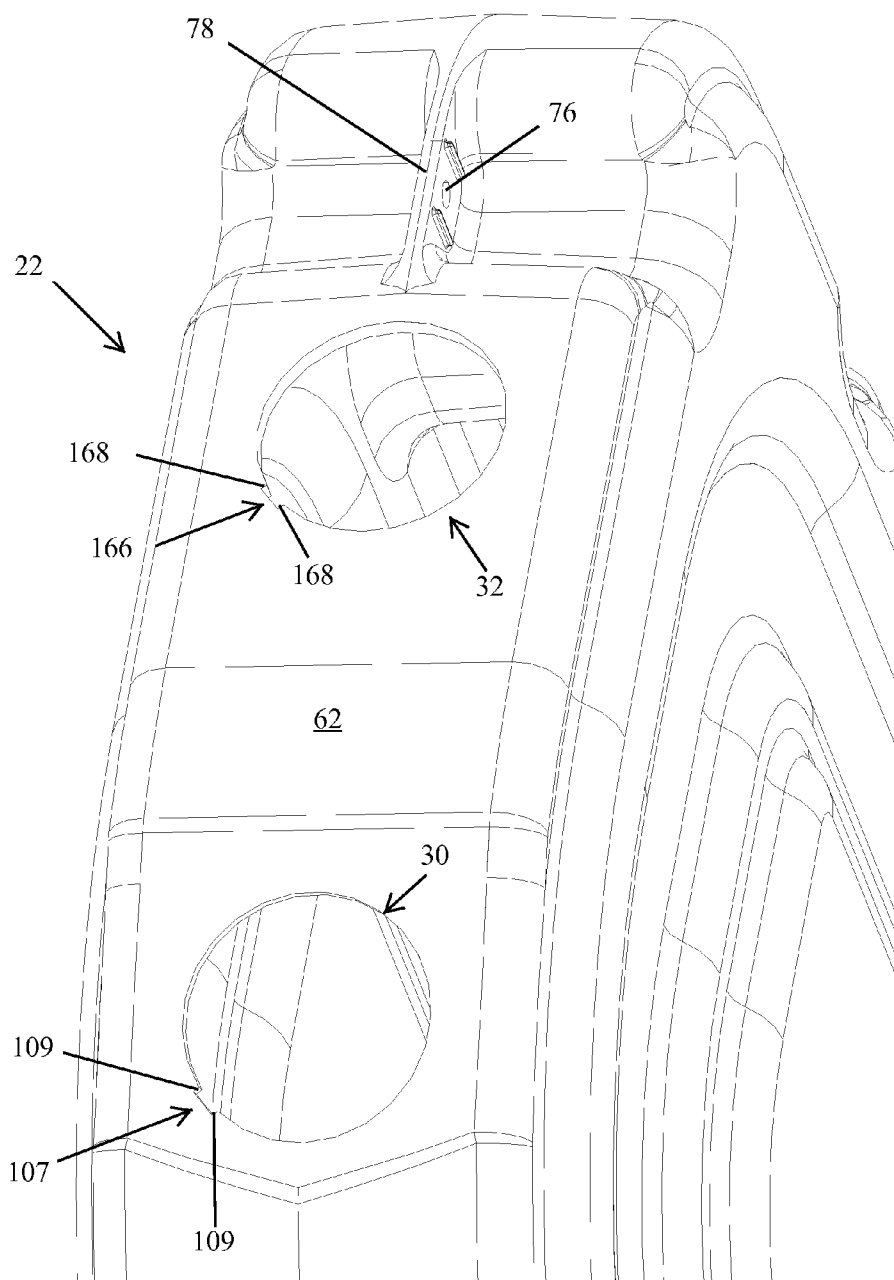


FIG. 12

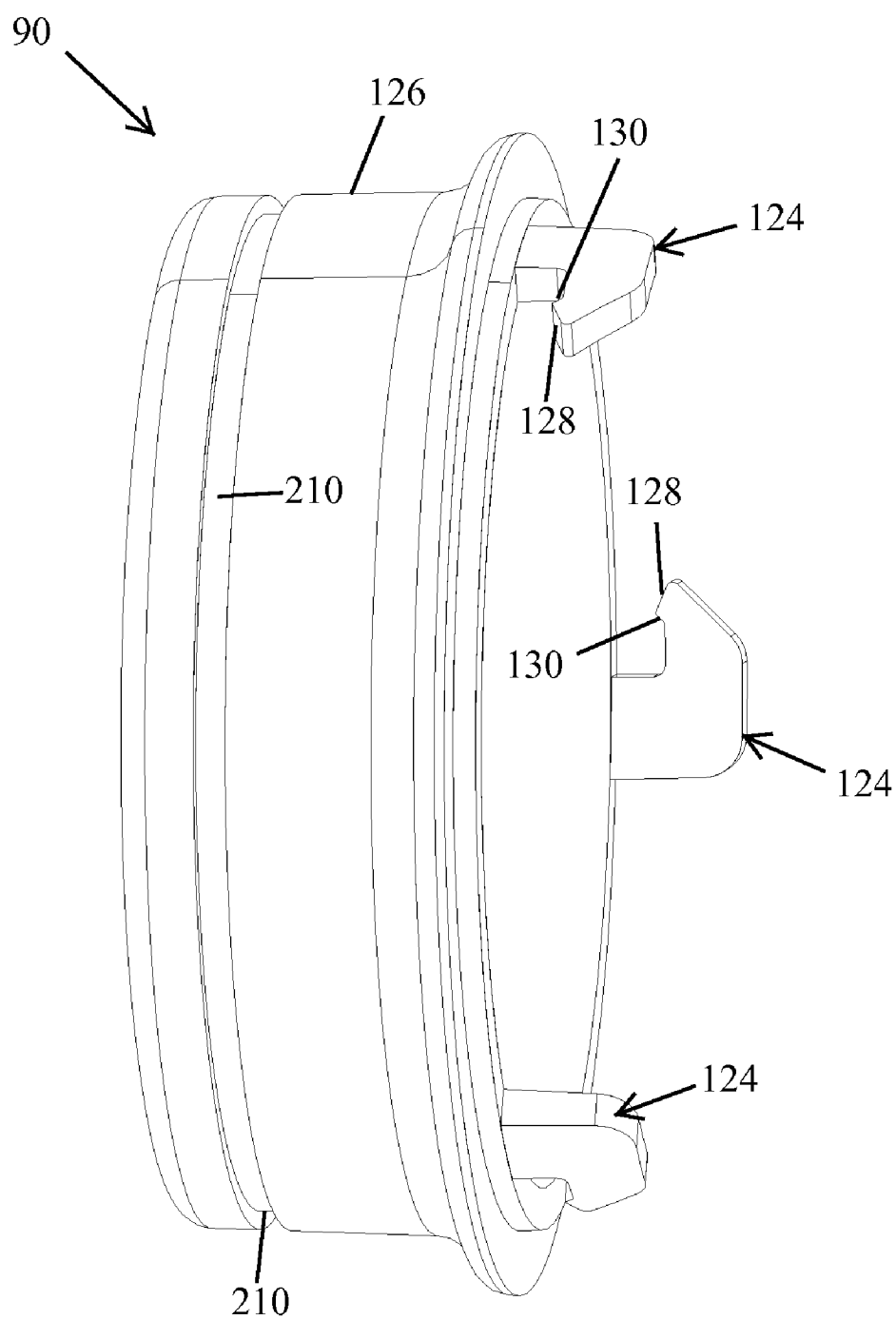


FIG. 13

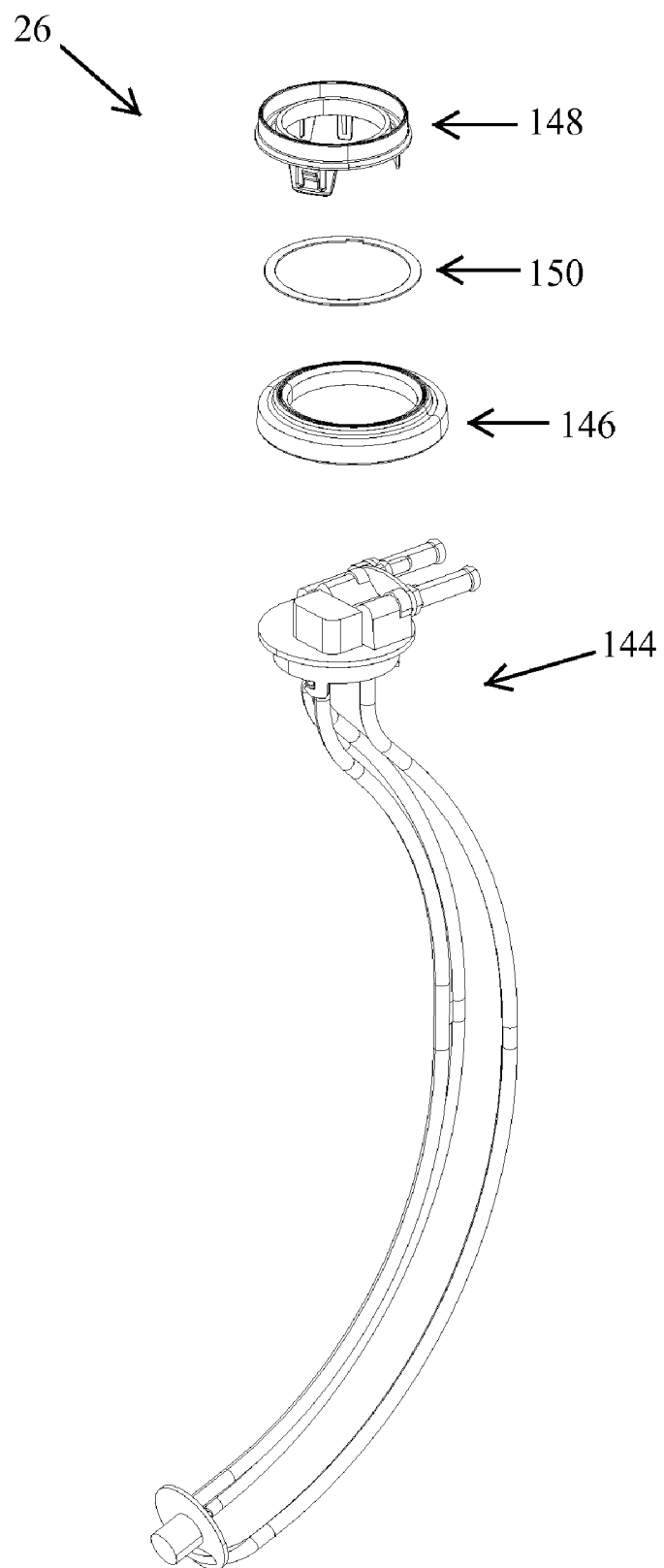


FIG. 14

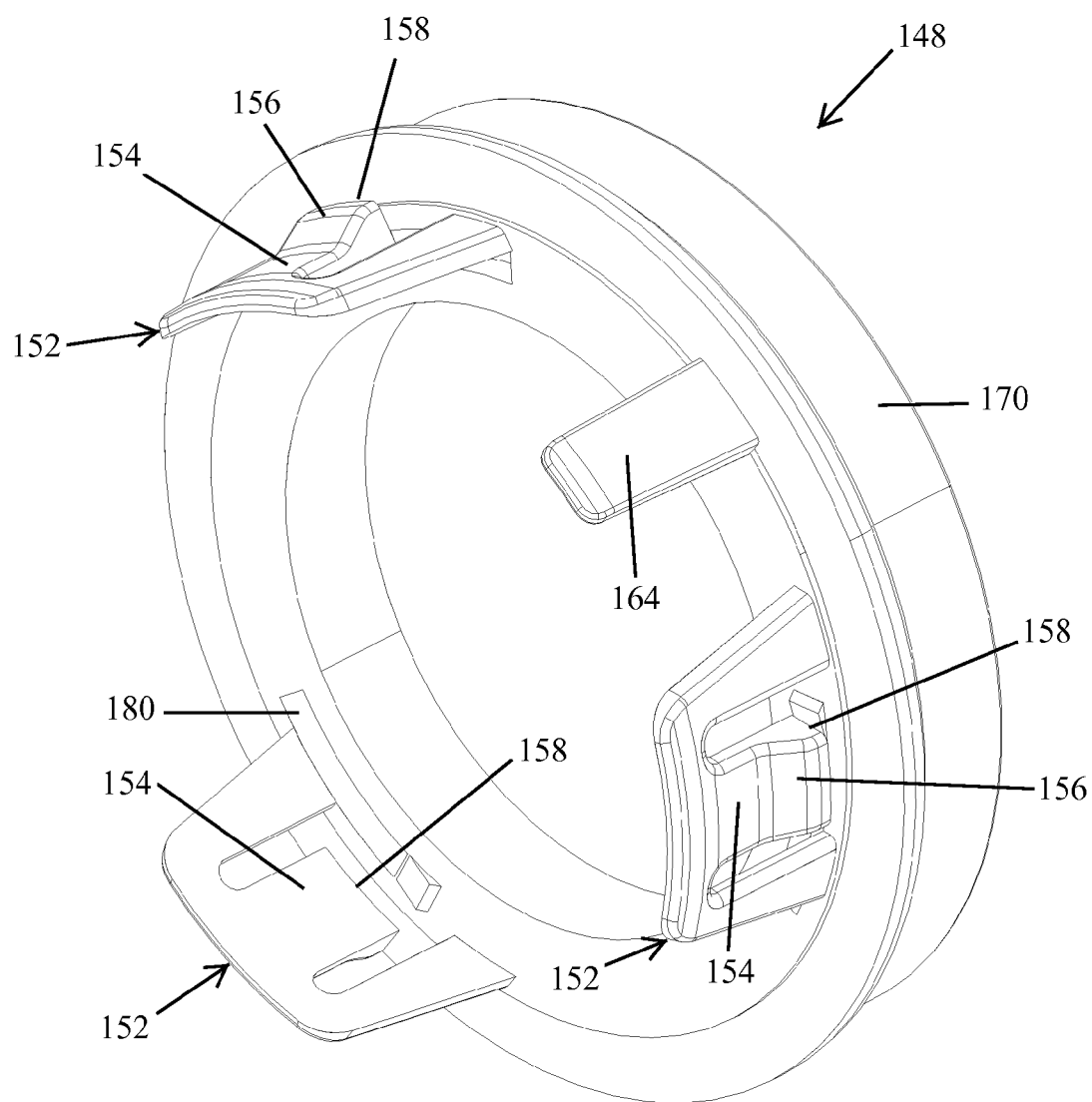


FIG. 15

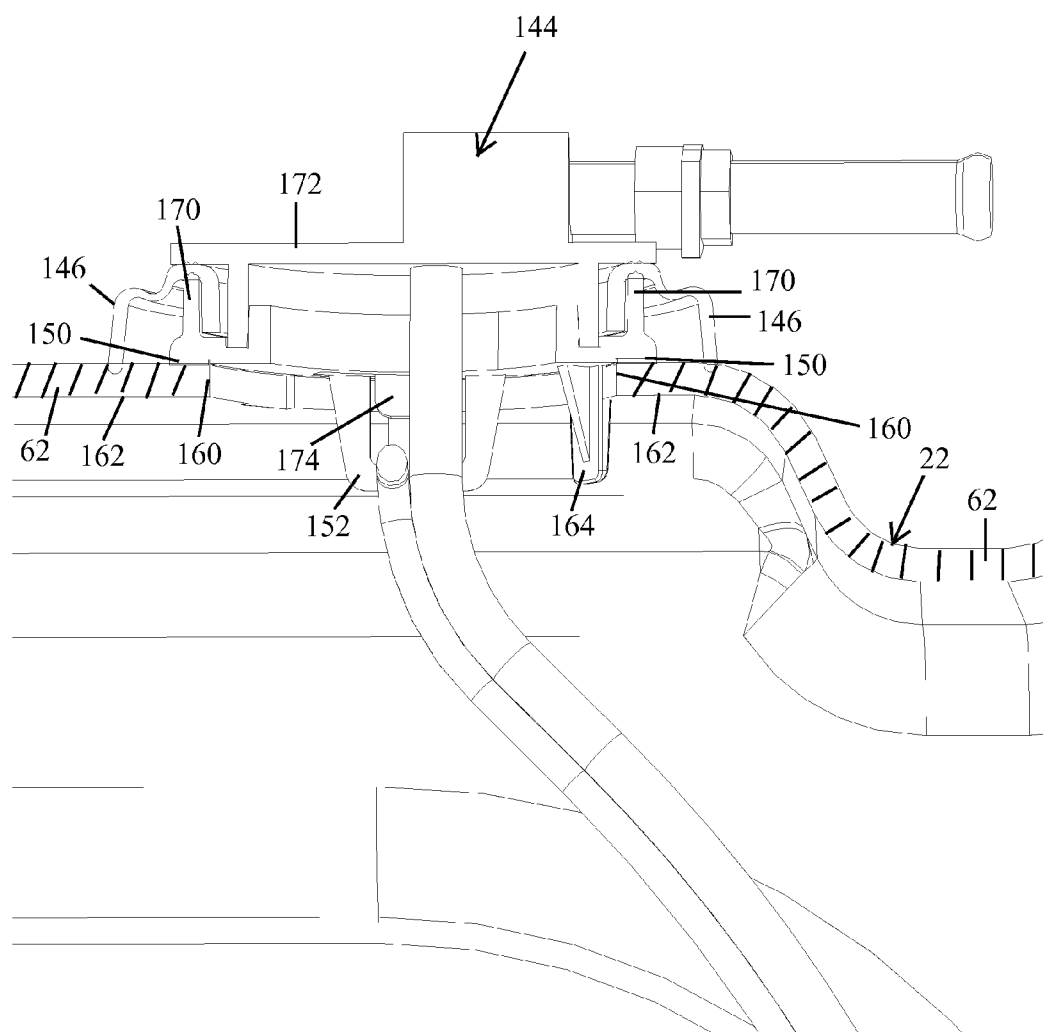


FIG. 16

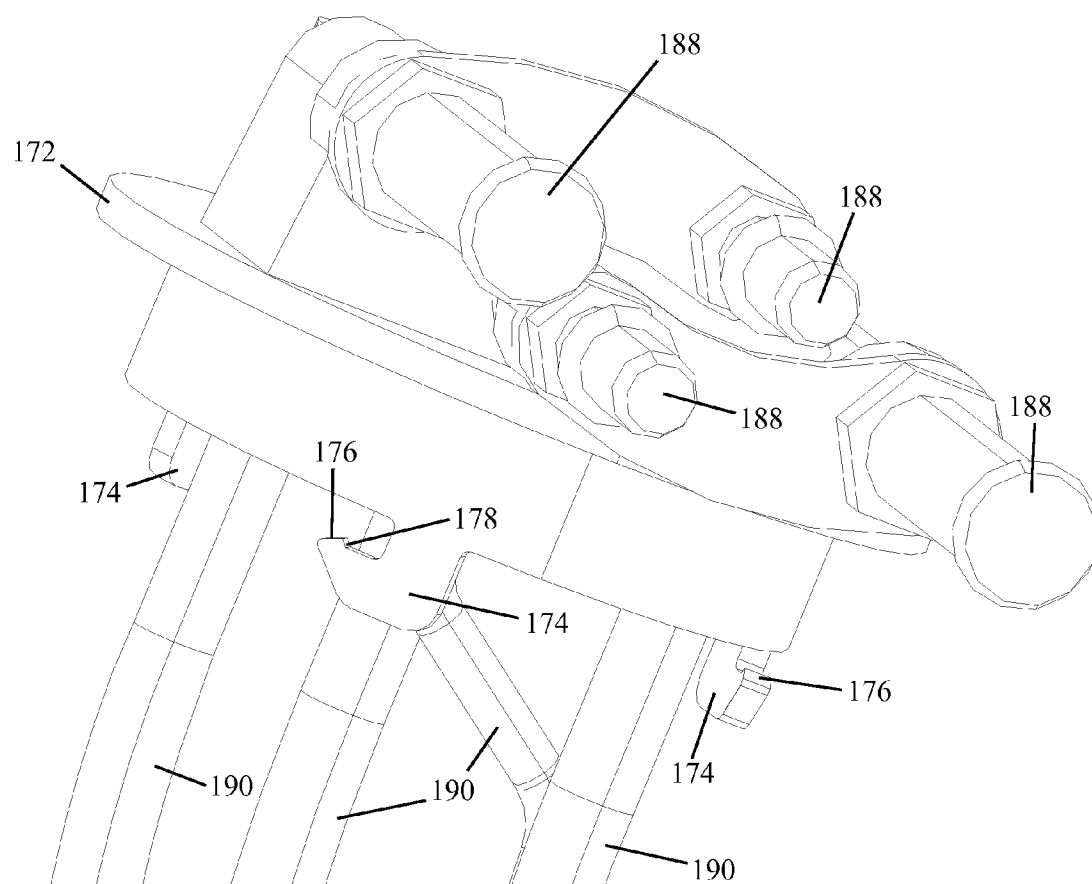


FIG. 17

