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(54) **FLUID DEPLOYMENT SYSTEM FOR DRILLING AND COMPLETION FLUIDS**

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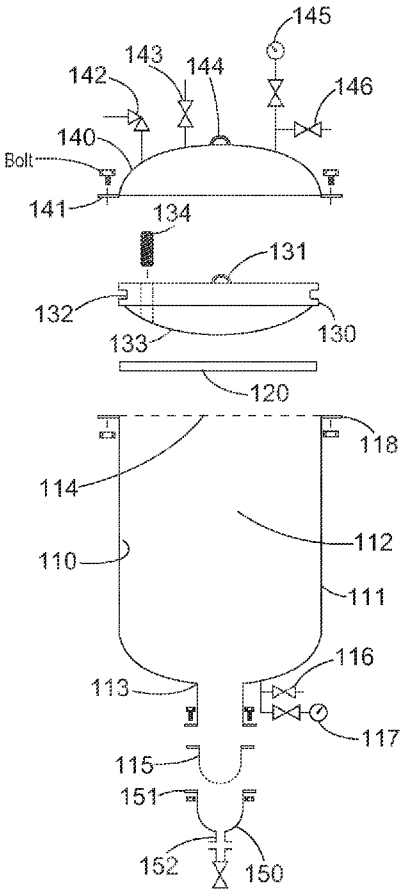
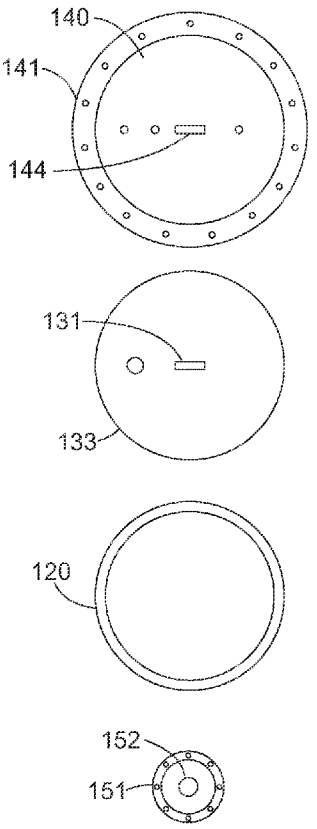
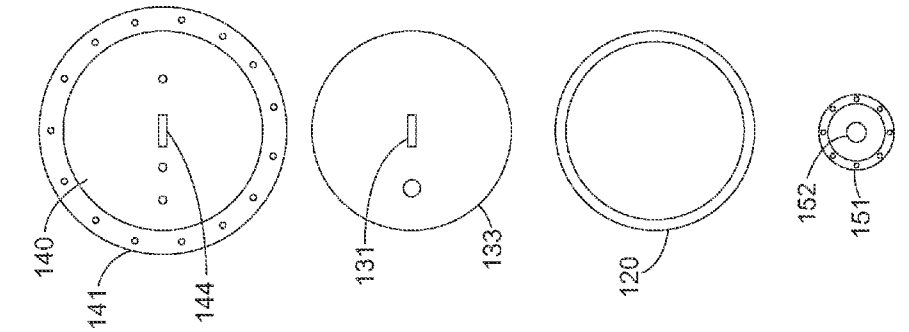
(57) **ABSTRACT**

An apparatus for building, transporting, storing, and deploying viscous fluids, comprising: a cylinder comprising a full bore opening and a discharge outlet; a plunger assembly mounted within the cylinder; and a shredder screen mounted within the discharge outlet.