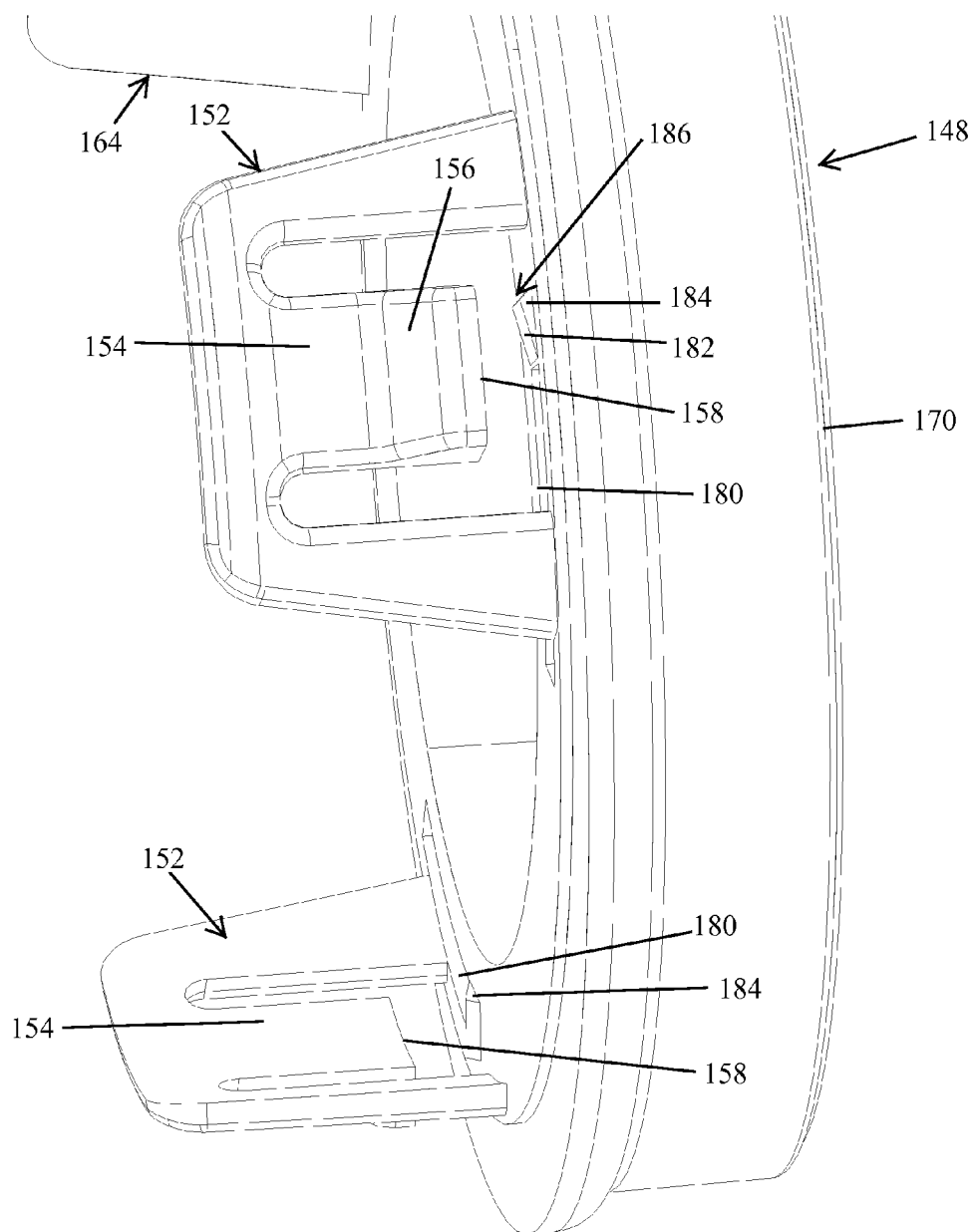


FIG. 18

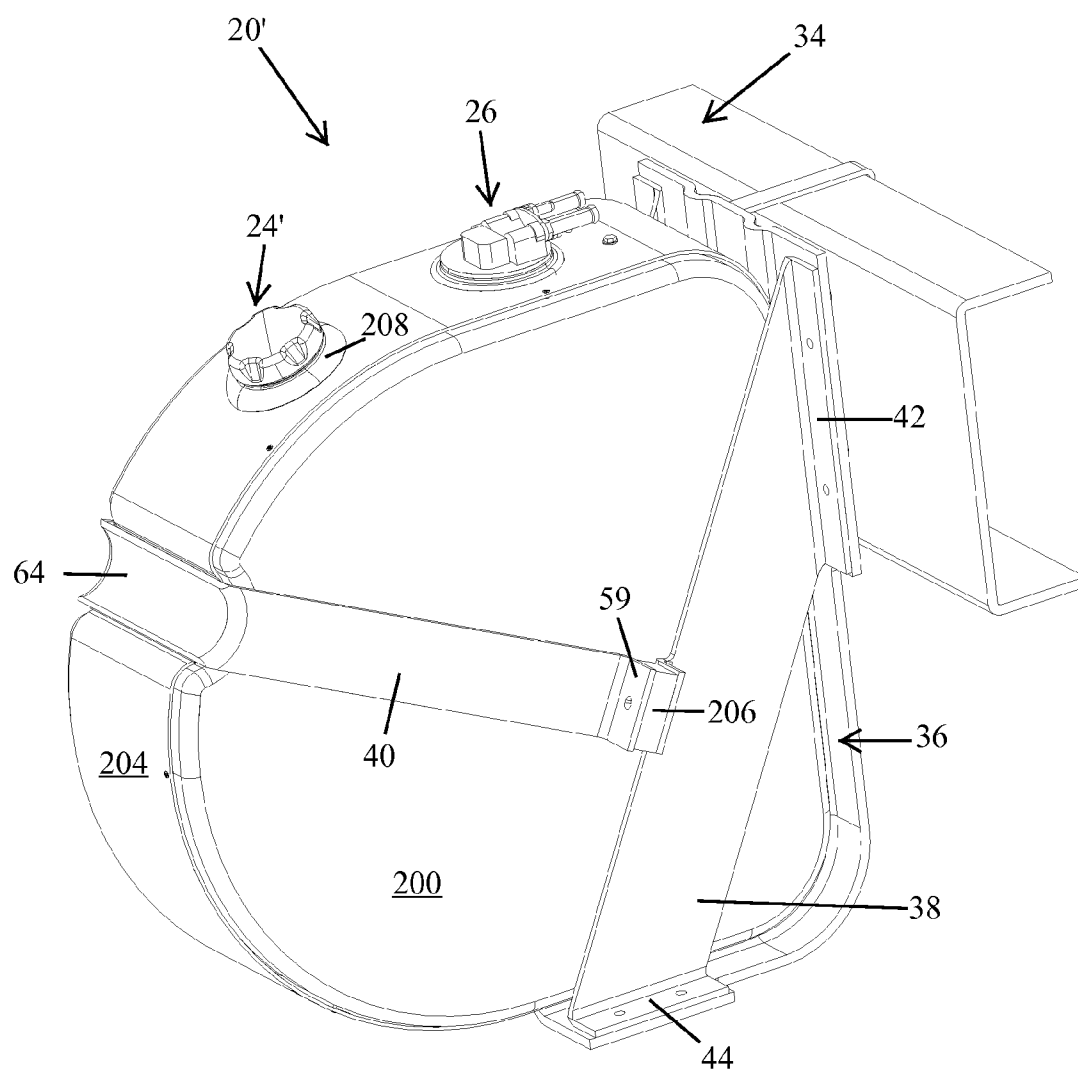


FIG. 19

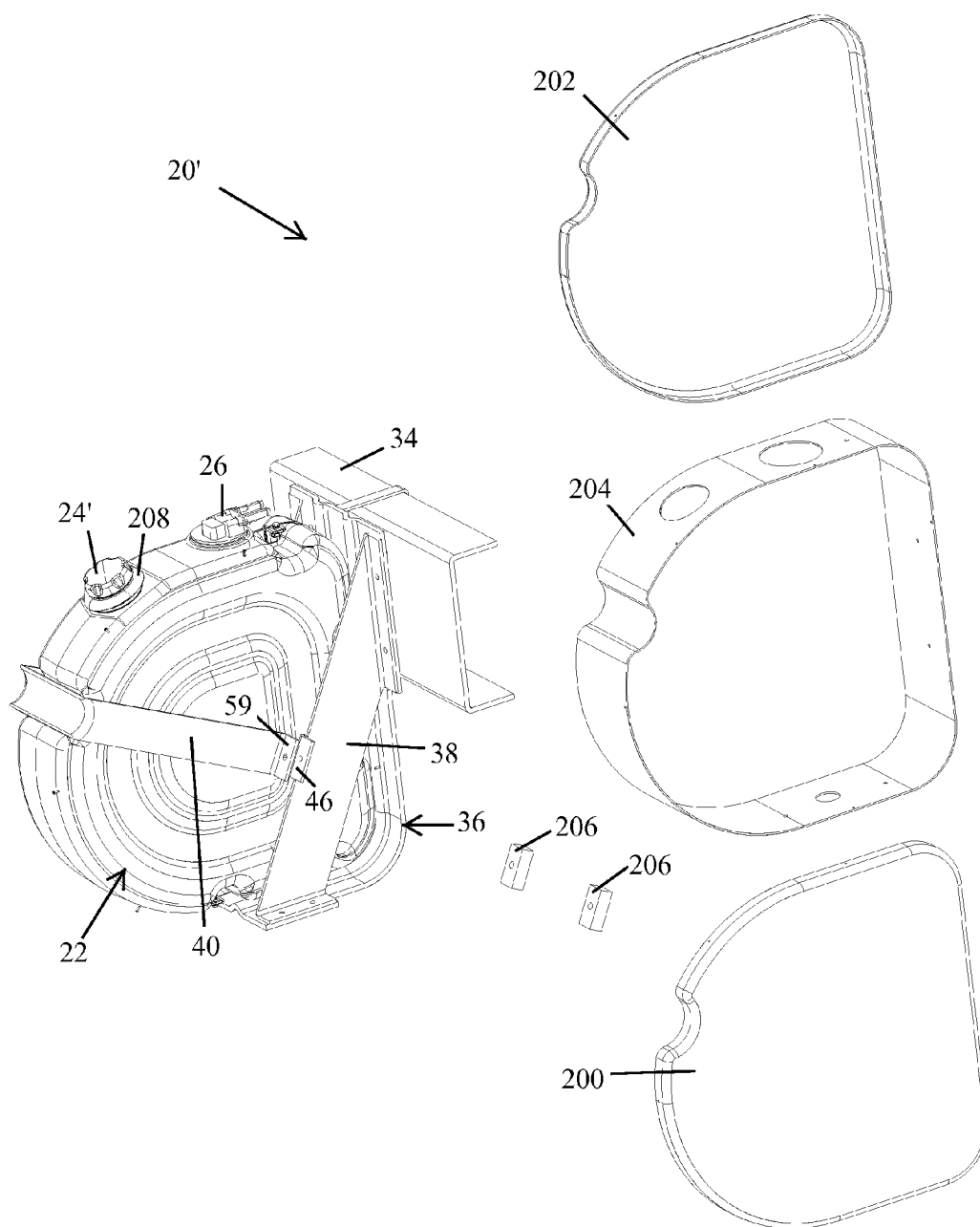


FIG. 20

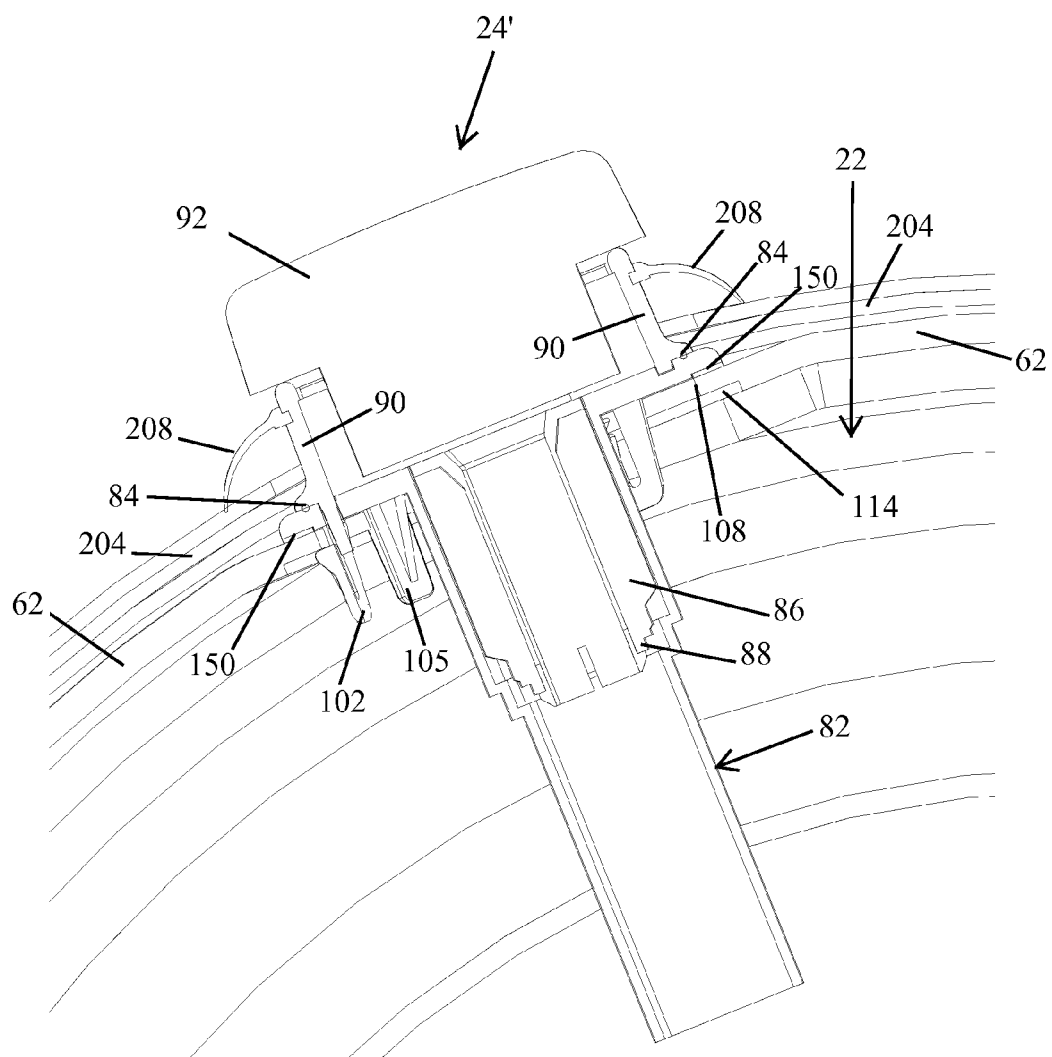


FIG. 21

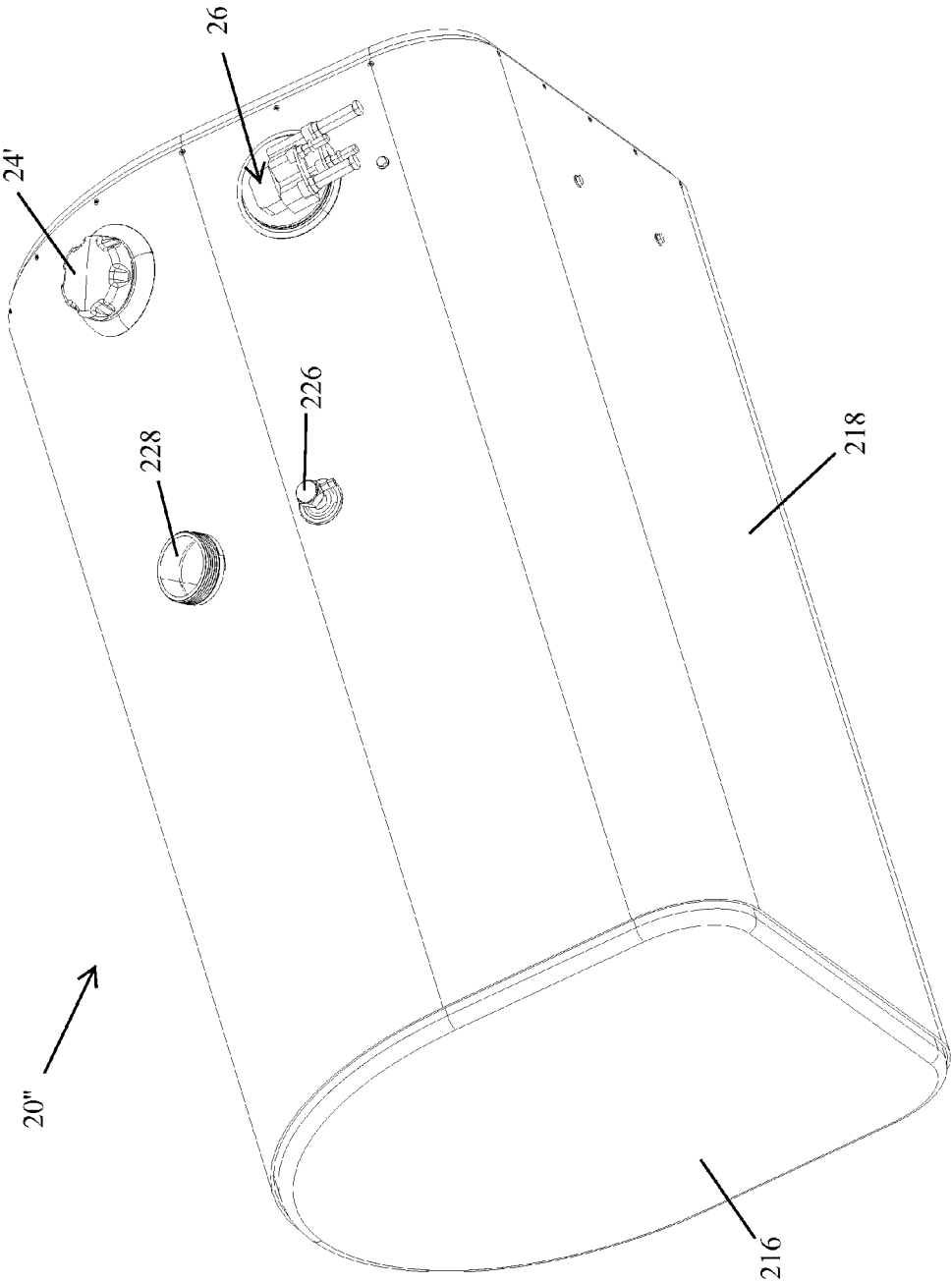


FIG. 22

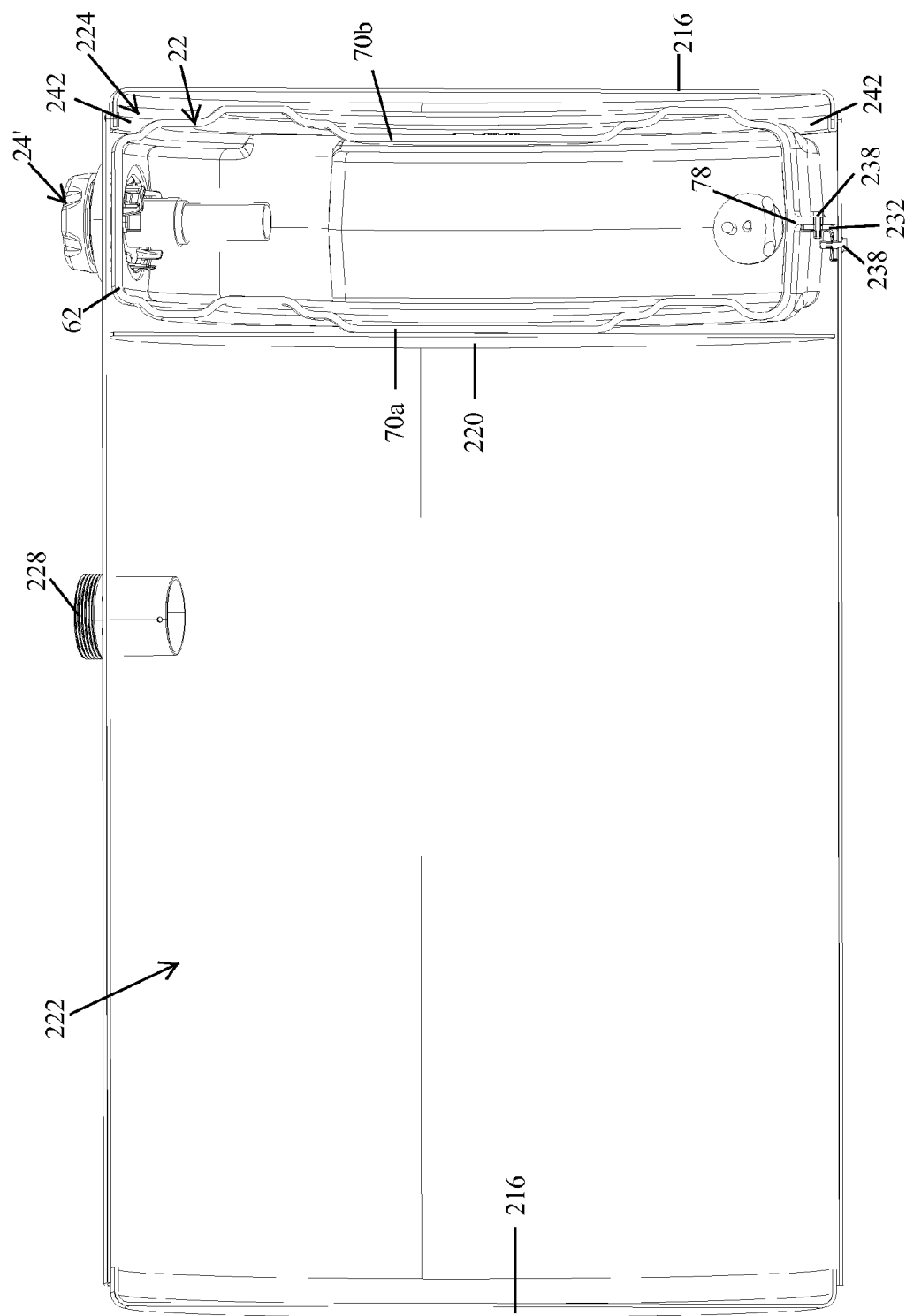
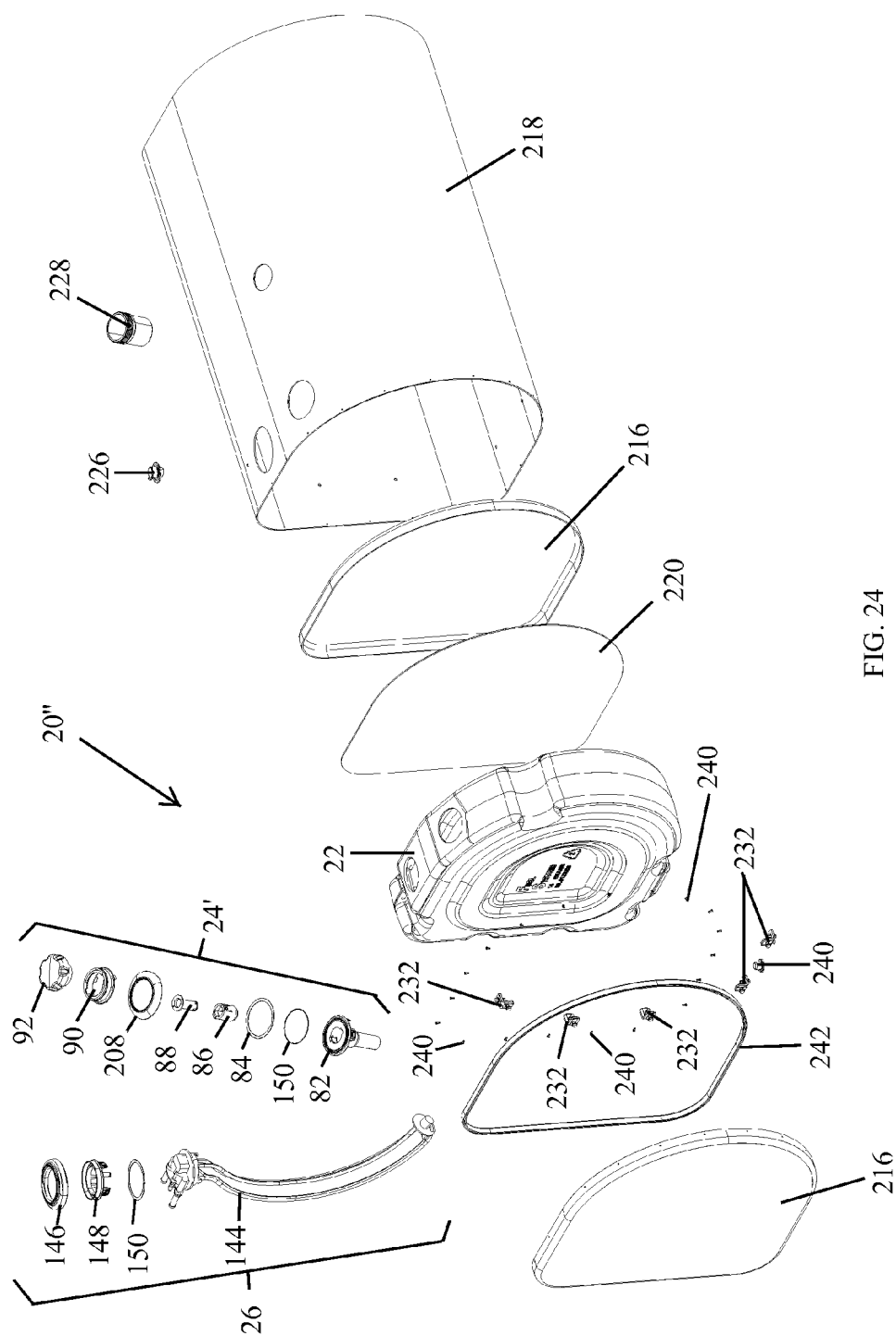