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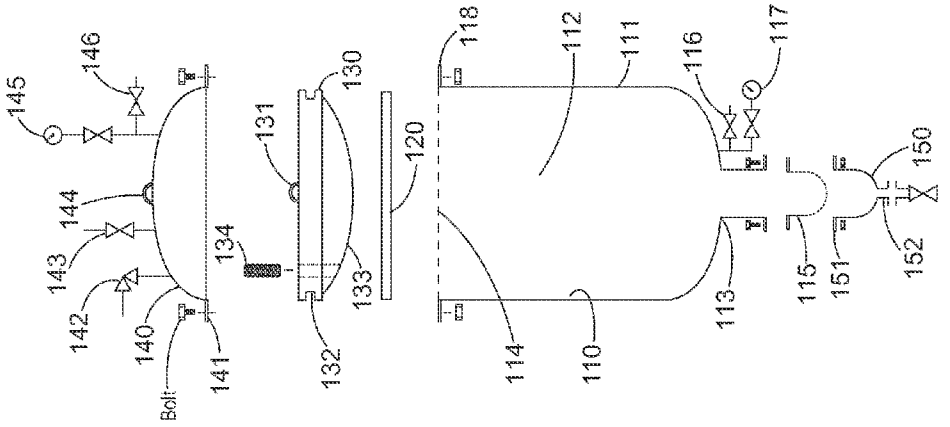
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Fig. 1

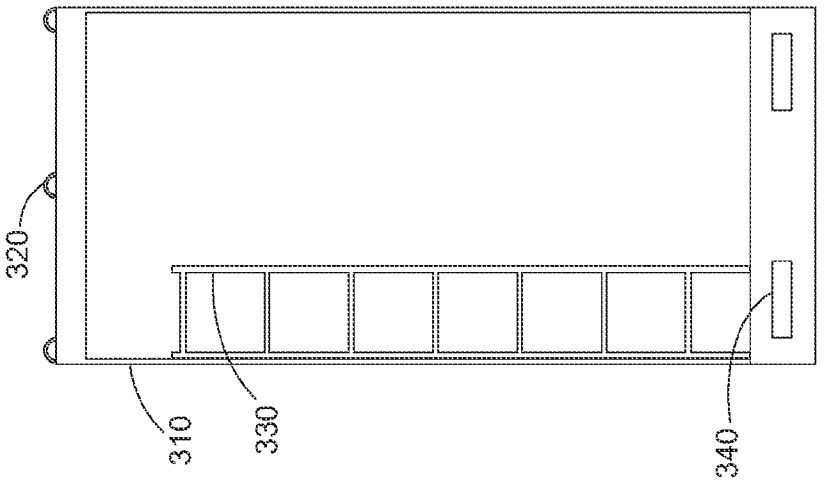

Fig. 3

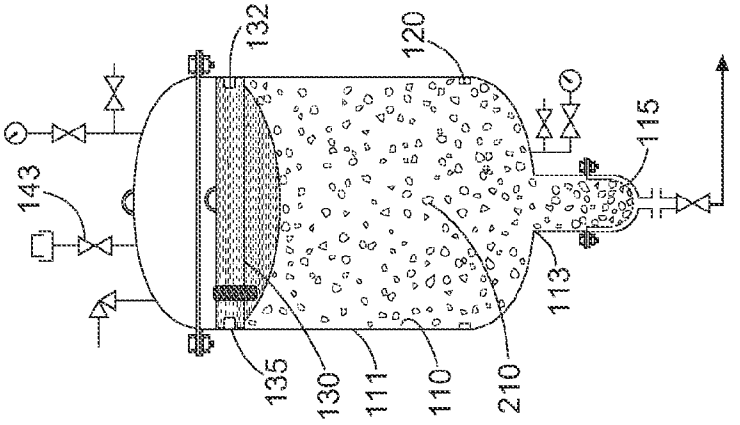

Fig. 2

FLUID DEPLOYMENT SYSTEM FOR DRILLING AND COMPLETION FLUIDS

BACKGROUND

[0001] The present disclosure relates generally to subterranean drilling and completion operations and, more particularly, the present disclosure relates to a method and apparatus for transporting, storing, and deploying a mixture of viscous fluids.