FIG. 23



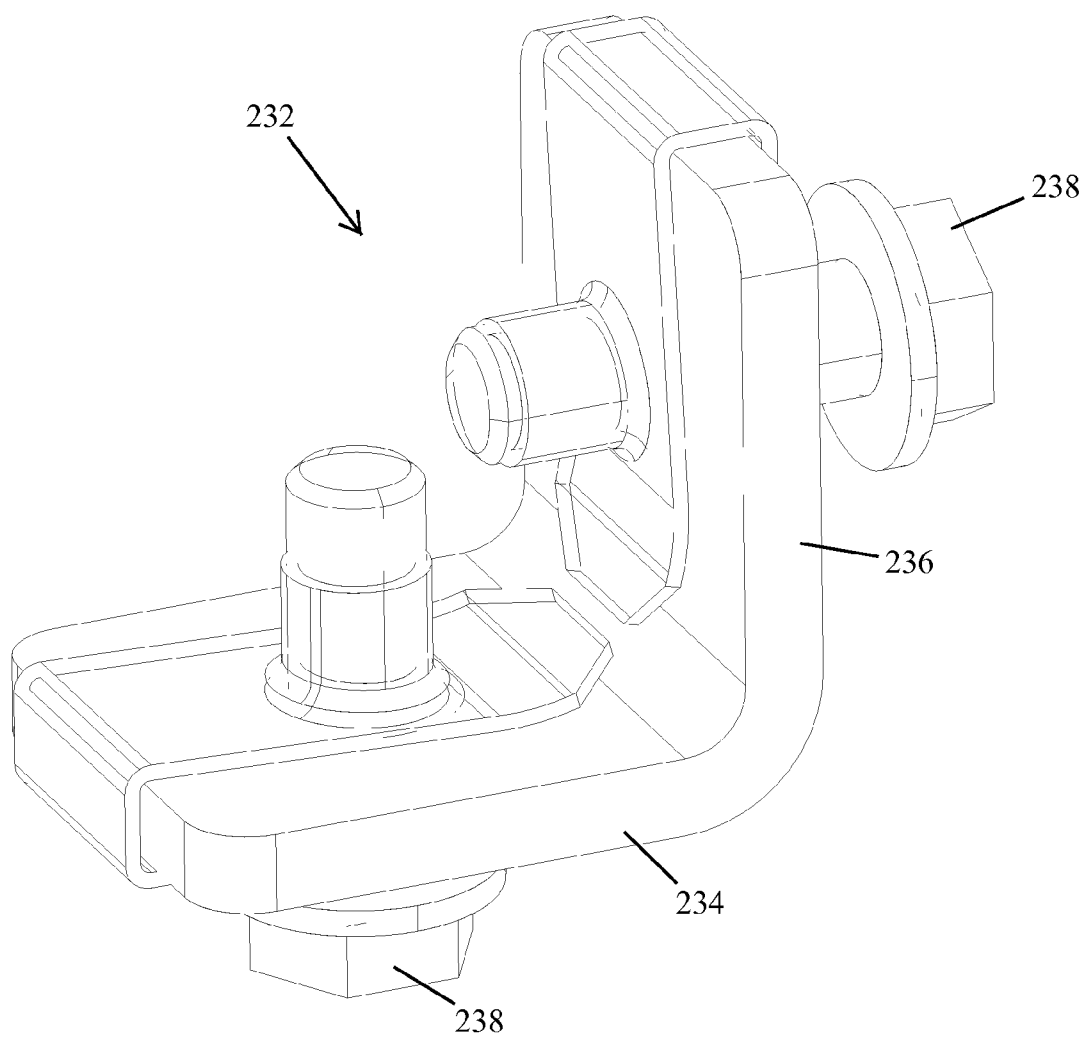


FIG. 25

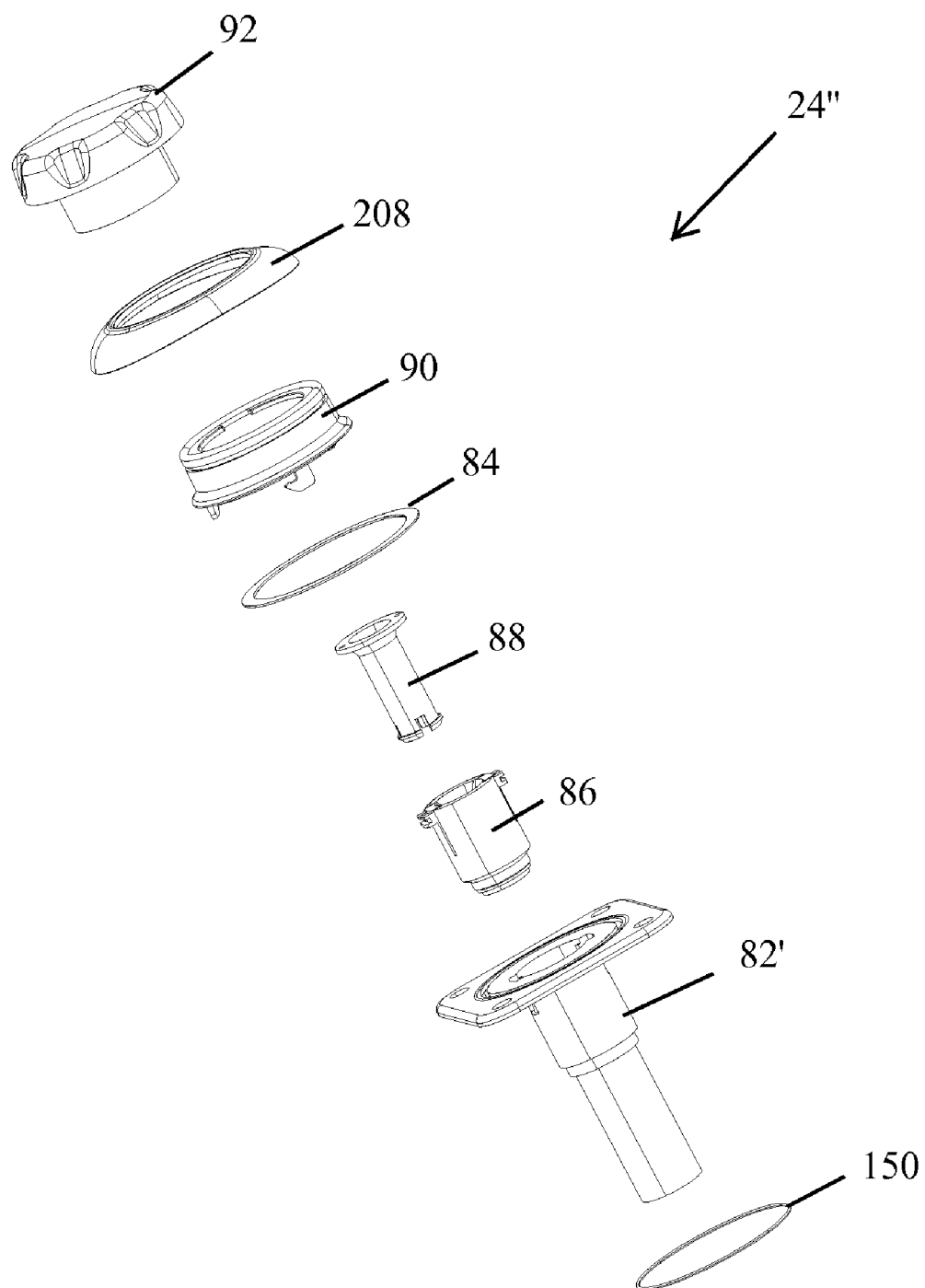


FIG. 26

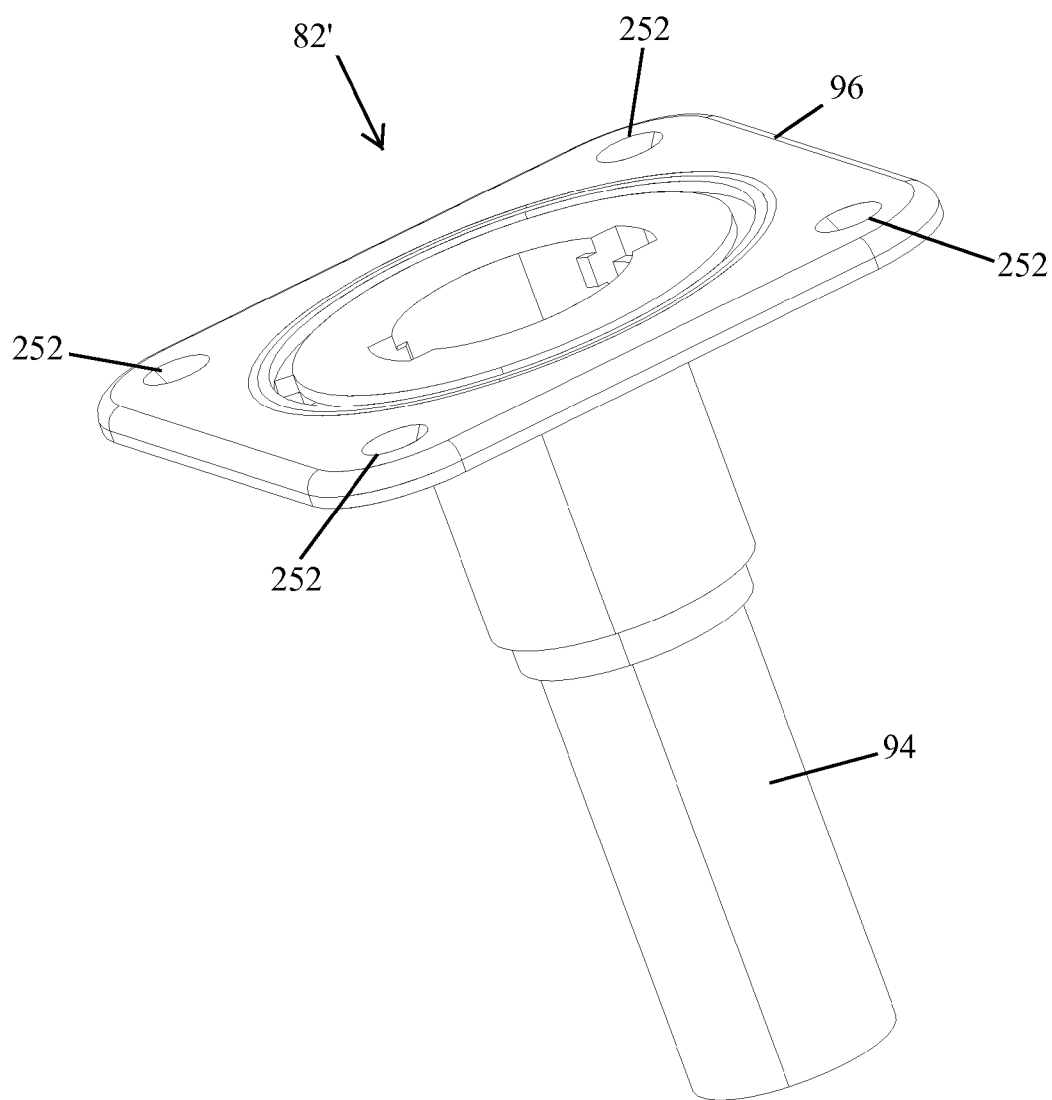


FIG. 27

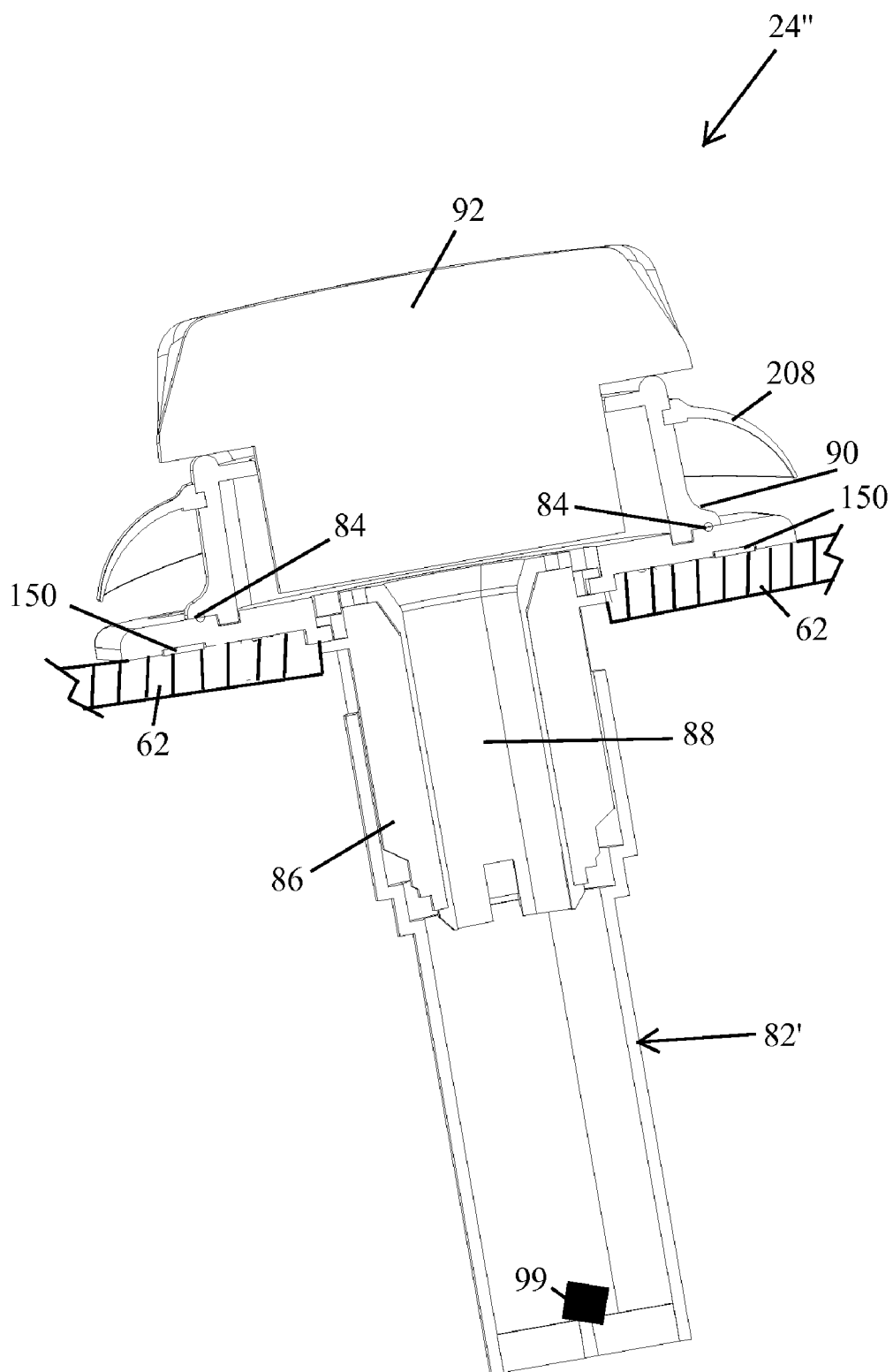


FIG. 28

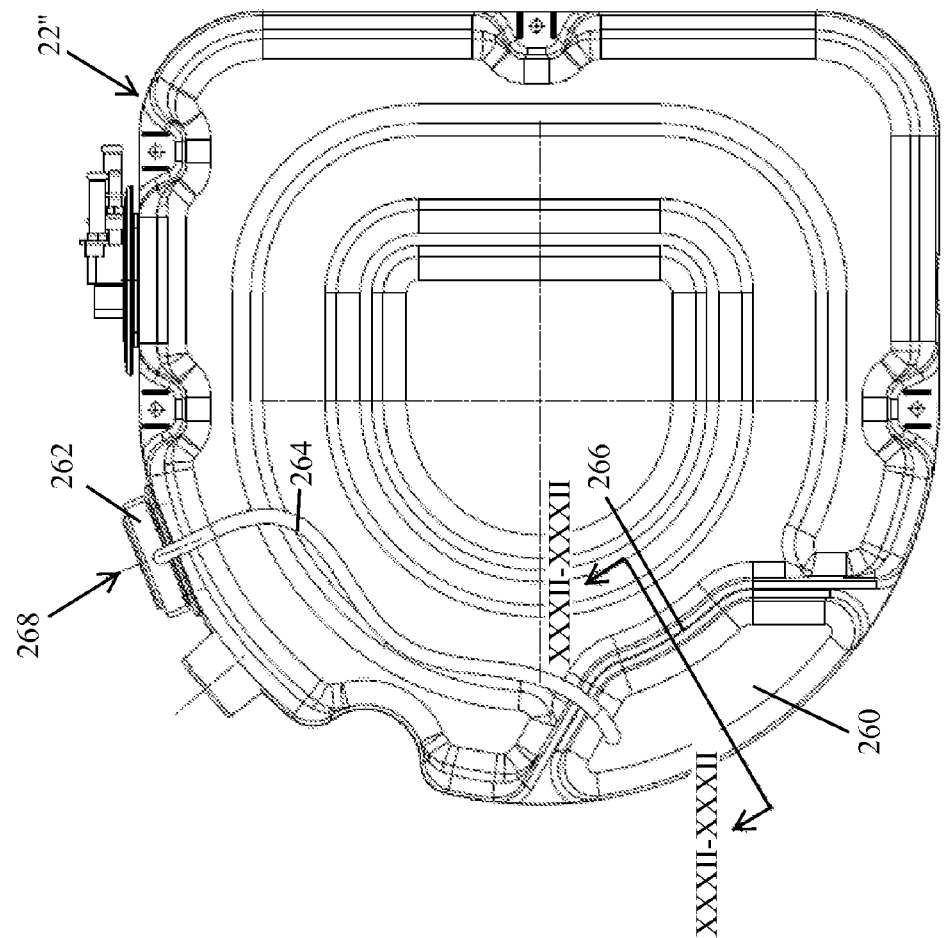


FIG. 30

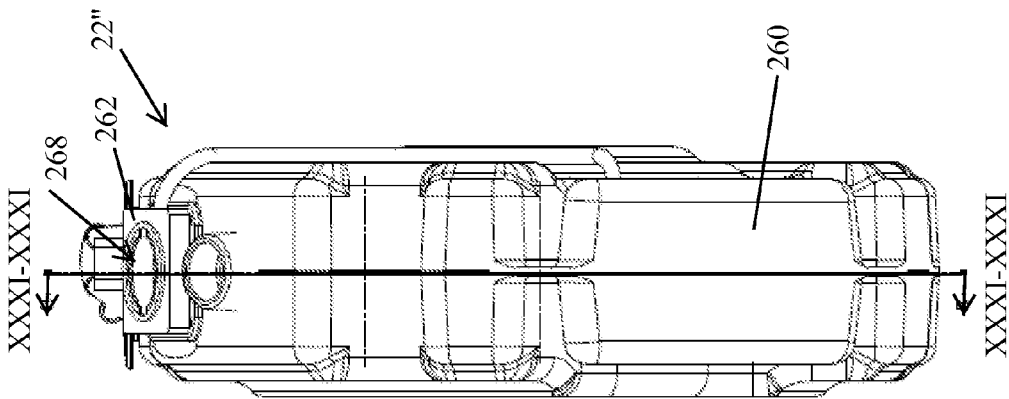


FIG. 29

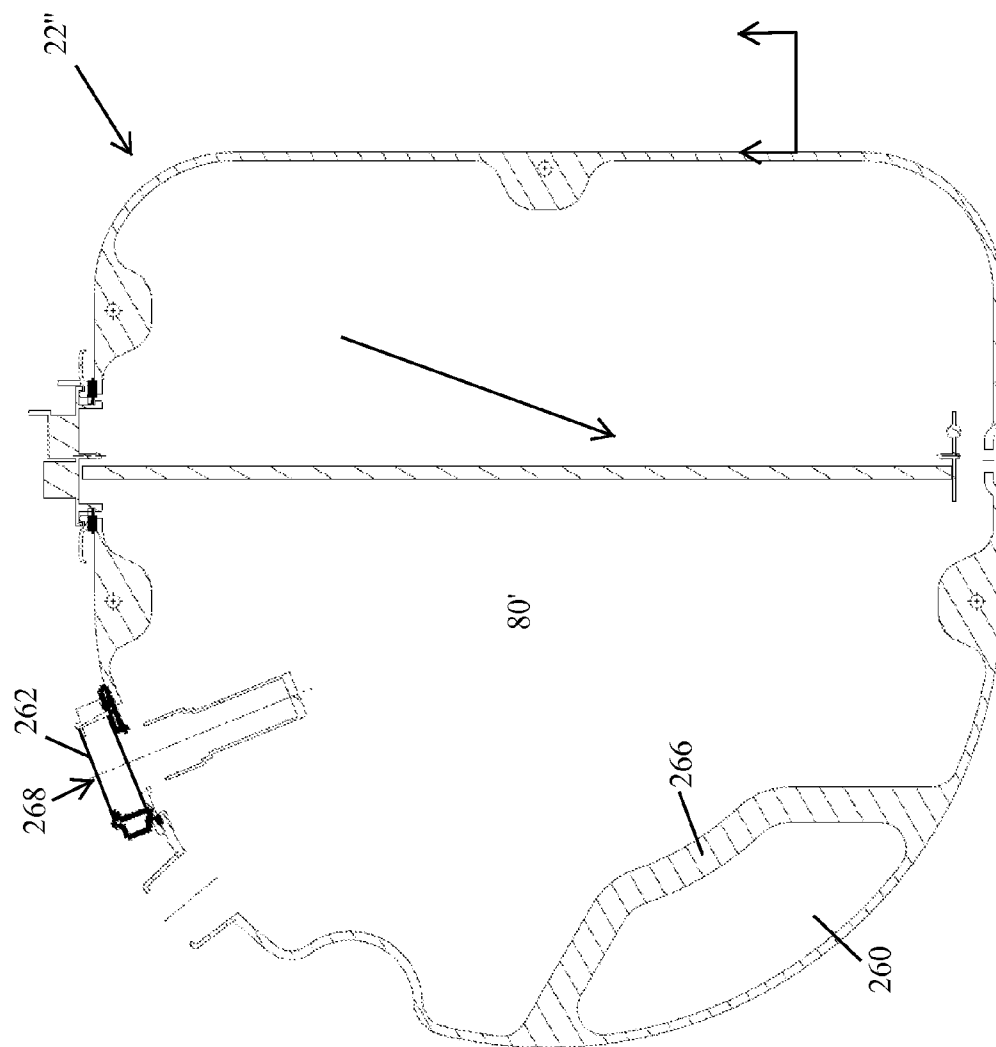


FIG. 31

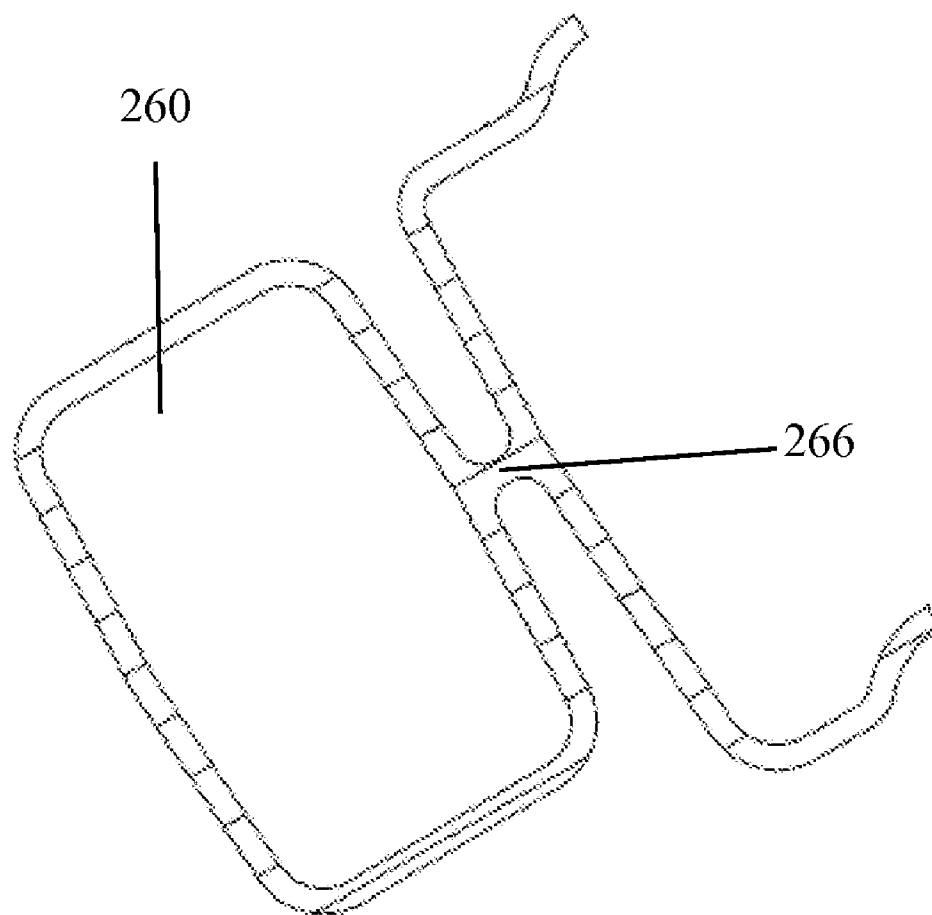


FIG. 32

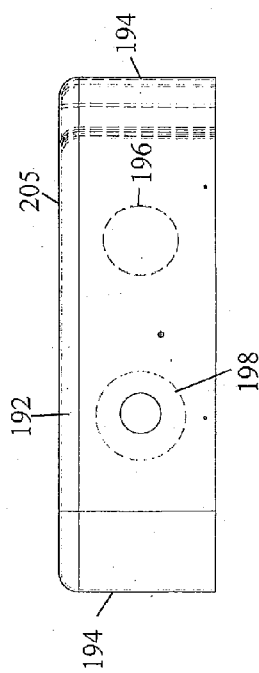


FIG. 35

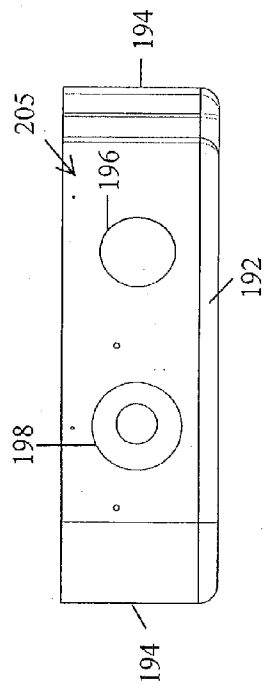


FIG. 36

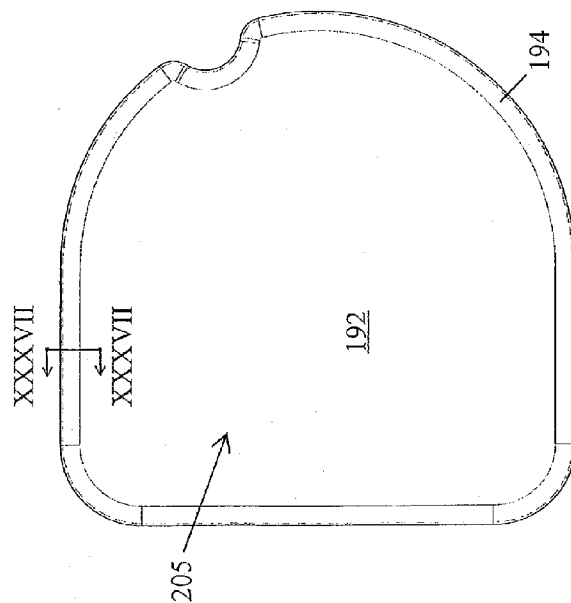


FIG. 33

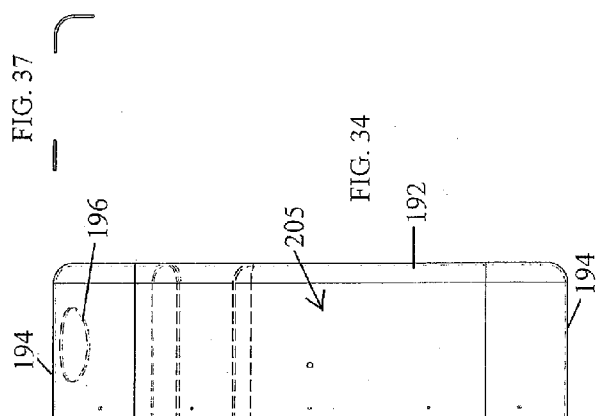


FIG. 34

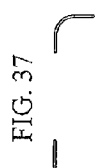


FIG. 37

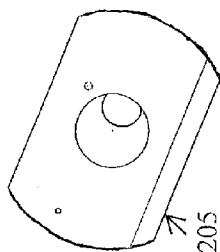


FIG. 38

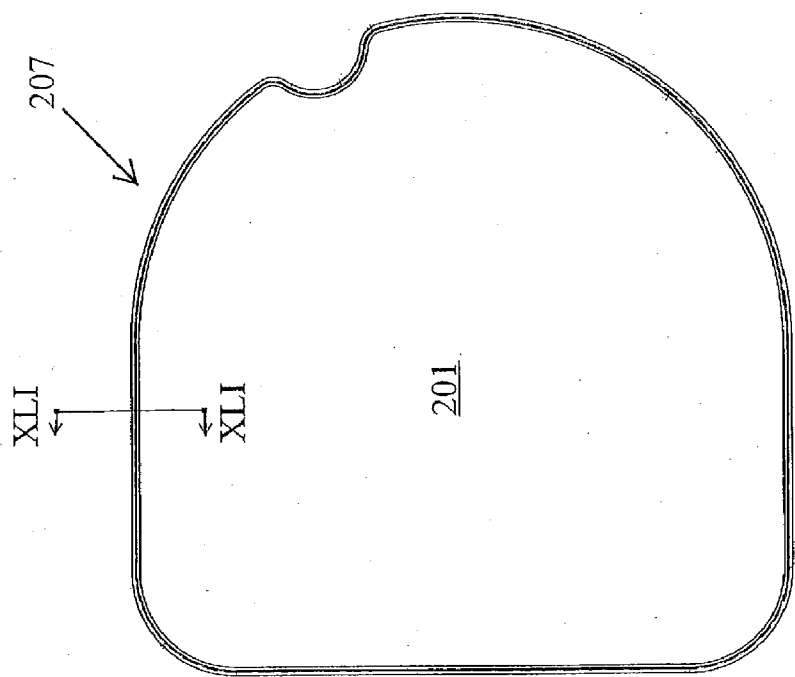


FIG. 39

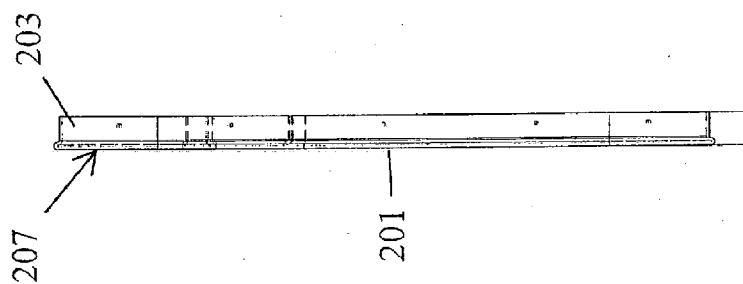


FIG. 40

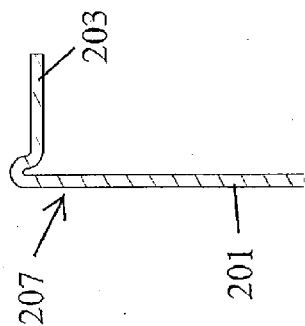


FIG. 41

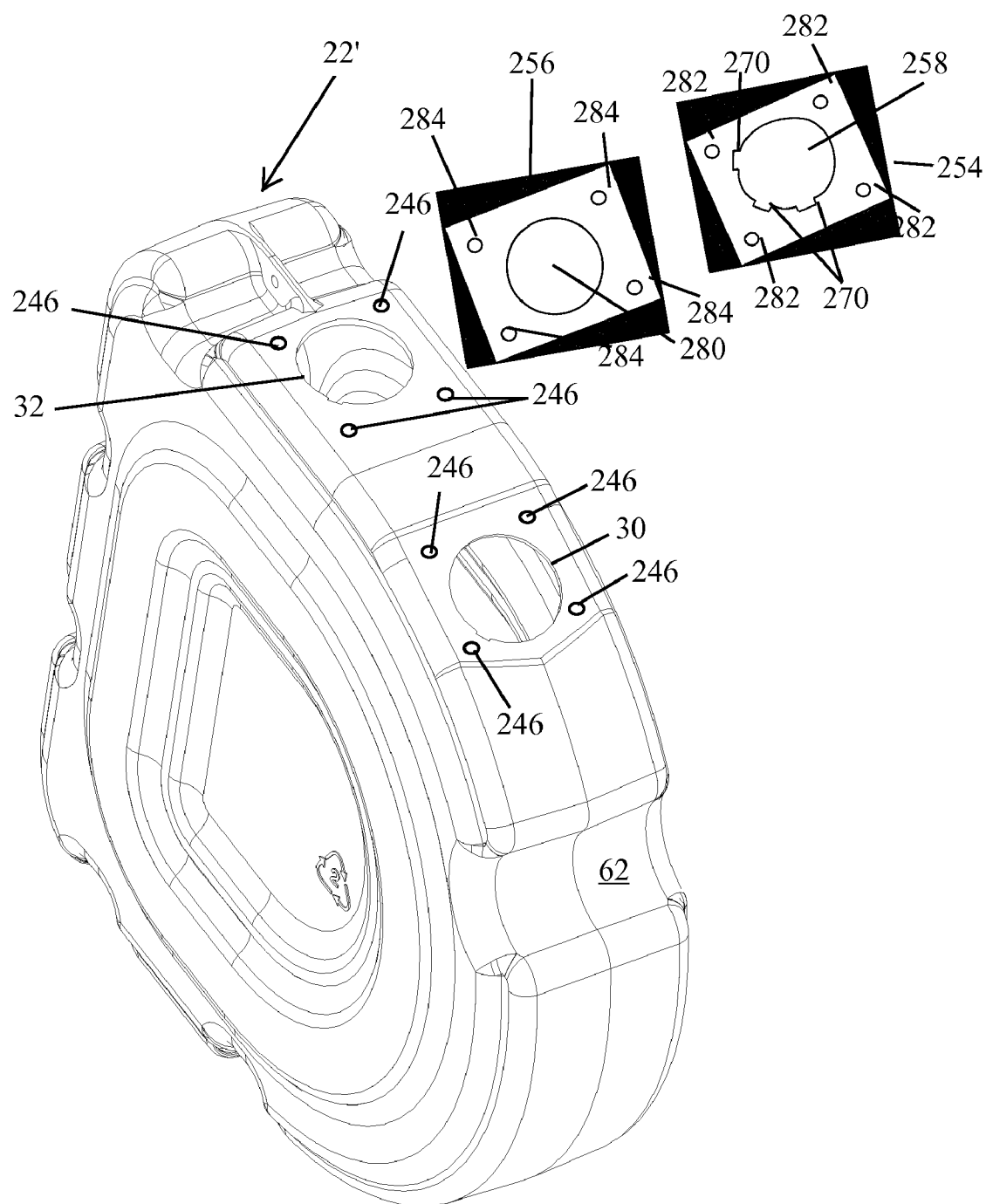


FIG. 42

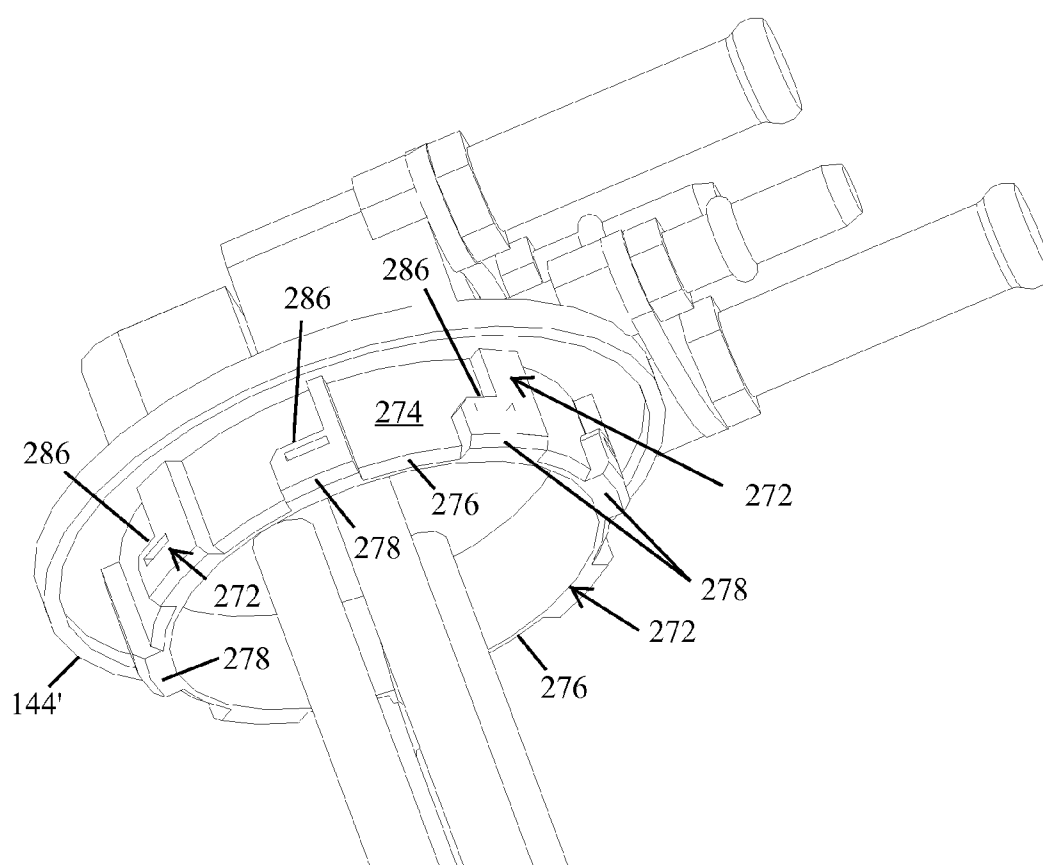


FIG. 43

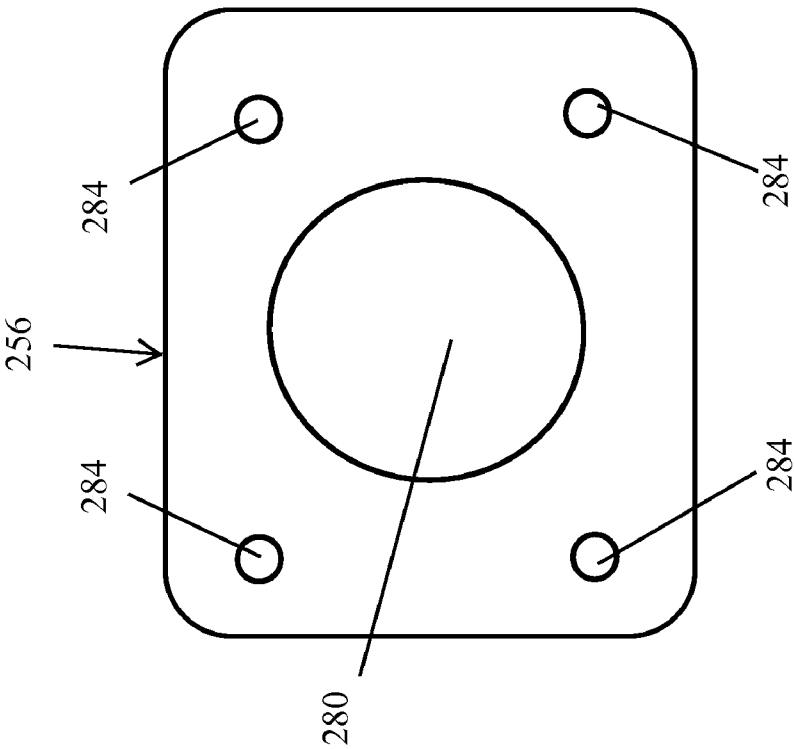


FIG. 45

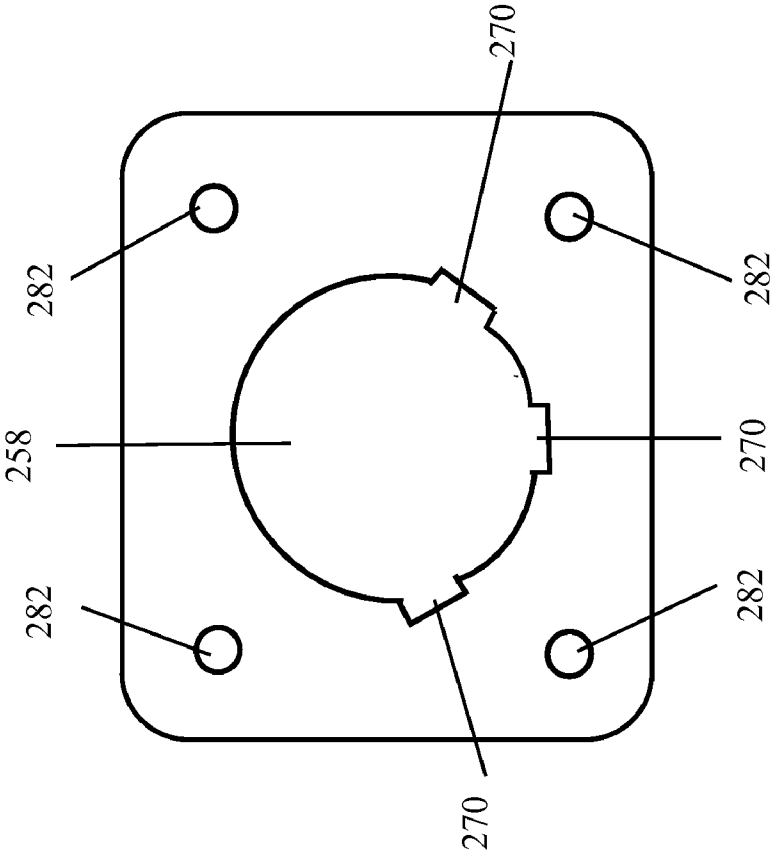


FIG. 44

UREA SOLUTION TANK ASSEMBLY

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to commonly-assigned, U.S. provisional application Ser. No. 61/012,484, filed Dec. 10, 2007 by applicants Robert H. Versaw Jr. et al. entitled UREA SOLUTION TANK ASSEMBLY, the complete disclosure of which is hereby incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] The present invention relates to tanks for storing urea solution, and more particularly to tanks that may be utilized in conjunction with a selective catalyst reduction (SCR) system that reduces the nitrogen oxide (NOx) emissions of a motorized vehicle.

[0003] Nitrogen oxides are one of the main components responsible for the generation of ground level ozone. They also contribute to the formation of acid rain, and have other deleterious side effects. The Environmental Protection Agency (EPA) tracks the emissions of nitrogen oxides, along with five other common pollutants, and sets national ambient air quality standards for NOx. NOx are primarily generated by the burning of fuels, such as by motor vehicles, electric utilities, or other sources.

[0004] One known method of reducing the amount of NOx emissions is to utilize a selective catalyst reduction process that uses a urea solution. For example, in a motor vehicle, the urea solution may be injected into the hot exhaust gas flow from the engine where it reduces the NOx by transforming it into nitrogen and water. In order to carry out the selective catalyst reduction process, urea solution must be stored and available for use by the SCR system.