[0002] Drilling and completion operations play an important role when developing oil, gas or water wells or when mining for minerals and the like. During drilling operations, a drill bit passes through various layers of earth strata as it descends to a desired depth. Drilling fluids are commonly employed during the drilling operations and perform several important functions including, but not limited to, removing the cuttings from the well to the surface, controlling formation pressures, sealing permeable formations, minimizing formation damage, and cooling and lubricating the drill bit. When drilling in the reservoir, it can be important to use special fluids that minimize damage to the formation. During completion operations, steps may be taken to enhance well productivity and additional downhole equipment may be installed.

[0003] When the drill bit passes through porous, fractured or vugular strata such as sand, gravel, shale, limestone and the like, the hydrostatic pressure caused by the vertical column of the drilling fluid exceeds the ability of the surrounding earth formation to support this pressure. During completion operations, communication with the surrounding formation occurs immediately during an open hole completion and after the perforation step for a cased well completion. Once there is communication between the well bore and the formation, the hydrostatic pressure caused by the completion fluid exceeds the ability of the surrounding earth formation to support this pressure. Consequently, some drilling or completion fluid is lost to the formation and fails to return to the surface. This loss may be any fraction up to a complete loss of the total circulating drilling or completion fluid volume. This condition is generally known in the art as "Lost Circulation." Failure to control Lost Circulation increases drilling cost and completion cost and can damage formation production capabilities.

[0004] The general practice is to add any number of materials to the drilling fluid which act to reduce or prevent the outward flow of the drilling fluid in a porous and or fractured stratum by sealing pores or cracks, thereby reducing or preventing Lost Circulation. The materials used in this process are commonly referred to as Lost Circulation Materials ("LCM") and may be some mixture of hard particles, gelled particles, and/or viscous fluids. Some materials typically used as LCM include, but are not limited to, wood fiber, popped popcorn, straw, bark chips, ground cork, mica, ground and sized minerals and the like. A small to medium quantity of specialized fluid is sometimes referred to as a "pill."

[0005] Fluid compositions used in drilling and completions can be complex and can be classified as various types of pills. Some examples of pills are LCM, barrier, sweeps, spacers, cleaners, push, wetting, and thermal insulation. These pills may contain viscosifiers, hard particles used for plugging and increasing density, gelled particles used for temporary plugging, suspension agents, gelling agents, buffers, corrosion inhibitors, emulsifiers, wetting agents, surfactants, solvents, salts, oils, water, brines, and biocides. Many pills are thixotropic and difficult to pump. Some pills form single gelled mass or large gelled clumps during storage that must be separated before pumping into the well bore. Some pills are pumped into the well bore without dilution while other pills are diluted and/or dispersed into a carrier fluid before pumping into the well bore.

[0006] For some LCM pills used in the reservoir section, the only particles used are gelled polymeric particles that can be quickly broken down by exposure to acidity before production is initiated. Derivatized Hydroxyethylcellulose ("DHEC") and Hydroxyethylcellulose ("HEC") are examples of polymers used in LCM pills. Depending on the extent of cross linking, DHEC and HEC can be used to form gelled particles and to increase the viscosity of the carrier fluid. The Halliburton product called MAX SEAL™ is an example of a product based on DHEC gelled particles that can be used to make a LCM pill that minimizes potential damage to the formation in the reservoir section.

[0007] These DHEC gelled particles and other fluids are typically transported and stored in five gallon buckets until needed. Prior to their use down hole, these particles and fluids can be transferred from their containers into a rig slug pit or cement unit displacement tank and dispersed into a carrier fluid such as filtered brine. However, during transportation and storage, the gelled particles and viscous fluid may clump together and form a single gelled mass or large clumps of gelled masses. Frequently, agitation inside the slug pit or displacement tank is inadequate to break the mass of gelled particles apart.

[0008] One current method utilized to break apart the gelled mass is to dump the gelled mass onto a shredder screen that is positioned on top of the displacement tank or slug pit and manually push the gelled mass through the shredder screen. However, manually pushing the gelled mass through the shedder screen may require considerable extra time, may introduce safety risks, and may not break all the gelled mass apart.