SUMMARY OF THE INVENTION

[0005] The present invention relates to an improved container assembly for storing the urea solution that may be used in an SCR system for reducing NOx emissions. The SCR system may be part of a motorized vehicle, or it may be an SCR system used to reduce the NOx emissions of a stationary source. In at least one aspect, the container assembly of the present invention provides an economical system for storing urea solution that is durable enough to withstand the rigors of motorized vehicle transport, and that may be incorporated into the design of existing motorized vehicles with little or no disruption to the vehicle manufacturer's existing design.

[0006] According to one aspect of the present invention, a tank assembly is provided for storing both diesel fuel and urea solution. The tank assembly includes first and second chambers and a tank positioned within the second chamber. The first chamber is adapted to store diesel fuel and includes a first aperture for receiving diesel fuel. The second chamber is fluidly isolated from the first chamber but shares at least a first wall with the first chamber. The tank includes a first hole adapted to receive a urea solution which is aligned with a second aperture defined within the second chamber. The alignment of the first hole and second aperture allow urea solution to be delivered through the second aperture and the first hole into the tank.

[0007] According to another aspect of the present invention, a tank assembly for storing urea solution is provided. The tank assembly includes a tank having a first sidewall, a

second sidewall, and a perimeter wall. The second sidewall is spaced from the first sidewall, and the first and second sidewalls each generally define a first and second plane, respectively, wherein the first and second planes are parallel to each other. The perimeter wall connects the first and second sidewalls together. The first wall further includes an indentation having a first shape, and the second wall includes a projection having a second shape. The second shape substantially matches the first shape such that the projection on a first one of the tanks may be inserted into the indentation on a second one of the tanks when a plurality of the tanks are stacked on top of each other. This stacking arrangement helps resist movement of the stacked tanks in any direction parallel to the first plane.

[0008] According to another aspect of the present invention, a tank assembly is provided. The tank assembly includes a tank adapted for storing urea solution, a reservoir fluidly isolated from the tank, a sensing unit, and a switch. The tank includes an aperture for receiving urea solution. The sensing unit is positioned adjacent the aperture and adapted to detect a quality of the urea solution being delivered to the aperture. The switch is adapted to direct the urea solution to the reservoir if the sensing unit determines that the quality of the urea solution does not conform to a predetermined standard. The switch is further adapted to allow the urea solution to enter the tank if the sensing unit determines the quality of the urea solution does conform to the predetermined standard.

[0009] According to yet another aspect of the present invention, a tank assembly for storing urea solution is provided. The tank assembly includes a tank, an L-shaped bracket, a plurality of side brackets, and a strap. The tank includes a first sidewall, a second sidewall, and a perimeter wall. The second sidewall is spaced from the first sidewall, and the first and second sidewalls each generally define planes that are parallel to each other. The perimeter wall connects the first and second sidewalls together. The L-shaped bracket is adapted to be secured to a motor vehicle. The side brackets are adapted to be secured to the L-shaped bracket. The strap is adapted to be secured to the side brackets in a recess defined in the perimeter wall of the tank. The recess is shaped to receive a portion of the strap whereby the strap and the recess cooperate to secure the tank to the L-shaped bracket and the side brackets.

[0010] According to still other aspects of the present invention, the tank may include one or more recesses allowing it to be secured to a vehicle via a strap, as well as a plurality of fastener holes allowing it to be secured to the vehicle via fasteners, thereby allowing the same tank to be mounted to the vehicle in different configurations. The tank may be made from molded plastic, and it may be positioned within an enclosure defined by a metal front cover and a metal rear cover that are connected together via a metal hoop. Alternatively, the enclosure may be designed as a two-piece structure having a first part with an integrated front and perimeter wall that fully encompasses the molded tank on three sides, and a second part that attaches to the first part and covers the fourth side of the tank. The switch may utilize a solenoid and the reservoir into which the urea solution is directed when its quality does not meet a predetermined standard may be integrally molded as part of the tank.