[0009] It is desirable to provide a system to transport, store, and deploy special viscous fluids that simplifies operations and totally eliminates the need to manually lift and pour product from buckets and may also eliminate the need to manually reduce the size of gelled clumps before transferring to a receiving vessel or directly into a wellbore. It is also desirable to avoid auxiliary equipment such as special pumps for very high viscosity fluids and to avoid the need for the drilling rig to provide electrical power. In many cases, it is also desirable to transfer special viscous fluids directly into a wellbore and avoid the need of rigs pits, vessels, manifold systems, and high pressure rig pumps to deliver the viscous fluid into the wellbore. It is also advantageous to avoid cleaning and then disposing of numerous empty buckets as well as pallet wrap and other packaging materials.

SUMMARY

[0010] The present disclosure relates generally to subterranean drilling and completion operations and, more particularly, the present disclosure relates to a method and apparatus for transporting, storing, and deploying a mixture of viscous fluid.

[0011] In one exemplary embodiment, the present disclosure is directed to an apparatus for building, transporting, storing, and deploying viscous fluids, comprising: a cylinder comprising a full bore opening and a discharge outlet; a plunger assembly mounted within the cylinder; and a shredder screen mounted within the discharge outlet.

[0012] In another embodiment, the present disclosure is directed to a method for transporting and storing viscous fluids, comprising: providing a viscous fluid; providing a fluid container, wherein the fluid container comprise: a cylinder comprising a full bore opening and a discharge outlet, a plunger assembly mounted within the cylinder; and a shredder screen mounted within the discharge outlet; and storing the viscous fluid in the fluid container.

[0013] In another embodiment, the present disclosure is directed to a method for transporting, storing and deploying viscous fluids, comprising: providing a viscous fluid; providing a fluid container, wherein the fluid container comprise: a cylinder comprising a full bore opening and a discharge outlet, a plunger assembly mounted within the cylinder; and a shredder screen mounted within the discharge outlet; storing the viscous fluid in the fluid container; and passing the viscous fluid through the shredder screen by activating the plunger assembly.

[0014] The features and advantages of the present invention will be apparent to those skilled in the art from the description of the preferred embodiments which follows when taken in conjunction with the accompanying drawings. While numerous changes may be made by those skilled in the art, such changes are within the spirit of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] These drawings illustrate certain aspects of some of the embodiments of the present invention, and should not be used to limit or define the invention.

[0016] FIG. **1** illustrates a disassembled apparatus, incorporating aspects of the present disclosure.

[0017] FIG. **2** illustrates an assembled apparatus, incorporating aspects of the present disclosure.

[0018] FIG. **3** illustrates a skid system.

[0019] While embodiments of this disclosure have been depicted and described and are defined by reference to example embodiments of the disclosure, such references do not imply a limitation on the disclosure, and no such limitation is to be inferred. The subject matter disclosed is capable of considerable modification, alteration, and equivalents in form and function, as will occur to those skilled in the pertinent art and having the benefit of this disclosure. The depicted and described embodiments of this disclosure are examples only, and not exhaustive of the scope of the disclosure.

DETAILED DESCRIPTION

[0020] The present disclosure relates generally to subterranean drilling and completion operations and, more particularly, the present disclosure relates to a method and apparatus for transporting, storing, and deploying a mixture of viscous fluid.

[0021] Illustrative embodiments of the present invention are described in detail herein. In the interest of clarity, not all features of an actual implementation may be described in this specification. It will of course be appreciated that in the development of any such actual embodiment, numerous implementation-specific decisions may be made to achieve the specific implementation goals, which may vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit of the present disclosure.