[0011] The various aspects of the present invention provide an advantageous storage solution for storing liquid catalysts, such as a urea solution. The storage solution is designed to be robust, easily manufactured, and able to be integrated into

existing vehicles such that manufacturers of vehicles will be able to implement SCR systems into their vehicles with minimal impact from the necessity of storing urea solution on the vehicle. These and other aspects of the present invention will be apparent to one skilled in the art in light of the following written description and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. 1 is a perspective view of a tank assembly according to a first embodiment of the present invention;
 [0013] FIG. 2 is a perspective, exploded view of the tank assembly of FIG. 1;
 [0014] FIG. 3 is a perspective, exploded view of a bracket system of the tank assembly of FIG. 1;
 [0015] FIG. 4 is a perspective view of a tank of the tank assembly of FIG. 1;
 [0016] FIG. 5 is a side, elevational view of the tank of FIG. 4;
 [0017] FIG. 6 is a vertical, cross-sectional view of the tank assembly of FIG. 1 illustrating several interior components of the tank;
 [0018] FIG. 7 is an exploded, perspective view of a filler tube assembly of the tank assembly of FIG. 1;
 [0019] FIG. 8 is a perspective view of a retainer of the filler tube assembly of FIG. 7;
 [0020] FIG. 9 is an elevational view of the retainer of FIG. 8;
 [0021] FIG. 10 is a close-up elevational view of the retainer of FIG. 8;
 [0022] FIG. 11 is a cross-sectional view of the filler tube assembly of FIG. 7 shown attached to a perimeter wall of the tank;
 [0023] FIG. 11A is a plan view of the retainer of FIG. 8;
 [0024] FIG. 12 is a perspective view of the tank of FIG. 1 illustrating first and second apertures defined within the tank;
 [0025] FIG. 13 is an elevational view of a shroud of the filler tube assembly of FIG. 7;
 [0026] FIG. 14 is an exploded, perspective view of a sensor unit assembly of the tank assembly of FIG. 1;
 [0027] FIG. 15 is a perspective view of a retainer of the sensor unit assembly of FIG. 14;
 [0028] FIG. 16 is a sectional view of the sensor unit assembly of FIG. 14 shown attached to a perimeter wall of the tank;
 [0029] FIG. 17 is a perspective view of a portion of a sensor unit of the sensor unit assembly of FIG. 14;
 [0030] FIG. 18 is a close-up, perspective view of the retainer of FIG. 15;
 [0031] FIG. 19 is a perspective view of a tank assembly according to alternative embodiment of the present invention;
 [0032] FIG. 20 is a perspective, exploded view of the tank assembly of FIG. 19;
 [0033] FIG. 21 is a sectional view of a filler tube assembly of the tank assembly of FIG. 19;
 [0034] FIG. 22 is a perspective view of a tank assembly according to another alternative embodiment of the present invention;
 [0035] FIG. 23 is a sectional view of the tank assembly of FIG. 22;
 [0036] FIG. 24 is a perspective, exploded view of the tank assembly of FIG. 22;
 [0037] FIG. 25 is a perspective view of an L-bracket;
 [0038] FIG. 26 is an exploded, perspective view of an alternative filler tube assembly;

[0039] FIG. 27 is a perspective view of a retainer of the filler tube assembly of FIG. 26;

[0040] FIG. 28 is a sectional view of the filler tube assembly of FIG. 26 shown with its components assembled together;

[0041] FIG. 29 is a front, elevational view of a tank according to another embodiment of the invention;

[0042] FIG. 30 is a side, elevational view of the tank of FIG. 29;

[0043] FIG. 31 is a sectional view of the tank of FIG. 29 taken along the line XXXI-XXXI;

[0044] FIG. 32 is a sectional view of the tank of FIG. 30 taken along the line XXXII-XXXII;

[0045] FIG. 33 is a side, elevational view of a tank enclosure body;

[0046] FIG. 34 is a front, elevational view of the tank enclosure body of FIG. 33;

[0047] FIG. 35 is a bottom view of the tank enclosure body of FIG. 33;

[0048] FIG. 36 is a top view of the tank enclosure body of FIG. 33;

[0049] FIG. 37 is a sectional view of the tank enclosure body of FIG. 33 taken along the line XXXVII-XXXVII in FIG. 33;

[0050] FIG. 38 is an enlarged view of the area labeled C in FIG. 33;

[0051] FIG. 39 is a side, elevational view of a tank enclosure end cap that may be attached to the tank enclosure body of FIG. 33;

[0052] FIG. 40 is a front, elevational view of the end cap of FIG. 39;

[0053] FIG. 41 is a sectional view of the end cap of FIG. 39 taken along the line XLI-XLI of FIG. 39;

[0054] FIG. 42 is a perspective view of an alternative tank having a plurality of fastener apertures defined therein for attaching components thereto, such as a gasket and an attachment plate for a sensor assembly;

[0055] FIG. 43 is a perspective view of a portion of an alternative sensor unit;

[0056] FIG. 44 is a plan view of a sensor attachment plate; and

[0057] FIG. 45 is a plan view of a sensor attachment plate gasket.

DETAILED DESCRIPTION OF THE INVENTION

[0058] A tank assembly 20 according to a first embodiment of the present invention is illustrated in FIG. 1. Tank assembly 20 includes a tank 22 for storing a urea solution, a filler tube assembly 24, a sensor unit assembly 26, and a bracket system 28. Filler tube assembly 24 is adapted to allow urea solution to be delivered to tank 22 through a first aperture 30 (FIG. 2). Sensor assembly 26 is adapted to sense the level of urea solution within tank 22, as well as to allow urea solution to be pumped out of tank 22 through a second aperture 32 for delivery to a selective catalyst reduction (SCR) system (not shown), which may be located on a motorized vehicle as part of a nitrogen oxide (NOx) emission reduction system for the motorized vehicle. Alternatively, in at least one embodiment, the SCR system may be utilized to help reduce the emissions from a stationary source of NOx, and tank assembly 20 may thus be mounted in a stationary location, rather than on a motorized vehicle. Regardless of the stationary or non-stationary aspect of the source of NOx emissions, sensor unit assembly 26 may also be adapted to return unused urea solu-

tion into tank 22 through second aperture 32, as well as others to perform additional functions, as will be discussed more below.

[0059] When used in conjunction with a motorized vehicle, bracket system 28 may be used to secure tank 22 to a chassis rail 34 (only a portion of which is illustrated in FIG. 1) that is part of a frame of a motor vehicle, such as truck. Bracket system 28 is particularly suited for mounting to the side of a truck in a location adjacent to an external diesel fuel tank for the truck. Bracket system 28, in the illustrated embodiment, includes an L-shaped bracket 36, two side brackets 38, and a strap 40 (FIG. 3). Side brackets 38 each include a vertical flange 42, a horizontal flange 44, and an angled flange 46. Vertical flanges 42, in the illustrated embodiment, each include a pair of apertures 48 that align with a pair of upper apertures 50 on L-shaped bracket 36. Any suitable fastener (not shown), such as, but not limited to, screws, bolts, rivets, and the like, may be inserted through apertures 48 and upper apertures 50 in order to secure side brackets 38 to L-shaped bracket 36.

[0060] Horizontal flanges 44 of each side bracket 38 include a plurality of apertures 52 that align with a plurality of lower apertures 54 on L-shaped bracket 36 (FIG. 3). Any suitable fasteners (not shown), such as, but not limited to, screws, bolts, rivets, and the like, may be inserted through apertures 52 and lower apertures 54 in order to secure horizontal flanges 44 of side brackets 38 to the lower portion of L-shaped bracket 36. As can further be seen in FIG. 3, each angled flange 46 includes at least one angled aperture 56. When bracket system 28 is assembled, angled aperture 56 aligns with a strap aperture 58 defined in a foot flange 59 adjacent each end of strap 40. This alignment allows a suitable fastener (not shown) to be inserted through both apertures 56 and 58 to thereby secure strap 40 to side brackets 38. Any suitable fastener may be used for this purpose, such as, but not limited to, screws, bolts, rivets, or the like.

[0061] As can be seen more clearly in FIG. 1, when suitable fasteners have secured side brackets 38 to L-shaped bracket 36 and strap 40 to side brackets 38, bracket system 28 securely encloses and rigidly constrains tank 22. This constraint is assisted by a recess 60 defined in a perimeter wall 62 of tank 22 (FIGS. 2 and 4). A head portion 64 of strap 40 is shaped to have a curvature that generally matches the curvature of recess 60. A rubber strap 66 (FIG. 2) may be placed between the head portion 64 of strap 40 and recess 60 of tank 22. Rubber strap 66 will thus be sandwiched between head portion 64 and recess 60 and, due to its flexible and compressible nature, reduce any vibrations that might otherwise be transferred from strap 40 to tank 22, as well as to more firmly secure tank 22 to bracket system 28.

[0062] Bracket system 28 firmly holds tank 22 such that there is substantially no movement of tank 22 within bracket system 28 when the components of bracket system 28 are secured together. As can be seen, bracket system 28 does not utilize any fasteners that pierce any portion of tank 22 itself. Tank 22 can therefore be secured to bracket system 28 without the use of any fasteners directly attached to, or inserted into, any portion of tank 22. Bracket system 28 thereby enables tank 22 to be secured to a vehicle, or other suitable structure, without having to drill any holes in tank 22, or otherwise create fastener apertures therein. Bracket system 28 may be secured to chassis rail 34 (FIGS. 1 and 2) by way of any suitable fasteners (not shown) inserted through a plu-

ality of bracket apertures 68 (FIGS. 2 and 3) defined in L-shaped bracket 36 and into chassis rail 34.

[0063] While other materials may be used, rubber strap 66 may be made of rubber, or any other similar type material, such as plastic, or something else. Tank 22 is usefully constructed of a material that does not react with the chemical components of the urea solution which it is adapted to store, such as stainless steel or a suitable plastic, like high density polyethylene (HDPE), or any other suitable plastic material. L-shaped bracket 36, side brackets 38, and strap 40 may also be made of any sufficiently strong material, such as steel, although other metals may be used, as well as other non-metals, plastics, and/or composite materials.

[0064] Tank 22, in the illustrated embodiment, includes a pair of generally planar sidewalls 70a and b that are connected together by perimeter wall 62 (FIGS. 1-2 and 4). Sidewalls 70a and b generally define planes (not shown) that are oriented in a vertical orientation when tank assembly 22 is attached to a motor vehicle. The two respective planes of sidewalls 70a and b are oriented generally parallel to each other and, in one embodiment, face in a direction generally perpendicular to the forward movement of the vehicle to which tank 22 may be attached. Tank 22 may be positioned in other orientations, of course, when attached to motor vehicle. Indeed, as noted above, tank 22 may, in at least one embodiment, be used for supplying urea solution to a stationary SCR system, in which case it would not necessarily be mounted to a vehicle of any kind.

[0065] Sidewalls 70a and b may be shaped differently from each other in order to assist the stacking of multiple ones of tanks 22 on top of each other during storage, or for other purposes prior to assembly of tank assembly 20. As can be seen more clearly from a comparison of FIGS. 1 and 4, sidewall 70a includes a projection or bulge 72 generally in the middle area of sidewall 70a. In the illustrated embodiment, projection 72 has the general shape of the letter "D," although it will be understood by those skilled in the art that the shape of projection 72 can be varied from the "D" shape illustrated in the accompanying drawings. Sidewall 70b (FIG. 4) includes an indentation 74 that, in the illustrated embodiment, is also generally "D" shaped. Indentation 74 is shaped and dimensioned to receive projection 72 from a separate tank 22 when multiple tanks 22 are stacked on top of each other, or compressed together in a side-by-side fashion.

[0066] During the manufacture or storage of tanks 22, projections 72 and indentations 74 help prevent tanks 22 from tipping over if they are stacked to a relatively high height. The insertion of a projection 72 from a first tank 22 into the indentation 74 of an adjacent tank helps prevent slippage of each tank with respect to each other. In other words, the seating of projection 72 in an indentation 74 allows two adjacent tanks 22 to fit together in a mating fashion whereby each tank is generally prevented from moving with respect to the other in any direction that is generally parallel to the planes defined by sidewalls 70a and b. This further allows multiple tanks to maintain alignment with each other when stacked vertically, or arranged in a side-by-side manner.

[0067] As was mentioned, the shape of projections 72 and indentations 74 of sidewalls 70a and b can be varied from that illustrated in the accompanying drawings. As some possible examples, an X shape, a square, a circle, or other geometric shapes may be used. Whatever shape is used, one of sidewalls 70a and b will have a projection in that shape and the other of sidewalls 70a and b will have an indentation that matches the

chosen shape. In some instances, it may be advantageous to choose a shape that is non-symmetrical, such as the “D” shape illustrated in the accompanying drawings. By choosing a non-symmetrical shape, it is not possible to stack multiple ones of tanks 22 on top of each other without them all having the same orientation. With the use of a symmetrical shape for projections 72 and indentations 74, it would be possible for one projection 72 of a first tank to fit into the corresponding indentation 74 of a second tank in multiple orientations. Indeed, if the shape of projections 72 and indentations 74 were circular, a projection 72 could be inserted into an indentation 74 in virtually an infinite number of different orientations. Non-symmetrical shapes thus may offer some benefits for projections 72 and indentations 74, although it will be understood that the present invention may be practiced with symmetrical shapes. It will also be understood that the present invention may be practiced, in at least some embodiments, with no projections 72 or indentations 74 whatsoever, in which case sidewalls 70a and b may be perfectly flat, or have other shapes.

[0068] In the illustrated embodiment, tank 22 may further include a plurality of fastener apertures 76 defined in a plurality of center walls 78 (FIGS. 4 and 5). Fastener apertures 76 are not utilized in the tank assembly 20 depicted in FIGS. 1-2, but they may be provided on tank 22 for allowing tank 22 to be mounted in different configurations, as will be described in more detail below. Generally speaking, when fastener apertures 76 are utilized, they receive suitable fasteners, such as screws, bolts, rivets, or the like, for mounting tank 22 to whatever structure it is desired to mount tank 22 to. Because tank 22 may be made of molded plastic, in one embodiment, the molding of tank 22 with fastener apertures 76 included therein allows the same tank 22 to be mounted in different configurations. This enables the same mold and design to be used for the tanks 22 even though they may be mounted differently in different situations, while adding negligible costs to tank 22 in those instances where fastener apertures 76 are not utilized.

[0069] As can be seen in greater detail in FIG. 6, sidewalls 70 and perimeter wall 62 of tank 22 combine to define an interior chamber 80 inside of tank 22. Chamber 80 stores urea solution for use in an associated SCR system. In the illustrated embodiment, there are only two openings into chamber 80: first aperture 30 (FIG. 2) in which filler tube assembly 24 is positioned, and second aperture 32, in which sensor unit assembly 26 is positioned. Filler tube assembly 24, as will be described in more detail below, provides an opening for inserting the nozzle of a urea solution pump, thereby providing access to the inside of tank 22 for adding additional urea solution to chamber 80. Sensor unit assembly 26, as will be described in greater detail below, generally senses the level of urea solution within chamber 80 of tank 22, provides inlet and outlet tubes to which hoses may be coupled for transferring the urea solution to the SCR system and for returning unused urea solution from the SCR system (such as when the motor vehicle's engine shuts off). Sensor unit assembly 26 may also provide structures for heating the urea solution to keep it from freezing, as well as additional sensors for monitoring the quality of the urea solution.

[0070] FIG. 7 illustrates in greater detail various of the components of filler tube assembly 24. The components of filler tube assembly 24, in the embodiment illustrated in FIG. 7, attach to each other, as well as to tank 22, without the use of any separate fasteners. This cuts down on the manufactur-

ing cost of filler tube 24 because it is easier to assemble, and there are no additional costs associated with separate fasteners. As will be discussed more below, filler tube assembly 24 can be modified to include the use of separate fasteners, if desired.

[0071] Filler tube assembly 24 includes a retainer 82, an O-ring 84, an outer housing 86, a reduction sleeve 88, a shroud 90, a retainer gasket 150, and a cap 92 (FIG. 7). In general, retainer 82 attaches to tank 22 in a snap-fitting manner with perimeter wall 62 of tank 22. Retainer gasket 150 provides a liquid-impervious seal between retainer 82 and tank 22. O-ring 84 provides a liquid-impervious seal between shroud 90 and retainer 82. Outer housing 86 and reduction sleeve 88 cooperate to define a filling aperture through which a urea solution dispensing nozzle may be inserted for filling chamber 80 with urea solution. Cap 92 provides a way for sealing the filling aperture during the interim time periods between fillings of tank 22. The design and construction of these components will be described in greater detail below.

[0072] Turning first to retainer 82, which is illustrated in greater detail in FIGS. 8-10, it includes a tubular body portion 94 (that defines a filler tube) having a circular plate portion 96 defined at a top end of the tubular body portion. The interior of tubular body portion 94 is hollow to thereby define a channel through which urea solution and/or the nozzle of a urea solution dispensing structure may be inserted. This internal channel of the tubular body portion 94 is aligned with a central aperture 98 of circular plate portion 96. An underside 100 of circular plate portion 96 includes a plurality of extensions 102 that are used to secure retainer 82 to tank 22 within first aperture 30 of tank 22. As can be seen more clearly in FIGS. 9 and 10, each extension 102 includes a flexible arm 104 having an outer cam surface 106. Each extension 102 also includes a bottom surface 110. As will be discussed in greater detail below, prong 105 is used as manufacturing assembly aid to insure an exact orientation of retainer 82 when it is attached to tank 22.

[0073] The purpose of extensions 102, flexible arms 104, cam surfaces 106, and bottom surfaces 110 can be more easily understood with respect to FIG. 11. Each flexible arm 104 is positioned on circular plate portion 96 at a location that will cause its respective outer cam surface 106 to engage an edge 108 (FIG. 11) of perimeter wall 62 of tank 22 as retainer 82 is inserted into first aperture 30 defined in perimeter wall 62. More specifically, the angled nature of cam surface 106, along with the flexibility of arms 104, will cause the arms 104 to flex inwardly toward tubular body portion 94 due to the contact with edges 108 as retainer 82 is inserted into first aperture 30 in an inward direction 112 (FIG. 11). This inward flexing will continue as retainer 82 is inserted in inward direction 112 until bottom surface 110 reaches a shoulder 114 defined adjacent edge 108 of perimeter wall 62.

[0074] When bottom surface 110 reaches shoulder 114, the resilient nature of flexible arms 104 will cause the arms 104 to spring or snap back to their unflexed positions, which is possible because edge 108 is no longer exerting a force against cam surfaces 106. When arms 104 snap back to their unflexed positions, retainer 82 will be prevented from being removed from tank 22 by the contact of bottom surface 110 of arms 104 with shoulder 114 of perimeter wall 62. Retainer 82 will thus be secured to tank 22 via a snap fit that requires no separate fasteners and no fastener apertures drilled, or otherwise defined, through any portions of perimeter wall 62 or sidewalls 70a or b.

[0075] Retainer 82 is prevented from rotating within first aperture 30 of tank 22 by way of a flexible prong 105 (FIG. 9) that fits into a cutout 107 defined along the perimeter of first aperture 30 (FIG. 12). When retainer 82 is inserted into first aperture 30, prong 105 will not flex inwardly toward tubular body portion 94 of retainer 82 if prong 105 is not aligned with cutout 107. Consequently, retainer 82 can only be inserted into first aperture 30 if prong 105 is aligned with cutout 107. When inserted in this manner, retainer 82 is prevented from rotating within first aperture 30 due to prong 105's contact with the pair of edges 109 defined on each end of cutout 107.

[0076] Tubular body portion 94 of retainer 82 includes an enlarged diameter region 116 positioned adjacent circular plate portion 96 (FIGS. 8, 9, and 11). Enlarged diameter region 116 houses outer housing 86 and reduction sleeve 88 (FIG. 11). Outer housing 86 and reduction sleeve 88 may be conventional components available commercially from ELAFLEX-Gummi Ehlers, GmbH, which has a principal place of business in Hamburg, Germany. Outer housing 86 and reduction sleeve 88 include a magnetic structure that may be detected by a corresponding magnetic detector on a nozzle of a urea solution dispenser. Such dispensers are commercially available in Europe and may be designed to inhibit the dispensing of urea solution until the magnetic detector detects the magnetic structure of outer housing 86 and reduction sleeve 88. This helps prevent a person from inadvertently dispensing urea solution into an improper tank, such as the gasoline or diesel tank of a motor vehicle.

[0077] Further, inner sleeve 88 includes an interior channel 118 (FIG. 11) having a diameter D. Diameter D may be dimensioned such that it can receive a specific-sized nozzle that is used for dispensing urea-solution that is different than the size of conventional nozzles used for dispensing gasoline and/or diesel fuel. Such a specific size would be dependent upon the manufacturer of the urea-solution dispensing nozzle. In at least one embodiment, diameter D is smaller than the diameter of conventional gasoline and diesel dispensing nozzles, thereby preventing a person from inserting a gasoline or diesel nozzle into tank 22 and inadvertently filling the tank with gasoline or diesel fuel. Diameter D may be varied to suit the particular nozzle size of whatever dispenser, or types of dispensers, that may be used to refill tank 22.

[0078] As can be more clearly seen in FIG. 11A, retainer 82 includes a cruciform 99 defined inside tubular body portion 94. Cruciform 99 includes first and second cross-bars 101a and b. Cruciform 99 acts as an anti-siphon guard that helps prevent a siphon hose from being inserted through tubular body portion 94 and into the liquid contents of tank 22.

[0079] As is illustrated more clearly in FIG. 8, retainer 82 includes a circular groove 120 defined in a top surface 122 of its circular plate portion 96. Circular groove 120 is dimensioned to receive O-ring 84. O-ring 84 is retained within circular groove 120 by shroud 90 which, when secured to retainer 82, compresses O-ring 84 such that a liquid-tight seal is formed between retainer 82 and shroud 90. O-ring 84 may be made from any suitable elastomeric-type material that is able to be compressed, that is resistant to reaction with urea-solution, and that is capable of forming a liquid-resistant seal between shroud 90 and retainer 82.

[0080] Shroud 90 is depicted in greater detail in FIG. 13. Shroud 90 includes a plurality of feet 124 that extend downwardly from a body portion 126. Each foot 124 includes an outer angled surface 128 and an inner angled surface 130. Feet 124 are dimensioned and spaced such that they each may

be inserted into corresponding slots 132 (FIGS. 8 and 10) defined in circular plate portion 96 of retainer 82. After feet 124 are inserted into slots 132, shroud 90 may be rotated such that each outer angled surface 128 comes into contact with a first surface 134 of a lip 136 defined on the underside 100 of retainer 82 (FIG. 10). Feet 124 are sufficiently flexible such that continued rotation of shroud 90 will cause feet 124 to flex enough to allow outer angled surface 128 of feet 124 to slide up first surface 134 of retainer 82. After outer angled surface 128 has slid past first surface 134, feet 124 will return to their unflexed (or less flexed) state, in which case inner angled surface 130 of shroud 90 will contact a second surface 138 of lips 136. Due to the relatively steep angle of inner angled surface 130 and second surface 138, along with O-ring 84's resistance to being compressed between shroud 90 and retainer 82 (which will tend to force surfaces 130 and 138 together), the contact between surfaces 130 and 138 will substantially prevent shroud 90 from being rotated in its opposite direction, thereby securing shroud 90 to retainer 82. Shroud 90 and retainer 82 may thus be secured together without the use of any separate fasteners.

[0081] As can be seen more clearly in FIG. 7, shroud 90 includes a pair of slots 140 that receive corresponding projections (not shown) on an underside of cap 92. These projections may be shaped in a conventional manner such that, upon rotation of cap 92 after insertion into a central aperture 142 of shroud 90, cap 92 is releasably secured to shroud 90. The design of the projections on cap 92, along with their interaction with shroud 90, may be the same or similar to the construction of conventional radiator caps and the manner in which those radiator caps are releasably secured to a radiator. Other designs may also be used, such as, but not limited to, external threads on cap 92 that threadingly mate with internal threads defined within central aperture 142 of shroud 90.

[0082] Sensor unit assembly 26 is depicted more clearly in FIG. 14 and includes a sensor unit 144, a cover 146, a retainer 148, and a gasket 150. Sensor unit assembly 26 is secured to tank 22 without the use of separate fasteners and/or separate holes drilled, or otherwise defined, in perimeter wall 62 of tank 22. Sensor unit assembly 26 is secured to tank 22 primarily by way of retainer 148, and retainer 148 generally operates in the same manner as retainer 82 of filler tube assembly 24, as has been described above.

[0083] Retainer 148 is depicted in greater detail in FIG. 15. Retainer 148 includes a plurality of extensions 152 that are generally the same as extensions 102 of retainer 82. Extensions 152 each include a flexible arm 154 having a cam surface 156 and a bottom surface 158. When retainer 148 is inserted into second aperture 32 of tank 22, cam surfaces 156 engage an edge 160 of second aperture 32, which causes the flexible arms 154 to flex inwardly (FIG. 16). This inward flexing continues until cam surfaces 156 reach an underside 162 of perimeter wall 62, at which point the flexible arms 154 snap back to their unflexed states, and bottom surfaces 158 engage underside 162, thereby preventing retainer 148 from being removed from second aperture 32. Retainer 148 further includes a prong 164 that functions in the same manner as prong 105 of retainer 82. That is, prong 164 fits into a cutout 166 (FIG. 12) defined on an inside of the perimeter of second aperture 32. Prong 164 prevents retainer 148 from rotating due to its contact with edges 168 of cutout 166. Gasket 150 may be sandwiched between retainer 148 and an exterior surface of perimeter wall 62, as illustrated in FIG. 16.

Retainer 148 and gasket 150 may thus be secured to tank 22 without the use of any separate fasteners or apertures defined in tank 22.

[0084] As can be seen more clearly in FIG. 16, cover 146 fits over a cylindrical wall 170 of retainer 148. Cover 146 is held in place by a top wall 172 of sensor unit 144 that sandwiches a portion of cover 146 between top wall 172 and cylindrical wall 170. Sensor unit 144, in turn, is secured to retainer 148 in a manner that is generally similar to the manner in which shroud 90 is secured to retainer 82, as has been discussed. That is, sensor unit 144, a portion of which is illustrated in greater detail in FIG. 17, includes a plurality of feet 174 that each have an outer angled surface 176 and inner angled surface 178. Feet 174 are dimensioned to fit into corresponding slots 180 defined on retainer 148 (FIGS. 15 and 18). After feet 174 are inserted into slot 180, sensor unit 144 may be rotated such that outer angled surfaces 176 each come into contact with a first surface 182 of a lip 184 defined on retainer 148 (FIG. 18). Due to the flexible nature of feet 174, sensor unit 144 may be further rotated until inner angled surfaces 178 of feet 174 come into contact with second surfaces 186 of lips 184, at which point feet 174 will return to an unflexed (or less flexed) state. This return to the unflexed state, along with the configuration of feet 174 and lips 185, will secure sensor unit 144 to retainer 148 and substantially prevent removal therefrom. Sensor unit 144 may thus be secured to retainer 148 without the use of separate fasteners.

[0085] Sensor unit 144 may include a plurality of ports 188 (FIG. 17) that may be in fluid communication with a plurality of tubes 190. Ports 188 may be used for a variety of different purposes, and the number may be varied from that illustrated. In general, one or more ports 188 may be connected to appropriate hoses (not shown) that are in fluid communication with the external SCR system that utilizes the urea solution contained within tank 22. For example, a first port 188 may be connected to a hose that transports urea solution to the SCR system, and a second port 188 may be connected to a hose that returns unused urea solution to tank 22. Another one or more ports 188 may be connected to hoses that are in fluid communication with the coolant fluid of the motor vehicle's engine. In such a case, the coolant may be pumped through one of the ports 188, cycled through one or more of tubes 190, and returned out to a different port 188, wherein the circulation of the coolant through tubes 190 within tank can help keep the urea solution from freezing during cold temperatures.

[0086] As yet another alternative, one or more of tubes 190 may house electrical heating filaments that supply heat to the urea solution within tank 22 to keep the urea solution from freezing during cold temperatures. In such a case, one or more of ports 188 could be electrically connected to the appropriate wires or cables that delivered the electricity to the heating elements inside tank 22. Still further, one or more of tubes 190 may house sensing equipment that determines the fluid level of the urea solution within tank 22. Such sensors would then pass that fluid level determination information on to an appropriate location on the vehicle, such as the vehicle's dashboard, where a driver of the vehicle would then be provided with an indication of how much urea solution remained within tank 22. The design and construction of sensor unit 144 may vary substantially from that shown in the accompanying drawings. In one embodiment, sensor unit 144 may be a conventional sensor unit commercially available from Wema Systems, which has a principal place of business in Laksevaag, Norway. Other types of sensor units, of course, can be used,

including ones that perform additional sensing functions, such as monitoring the quality of the urea solution, the temperature, or any other parameter that may desirably be measured with respect to tank 22.

[0087] FIGS. 19 and 20 depict an alternative tank assembly 20' according to another aspect of the present invention. Tank assembly 20' may be constructed to include a number of components that are identical with components of tank assembly 20. Such identical components are illustrated in FIGS. 19 and 20 with the same reference numerals as were used with tank assembly 20. Because these components are the same, they will not be described further. In one embodiment, the components of tank assembly 20' that are different from tank assembly 20 are a front cover 200, a rear cover 202, a hoop 204, a pair of spacers 206, and a cover 208. In other embodiments, tank assembly 20' may differ from tank assembly 20 by the addition, modification, or removal of other components as well.

[0088] Front cover 200, rear cover 202, and hoop 204 (FIGS. 19-20) are sealed together to define a chamber in which tank 22 may be positioned. Front cover 200, rear cover 202, and hoop 204—which may be constructed of a metal, such as, but not limited to, steel—may be secured together through the use of rivets. Other methods of sealing these components together may also be used. Front cover 200, rear cover 202, and hoop 204 provide protection against physical damage to tank 22, which is positioned inside of these components.

[0089] In order to secure tank 22 and front cover 200, rear cover 202, and hoop 204 to a motor vehicle, a bracket system may be used, such as the bracket system 28 discussed previously with respect to tank assembly 20. FIGS. 19 and 20 illustrate various components of bracket system 28, including L-shaped bracket 36, side brackets 38, and strap 40. In order to accommodate the dimensional change due to the inclusion of hoop 204, spacers 206 are inserted between angled flange 46 of side brackets 38 and foot flange 59 of strap 40 (as shown in FIG. 19). Spacers 206 may be constructed of any suitable material, such as, but not limited to, an elastomeric or compressible type material that is able to generally withstand the weather conditions to which it may be subjected to when tank assembly 20' is attached to a motor vehicle.

[0090] One other component of tank assembly 20' that may differ from tank assembly 20, as noted above, is the inclusion of cover 208. Cover 208 is positioned externally to hoop 204 and is seated around shroud 90 of filler tube assembly 24'. More specifically, cover 208 fits into a circular groove 210 defined in body portion 126 of shroud 90 (FIG. 13). Cover 208 may be made of a suitably flexible material in order to allow itself to be stretched over body portion 126 until it seats itself in circular groove 210. Filler tube assembly 24' differs from filler tube assembly 24 in that it includes cover 208. In all other respects, filler tube assembly 24' may be the same as filler tube assembly 24, although it will be understood by those skilled in the art that additional modifications can be made to filler tube assembly 24' (as well as filler tube 24).

[0091] Front cover 200, rear cover 202, and hoop 204 of tank assembly 20' may alternatively be replaced by a two-part enclosure that includes an enclosure body 205 and an end cap 207 (FIGS. 33-41). Enclosure body 205 (FIGS. 33-38) includes a sidewall 192 and a perimeter wall 194 having a first aperture 196 and a second aperture 198 defined therein. First aperture 196 is positioned to align with first aperture 30 of tank 22 when tank 22 is positioned inside of enclosure body

205 and end cap **207**. Second aperture **198** is positioned to align with second aperture **32** of tank **22** when tank **22** is positioned inside of enclosure body **205** and end cap **207**.

[0092] End cap **207** (FIGS. 39-41) includes a main wall **201** having a flange **203** defined generally around the perimeter of main wall **201**. Flange **203** is generally oriented perpendicularly to main wall **201**. Flange **203** may include a plurality of apertures defined therein for receiving fasteners (such as, but not limited to, rivets, screws, bolts, etc) that are inserted through perimeter wall **194** of enclosure body **205** to thereby secure enclosure body **205** to end cap **207**. Alternatively, end cap **207** may be secured to enclosure body **205** via welding, or any other suitable fastening technique. As noted, end cap **207** and enclosure body **205** provide another manner of enclosing and protecting tank **22** which may be utilized in lieu of front cover **200**, rear cover **202**, and hoop **204**. It will, of course, be recognized by those skilled in the art that other methods of enclosing tank **22** may also be used in conjunction with the various embodiments depicted and discussed herein.

[0093] A tank assembly **20"** according to another embodiment of the present invention is depicted in FIG. 22. Tank assembly **20"** includes a number of components that may be the same as one or more of the components described above with respect to tank assemblies **20** and **20'**. Such common components are identified in the accompanying drawings with the same reference numerals as have been used for tank assemblies **20** and **20'**, and further description of such components is not deemed necessary since they are the same components as has been previously described. It will be understood, of course, however, that one or more of such components could be modified according to other embodiments of the present invention.

[0094] Tank assembly **20"** is constructed so as to be able to store, in addition to urea solution, another liquid. The other liquid is stored in a separate chamber inside of tank assembly **20"** that is fluidly isolated from the chamber in which the urea solution is stored. The other liquid may be a liquid fuel for a motorized vehicle, such as gasoline or diesel fuel. In the embodiment illustrated in FIG. 22, tank assembly **20"** is constructed in a shape that is especially suited for attachment to the side, or chassis rail, of a truck, and thus the separate chamber inside of tank assembly **20"** may be utilized for storing diesel fuel. For purposes of the following written description, it will be assumed that the other liquid stored inside tank assembly **20"** is diesel fuel, although it will be understood that this reference is only made for purposes of describing one embodiment, and that other embodiments may store other types of liquids.

[0095] Tank assembly **20"** includes two end plates **216** that are attached at either end to a barrel section **218** (FIGS. 23-24). A baffle **220** is positioned internally within barrel section **218** and divides the interior of barrel section **218** into a first chamber **222** and a second chamber **224** (FIG. 23). Baffle **220** may be secured inside barrel section **218** by way of welding, or any other suitable fastening means. First chamber **222** may store diesel fuel for a truck. The size of first chamber **222** may thus vary in order to match the desired amount of fuel for a particular truck. Barrel section **218**, baffle **220**, and end plates **216** may be positioned and dimensioned such that first chamber **222** may store any suitable amount of diesel fuel, which may vary according to the size and/or type of truck to which tank assembly **20"** may be attached.

[0096] Tank assembly **20"** in the embodiment illustrated in FIGS. 22-24 includes a nipple **226** and a filler tube **228**

defined in barrel section **218**. Filler tube **228** provides an opening for inserting a nozzle of a diesel pump so that a person can fill first chamber **222** up with diesel fuel. The diesel fuel of first chamber **222** comes into direct contact with the interior walls of baffle **220**, barrel section **218** (specifically that portion of barrel section **218** defined on the opposite side of baffle **220** as second chamber **224**), and one of end plates **216**. A cap, or other structure, may be releasably attached to filler tube **228** such that a substantially liquid tight seal is created over filler tube **228** when first chamber **222** is not being filled. Filler tube **228** may take on a wide variety of different forms, and in at least one embodiment, may be any conventional filler tube used on a conventional diesel fuel tank.

[0097] Nipple **226** on tank assembly **20"** may be used to provide an outlet from first chamber **222** such that diesel fuel may be pumped out of first chamber **222** to the engine of the motor vehicle to which tank assembly **20"** is attached. Nipple **226** may take on any suitable form, such as any conventional nipple used on conventional diesel fuel tanks.

[0098] Second chamber **224** houses a urea solution tank **22** that, in the illustrated embodiment, is the same urea solution tank **22** that is used with tank assemblies **20** and **20'**, discussed previously. Tank assembly **20"** could, of course, be used with tanks configured and designed differently than tank **22**. Tank **22**, in the illustrated embodiment, includes a filler tube assembly **24'** and a sensor unit assembly **26**, which may be identical to the filler tube assembly **24'** and sensor unit assembly **26** that is used with tank assembly **20'**, as discussed above.

[0099] Sensor unit assembly **26** of tank assembly **20"**, in the embodiment illustrated in FIG. 24, is the same as sensor unit assembly **26** described previously with respect to tank assemblies **20** and **20'**. More specifically, sensor unit assembly **26** includes a sensor unit **144**, a cover **146**, a retainer **148**, and a gasket **150**. These components are assembled together in the same manner as has been previously described above. Similarly, the components of filler tube assembly **24'** of tank assembly **20"** are assembled together in the same manner as has been described previously with respect to filler tube assembly **24** and assembly **24'**. Accordingly, further description of these components is not necessary.

[0100] Tank **22** may be secured inside of second chamber **224** in a variety of different manners. In the embodiment illustrated, tank **22** is secured inside of second chamber **224** to the interior of barrel section **218** by way of a plurality of L-brackets **232**, one of which is illustrated in greater detail in FIG. 25. L-bracket **232** includes a first section **234** and a second section **236** oriented at generally a right angle to first section **234**. Fastener apertures are defined in each section **234** and **236** for receiving fasteners **238**, which may be bolts, screws, or other suitable fasteners. One of fasteners **238**, in addition to being inserted through L-bracket **232**, is inserted through one of fastener apertures **76** defined in tank **22** (FIG. 5). The other fastener **238** is inserted through a suitably aligned hole (not shown) in barrel section **218**. As can be seen in FIG. 5, tank **22** in the illustrated embodiment includes five fastener apertures **76**. In this embodiment, five L-brackets with corresponding fasteners **238** may thus be used to secure tank **22** to barrel section **218**. FIG. 23 illustrates an L-bracket **232** in the position in which it helps secure tank **22** to barrel section **218**. The number and types of fasteners may, of course, be varied from that illustrated depending upon the design considerations and/or needs of a particular application.

[0101] In the embodiment illustrated in FIG. 24, the end plate 216 adjacent tank 22 may be secured to barrel section 218 by way of a plurality of rivets 240, although other types of fastening methods may alternatively be used, such as, but not limited to, screws, bolts, self-tapping screws, and welding. A gasket 242 may be positioned between the end plate 216 adjacent tank 22 and barrel section 218. The position of gasket 242 when end plate 216 is secured to barrel section 218 is illustrated in FIG. 23. By positioning tank 22 inside of barrel section 218 and end plates 216, tank 22 may not only be concealed from view, but tank assembly 20" assumes a look that is substantially identical to the look of conventional diesel fuel tanks mounted to the side of trucks. Tank assembly 20", in the illustrated embodiment, thus provides an aesthetic advantage in that it enables a truck manufacturer to easily incorporate a urea solution tank with minimal changes to the overall look of the truck. Of course, tank assembly 20" may take on other forms than the embodiment illustrated, including forms that don't offer the aesthetic advantage of looking like a conventional diesel fuel tank.

[0102] As has been noted above, the design of filler tube assemblies 24 and 24' and sensor tube assembly 26 may be varied from that illustrated (as well as other components of the various tank assemblies). One such modification of a filler tube assembly is depicted in FIGS. 26-28. Filler tube assembly 24" of FIGS. 26-28 differs from filler tube assembly 24 and 24' described previously in that filler tube assembly 24" includes a modified retainer 82'. Filler tube assembly 24" includes a number of components that are the same as components previously described above. These components include the same reference numerals as have been used above, and because they operate in the same manner as has been previously described, they will not be described further. These components include cap 92, cover 208, shroud 90, O-ring 84, reduction sleeve 88, gasket 150, and outer housing 86.

[0103] Modified retainer 82' is illustrated in greater detail in FIG. 27. Modified retainer 82' primarily differs from retainer 82 described previously in that it includes a plurality of fastener holes 252 that are defined in plate portion 96 of retainer 82'. Further, retainer 82' does not include any extensions 102 used to secure it to tank 22. Instead, retainer 82' is secured to tank 22 by way of suitable fasteners, such as screws, bolts, rivets, or the like, inserted through fastener holes 252 and into corresponding holes 246 defined in perimeter wall 62 of a tank 22' (FIG. 42). Tank 22' differs from tank 22 in that it includes holes 246 defined generally around the perimeter of first and second apertures 30 and 32. Tank 22' may also differ from tank 22 in that it does not include cutouts 107 and/or 166 in apertures 30 and/or 32.

[0104] Holes 246 may be holes having internal threads, and such internal threads may be defined by threaded metallic threaded inserts (not shown) that are molded into tank 22 during the molding process (as noted above, tank 22, in at least one embodiment, may be constructed from a suitable molded plastic). Retainer 82', unlike retainer 82, is thus secured to tank 22 by way of a plurality of separate fasteners. The use of the separate fasteners obviates the need for utilizing a prong and cutout arrangement for preventing the rotation of retainer 82' with respect to tank 22. Consequently, retainer 82' does not include a prong 105, nor, as mentioned, does the corresponding aperture 30 into which retainer 82' is inserted into tank 22 need to have a cutout, such as cutout 107 discussed previously. Holes 246, as will be discussed more

below, may be arranged in a non-symmetrical manner such that the filler tube assembly and/or the sensor assembly that is mounted via fasteners inserted into holes 246 can only be attached in a single orientation, thereby assisting the manufacturing process and helping to prevent errors in assembly.

[0105] Gasket 150 of filler tube assembly 24" may be positioned between an underside 100 of plate portion 96 of modified retainer 82' and the exterior surface of perimeter wall 62 of tank 22, as is illustrated more clearly in FIG. 28. In some embodiments, gasket 150 may be omitted from filler tube assembly 24", and in still other embodiments, additional gaskets may be used. Indeed, fewer or greater numbers of gaskets may be used in any of the various tank assembly embodiments discussed above. Still further, in one embodiment, the gaskets 150 that are used in various locations on the various tank assemblies 20, 20', and 20" may all be the same. That is, they may all be constructed of the same material and have the same dimensions. Such uniformity reduces manufacturing costs by allowing a single component to be used in multiple locations for multiple purposes. In other embodiments, the size and/or material of gaskets 150 may vary individually in order to match the components they respectively interact with.

[0106] FIGS. 42-45 illustrate various components of an alternative sensor unit assembly. These components include a sensor unit 144' (FIG. 43), a sensor attachment plate 254, and a sensor attachment plate gasket 256 (FIGS. 42 and 44-45). Sensor unit 144' differs from sensor unit 144 in the manner in which it attaches to a tank, such as tank 22'. Specifically, sensor unit 144' attaches to tank 22' via a plurality of fasteners inserted into holes 246 of tank 22' (FIG. 42) in a manner that will now be described.

[0107] As can be seen in FIG. 44, sensor attachment plate 254 includes a central aperture 258 having a plurality of cutouts 270 defined along the perimeter of central aperture 258. Cutouts 270 are dimensioned and positioned to receive a corresponding number of projections 272 defined on an exterior surface 274 of a cylindrical wall 276 on sensor unit 144' (FIG. 43). (It will be noted that sensor unit 144' of FIG. 43 includes more projections 272 than there are cutouts 270 illustrated in FIGS. 42 and 44. In practice, the number of projections 272 would match the number and position of cutouts 270). Sensor attachment plate 254 further includes a plurality of attachment holes 282 that are used to secure attachment plate 254 to tank 22', as will be discussed more below.

[0108] Sensor attachment plate gasket 256 (FIG. 45) also includes a central aperture 280 that has a radius greater than the radius of central aperture 258 of attachment plate 256. Gasket further includes a plurality of attachment holes 284 that may be aligned with attachment holes 282 of attachment plate 254. Gasket 256 fits between perimeter wall 62 of tank 22' and attachment plate 254. Gasket 256 and attachment plate 254 are secured to perimeter wall 62 by way of fasteners inserted through attachment holes 282 and 284 and into holes 246 of tank 22'. Any suitable fastener may be used.

[0109] As was noted above, fastener holes 246 and attachment holes 282 and 284 are, in one embodiment, positioned such that they are not symmetrical. That is, in the embodiment illustrated in FIGS. 42, 44, and 45, a line drawn between each of the four holes 246 (or holes 282, and 284) would not define a square, a diamond, or any other symmetrical shape. In this manner, attachment plate 254 and gasket 256 can only be attached to tank 22' in a single orientation. If either plate 254

or gasket 256 are rotated from this single orientation, holes 246, 282, and 284 will not align with each other, and a fastener cannot be inserted through all of these holes. This helps insure that sensor unit assembly 144' is assembled onto tank 22' in only a single, correct orientation, thereby reducing the potential for mistakes made during the manufacturing of the tank assembly. Attachment holes 246 for securing filler tube assembly 24" to tank 22' may also be non-symmetrical in the same or similar manner as the attachment holes 246 used for securing the sensor unit assembly to tank 22'. Thus, both the sensor unit assembly and filler tube assembly will only be able to be attached to tank 22' in a single orientation.

[0110] The number of holes 246, 282, and 284 can be varied from the four illustrated, and the particular arrangement of these holes can be varied in a variety of different configurations such that a non-symmetrical configuration is achieved. By defining cutouts 270 in a non-symmetrical fashion, it is possible to ensure that sensor unit 144' is mounted to tank 22' in only a single orientation. After attachment plate 254 and gasket 256 are secured to tank 22' by way of suitable fasteners inserted through holes 236, 282, and 284, sensor unit 144' is mounted to tank 22' by inserting a bottom end 278 (FIG. 43) of projections 272 into cutouts 270 of sensor attachment plate 254. After projections 272 are sufficiently inserted through central aperture 258, sensor unit 144' is rotated. This rotation causes a set of shoulders 286 (FIG. 43) to engage the underside of attachment plate 254 and thereby prevent sensor unit 144' from being removed from tank assembly 22'. Sensor unit 144' is substantially prevented from rotating back to the position in which projections 272 are in alignment with cutouts 270 by the frictional interaction of projections 272 with gasket 256.

[0111] FIGS. 29-32 illustrate one of several alternative tank designs that may be used with any of the tank assemblies discussed above. Specifically, FIGS. 29-32 illustrate a tank 22" that includes a reservoir 260 fluidly isolated from a chamber 80' by an internal wall 266 (FIGS. 31-32). Tank 22", like tank 22, may be molded from a suitable plastic, and reservoir 260 may be molded as an integral part of tank 22". The general purpose of reservoir 22" is to store urea solution that does not conform to the requirements of the SCR system to which the tank 22" is supplying urea solution. For example, with motor vehicle SCR systems, it has been found that urea solutions containing approximately 32.5% urea are well suited for the SCR system. Accordingly, reservoir 260 may be utilized to store urea solution that varies from the desired concentration of urea by a predetermined amount.

[0112] Tank 22" is adapted to work in conjunction with a sensor 262 that detects one or more parameters of the urea solution as a person attempts to fill chamber 80' with the urea solution. In other words, when a person inserts a urea solution nozzle into a filling aperture 268, sensor 262 detects at least one quality of the urea solution that is dispensed from the nozzle. If sensor 262 detects that the quality meets a predetermined standard (within a predetermined tolerance), then sensor 262 allows the urea solution to be dispensed into chamber 80'. In contrast, if sensor 262 detects that the urea solution has a quality that does not conform to the predetermined standard, it diverts the incoming urea solution to reservoir 260 via a conduit 264, which may be a hose, or any other suitable structure.

[0113] Sensors 262 may take on any suitable form, including sensors of the type manufactured by Wema Systems, which has a principal place of business in Laksevaag, Nor-

way. Sensor 262 may monitor the specific gravity of the urea solution, its electrical conductivity, or other factors that relate to the desired characteristics of the urea solution, including combinations of two or more of these factors. Sensor 262 includes a switch (not shown), which may comprise an electrically operated solenoid that moves a valve, or other similar structure, in order to selectively divert the incoming urea solution into either chamber 80' or reservoir 260. Other types of switches besides solenoids may be used.

[0114] Tank 22" can be modified substantially from the embodiment illustrated in FIGS. 29-32. For example, tank 22" could be modified to include an auxiliary chamber (not shown) adjacent filling aperture 268 that is in fluid contact with sensor 262. The auxiliary tank could be utilized to temporarily store the incoming urea solution until sensor 262 was able to determine whether it conformed to the predetermined standards or not. Once the proper determination was made, sensor 262 would activate the switch to divert the urea solution into the appropriate location, e.g. either to reservoir 260 or chamber 80'.

[0115] Alternatively, tank 22" could be constructed such that sensor 262 could only divert the urea solution of the auxiliary chamber into chamber 80'. In such an embodiment, if sensor 262 detected that the urea solution within the auxiliary chamber did not conform to the predetermined standard, sensor 262 would not activate any switch or valve. Instead, the urea solution would remain in the auxiliary chamber until it was manually drained by a person, such as through a drain plug defined in an appropriate location on the auxiliary chamber. Still other design variations of tank assembly 22" could be made such that it was capable of separating and storing two different types of urea solution—the first being that which met one or more predetermined standards, and the second being that which did not meet the one or more predetermined standards.

[0116] While several forms of the invention have been shown and described, other forms will be apparent to those skilled in the art. Therefore, it will be understood that the embodiments shown in the drawings and described above are merely for illustrative purposes, and are not intended to limit the scope of the invention as defined by the following claims, which are to be interpreted under the principles of patent law, including the doctrine of equivalents.

What is claimed is:

1. A tank assembly for holding both diesel fuel and urea solution, said tank assembly comprising:

- a first chamber defined within said container, said first chamber being adapted to store diesel fuel;
- a first aperture defined within said first chamber for receiving diesel fuel;
- a second chamber defined with said container, said second chamber and said first chamber being fluidly isolated from each other, and said first and second chambers sharing at least a first wall;
- a tank positioned within said second chamber, said tank having a first hole adapted to receive a urea solution; and
- a second aperture defined within said second chamber wherein said second aperture is aligned with said first hole such that urea solution can be delivered through said second aperture and said first hole into said tank.

2. The tank assembly of claim 1 wherein said tank is made from a material different from said second chamber, and said tank is made from molded plastic.

3. The tank assembly of claim 1 further including:

a reservoir;

a sensing unit positioned adjacent said second aperture, said sensing unit adapted to detect a quality of the urea solution; and

a switch adapted to direct the urea solution to said reservoir if said sensing unit determines that the quality of the urea solution does not conform to a predetermined standard, said switch further adapted to allow the urea solution to enter said tank if said sensing unit determines the quality of the urea solution does conform to the predetermined standard.

4. The tank assembly of claim 3 wherein said switch includes a solenoid that may be selectively activated in order to direct the urea solution into either said tank or said reservoir.

5. The tank assembly of claim 4 further including a drain plug positioned at a lower region of said reservoir, said drain plug adapted to be selectively removed from said reservoir such that liquid within said reservoir may be removed through said drain plug.

6. The tank assembly of claim 1 further including:

a second hole in said tank;

a second aperture defined in said second chamber, said second hole and said second aperture being aligned with each other; and

a sensor assembly positioned within said second hole and said second aperture, said sensor assembly adapted to detect a level of urea solution with said tank, and said sensor assembly further including a tube for transporting urea solution out of said tank.

7. The tank assembly of claim 1 wherein said tank includes a first sidewall and a second sidewall, said first and second sidewalls generally each defining first and second planes, respectively, that are parallel to each other, wherein said first sidewall includes a projection at a first location and said second sidewall includes an indentation at a second location, said first and second locations being defined such that said projection of a first one of said tanks is able to be inserted into said indentation of a second one of said tanks when a plurality of said tanks are stacked on top of each other in a position external to said second chamber.

8. The tank assembly of claim 1 further including a filler tube assembly positioned within said second aperture of said second chamber, said filler tube assembly including a filler tube, a shroud, an outer housing, and a reduction sleeve, said filler tube, shroud, outer housing, and reduction sleeve all adapted to be secured to each other without the use of separate fasteners.

9. The tank assembly of claim 1 further including a plurality of fastener apertures defined in said perimeter wall around said second aperture, said plurality of fastener apertures being adapted for securing a filler tube assembly within said second aperture, and said plurality of fastener apertures being arranged in a non-symmetrical manner such that said filler tube assembly can only be mounted within said second aperture in a single orientation.

10. The tank assembly of claim 1 further including a filler tube positioned within said second aperture, said filler tube including an anti-siphon structure adapted to hinder a hose from being inserted through said filler tube and into said tank.

11. A tank assembly for storing urea solution comprising:
a tank adapted to store urea solution, said tank comprising
a first wall sidewall, a second sidewall, and a perimeter

wall, said second sidewall spaced from said first sidewall, said first and second sidewalls each generally defining a first and second plane, respectively, wherein said first and second planes are parallel to each other, and said perimeter wall connecting said first and second sidewalls together;

an indentation on said first wall having a first shape; and

a projection on said second wall having a second shape, said second shape substantially matching said first shape such that said projection on a first one of said tanks may be inserted into said indentation on a second one of said tanks when a plurality of said tanks are stacked on top of each other, whereby said first tank resists movement of said second tank in any direction parallel to said first plane when said projection on said first tank is inserted into said indentation on said second tank.

12. The tank assembly of claim 11 further including an aperture defined in said perimeter wall for receiving an assembly and a plurality of fastener apertures defined in said perimeter wall around said aperture, said plurality of fastener apertures being adapted for securing the assembly within said aperture, and said plurality of fastener apertures being arranged in a non-symmetrical manner such that said assembly can only be mounted within said aperture in a single orientation.

13. The tank assembly of claim **12** wherein said assembly is one of a filler tube assembly and a sensor assembly.

14. The tank assembly of claim 11 further including:

an L-shaped bracket adapted to be secured to a motor vehicle;

a plurality of side brackets adapted to be secured to said L-shaped bracket;

a strap adapted to be secured to said side brackets; and

a recess defined in the perimeter wall of said tank, said recess shaped to receive a portion of said strap whereby said strap and said recess cooperate to secure said tank to said L-shaped bracket and said side brackets.

15. The tank assembly of claim 14 wherein said tank is secured to said L-shaped bracket and said side brackets without the use of any fastener that pierces any portion of said tank and any one of said L-shaped bracket and said side brackets.

16. The tank assembly of claim 14 further including:

a metal hoop secured around said perimeter wall;

a metal front cover secured to said metal hoop and positioned generally adjacent said first sidewall;

a metal rear cover secured to said metal hoop and positioned generally adjacent said second sidewall wherein said metal hoop and said metal front and rear covers, in combination, define an enclosure in which said tank is positioned; and

wherein said perimeter wall and said first and second side-walls of said tank are made of plastic.

17. The tank assembly of 14 further including a metal enclosure surrounding said tank, said metal enclosure including a first part and a second part, said first part surrounding said first sidewall and said perimeter wall of said tank, and said second part surrounding said second sidewall of said tank.

18. The tank assembly of claim **16** further including:

a first spacer positioned between said L-shaped bracket and
a first one of said side brackets, said first side bracket
being secured to said L-shaped bracket by a first fastener

inserted through a first set of aligned holes in said first side bracket, said first spacer, and said L-shaped bracket; and

a second spacer positioned between said L-shaped bracket and a second one of said side brackets, wherein said second side bracket is secured to said L-shaped bracket by a second fastener inserted through a second set of aligned holes in said second side bracket, said second spacer, and said L-shaped bracket

19. The tank assembly of claim **11** further including:

a reservoir fluidly isolated from said tank;

a sensing unit positioned adjacent an aperture adapted to receive a urea solution dispensing nozzle, said sensing unit adapted to detect a quality of the urea solution dispensed from the nozzle; and

a switch adapted to direct the urea solution to said reservoir if said sensing unit determines that the quality of the urea solution does not conform to a predetermined standard, said switch further adapted to allow the urea solution to enter the tank if said sensing unit determines the quality of the urea solution does conform to the predetermined standard.

20. The tank assembly of claim **11** further including an aperture defined in said perimeter wall of said tank, and a filler tube positioned within said aperture, said filler tube including an anti-siphon structure adapted to hinder a hose from being inserted through said filler tube and into said tank.

21. A tank assembly comprising:

a tank adapted for storing urea solution;

an aperture defined within said tank for receiving urea solution;

a reservoir fluidly isolated from said tank;

a sensing unit positioned adjacent said aperture, said sensing unit adapted to detect a quality of the urea solution being delivered to the aperture; and

a switch adapted to direct the urea solution to said reservoir if said sensing unit determines that the quality of the urea solution does not conform to a predetermined standard, said switch further adapted to allow the urea solution to enter the tank if said sensing unit determines the quality of the urea solution does conform to the predetermined standard.

22. The assembly of **21** wherein said tank further includes: a plurality of fastener holes adapted to allow said tank to be secured to a diesel fuel tank; and

a recess in a perimeter wall of said tank, said recess shaped to receive a portion of a strap whereby a strap may be used to secure the tank to a bracket for mounting to a vehicle frame; and

wherein said tank and said reservoir are both defined by a single structure made of molded plastic wherein said tank and said reservoir share at least one wall.

23. The assembly of claim **21** wherein said tank further includes:

a first wall sidewall;

a second sidewall spaced from said first sidewall, said first and second sidewalls each generally defining a first and second plane, respectively, wherein said first and second planes are parallel to each other; and

a perimeter wall connecting said first and second sidewalls together.

24. The assembly of claim **23** further including:

a metal hoop secured around said perimeter wall;

a metal front cover secured to said metal hoop and positioned generally adjacent said first sidewall; and

a metal rear cover secured to said metal hoop and positioned generally adjacent said second sidewall wherein

said metal hoop and said metal front and rear covers, in combination, define an enclosure in which said tank is positioned.

25. The assembly of claim **23** further including a metal enclosure surrounding said tank, said metal enclosure including a first part and a second part, said first part surrounding said first sidewall and said perimeter wall of said tank, and said second part surrounding said second sidewall of said tank.

26. The assembly of **24** further including:

an L-shaped bracket adapted to be secured to a motor vehicle;

a plurality of side brackets adapted to be secured to said L-shaped bracket;

a strap adapted to be secured to said side brackets; and

a recess defined in the perimeter wall of said tank, said recess shaped to receive a portion of said strap whereby said strap and said recess cooperate to secure said tank to said L-shaped bracket and said side brackets.

27. A tank assembly for storing urea solution comprising:

a tank adapted to store urea solution, said tank comprising a first sidewall, a second sidewall, and a perimeter wall, said second sidewall spaced from said first sidewall, said first and second sidewalls each generally defining a first and second plane, respectively, wherein said first and second planes are parallel to each other, and said perimeter wall connecting said first and second sidewalls together;

an L-shaped bracket adapted to be secured to a motor vehicle;

a plurality of side brackets adapted to be secured to said L-shaped bracket;

a strap adapted to be secured to said side brackets; and

a recess defined in the perimeter wall of said tank, said recess shaped to receive a portion of said strap whereby said strap and said recess cooperate to secure said tank to said L-shaped bracket and said side brackets.

28. The assembly of claim **27** further including:

a metal hoop secured around said perimeter wall;

a metal front cover secured to said metal hoop and positioned generally adjacent said first sidewall; and

a metal rear cover secured to said metal hoop and positioned generally adjacent said second sidewall wherein said metal hoop and said metal front and rear covers, in combination, define an enclosure in which said tank is positioned.

29. The assembly of claim **27** further including a metal enclosure surrounding said tank, said metal enclosure including a first part and a second part, said first part surrounding said first sidewall and said perimeter wall of said tank, and said second part surrounding said second sidewall of said tank.

30. The tank assembly of claim **27** further including an aperture defined in said perimeter wall for receiving a filler tube assembly and a plurality of fastener apertures defined in said perimeter wall around said aperture, said plurality of fastener apertures being adapted for securing the filler tube assembly within said aperture, and said plurality of fastener apertures being arranged in a non-symmetrical manner such that said filler tube assembly can only be mounted within said aperture in a single orientation.