[0022] To facilitate a better understanding of the present disclosure, the following examples of certain embodiments are given. In no way should the following examples be read to limit, or define, the scope of the disclosure. Embodiments of the present disclosure may be applicable to horizontal, vertical, deviated, or otherwise nonlinear wellbores in any type of subterranean formation. Embodiments may be applicable to injection wells as well as production wells, including hydrocarbon wells.

[0023] The present disclosure is directed to an apparatus for transporting, storing, and deploying viscous fluids. The viscous fluids that may or may not contain hard particles and/or gelled particles. The viscous fluids may or may not be thixotropic in nature.

[0024] In certain embodiments, the apparatus is capable of quickly deploying fluids such as LCM pills without premixing. The apparatus can be mounted on a skid such that the entire system is certified for marine and/or ground transport allowing a pre-mixed pill to be transported, stored, and deployed from one container. After discharge of the pill, the empty skid mounted apparatus can be returned to a fluid blending site and re-filled with a pill.

[0025] FIG. **1** shows an example a disassembled apparatus **100** according to aspects of the present disclosure. The disassembled apparatus **100** may include a cylinder **110**, a plunger stop ring **120**, a plunger assembly **130**, a dish head **140**, and a strainer bowl **150**.

[0026] In certain embodiments, cylinder **110** may be of a metal construction. Cylinder **110** be certified to transport and store drilling fluids for downhole operations and may comply with all applicable codes and regulations. Cylinder **110** may be generally cylindrical, and may comprise a cylinder wall **111** that defines an inner chamber **112**. Cylinder wall **111** may be fabricated to a specified roundness and may be polished to a smooth finish. The inner chamber **112** may be accessible through at least one opening **113** at the bottom of cylinder **110** and one opening **114** at the top of cylinder **110**. In certain embodiments, opening **114** may be a full bore opening. In certain embodiments, opening **113** may be a discharge outlet. In certain embodiments, the full bore opening may allow the insertion of fluid composition into inner chamber **112**. In certain embodiments, the full bore opening may allow for the insertion of plunger assembly **130** into the cylinder **110**. The full bore opening may be sealed using dish head **140** that may removably engageable with cylinder **110**.

[0027] Cylinder **110** may further comprise a strainer element **115**. In certain embodiments, strainer element **115** may comprise a shredder screen. In certain embodiments, as shown in FIG. **1**, cylinder **110** may further comprise one or more vents **116** and one or more pressure gauges **117**. In certain embodiments, the cylinder **110** may further comprise one or more flanges **118** for assembly.

[0028] In certain embodiments, cylinder **110** may further comprise plunger stop ring **120**. Plunger stop ring **120** may be installed into cylinder **110** and welded into place. Once assembled, plunger stop ring **120** may prevent plunger assembly **130** from extending to the discharge end of cylinder **110**.

[0029] In certain embodiments, plunger assembly **130** may comprise cable pull eye **131**, a machined groove **132** containing a seal ring **135**, a pressure equalization port **133**, and a screw plug **134**. In certain embodiments, pressure equalization port **133** may be manually opened and then closed wherein refilling the apparatus by use of a screw plug. In

certain embodiments, pressure equalization port **133** is only opened when installing the plunger back into the cylinder on top of the pill.

[0030] Plunger assembly **130** may be fabricated to a specified roundness and diameter. In certain embodiments, plunger assembly **130** may have the same roundness and slightly less diameter than the cylinder wall **111**. Plunger assembly **130** may have a slip fit tolerance with cylinder wall **111** and an elastomeric, plastic, or piston seal ring on the surface that contacts cylinder wall **111** in order to prevent pill from by-passing the plunger assembly **130** as the plunger forces the pill out of cylinder **110**. The discharge side of plunger assembly **130** may have a convex shape that allows for a more complete discharge of pill from the cylinder **110**. Plunger assembly **130** may be driven with a pressurized gas or a liquid displacing a pill into a drilling rig vessel, pit, or directly into a wellbore. The apparatus can be designed for low or medium pressure applications, such as transfers to pits or vessels, or for high pressure applications, such as a direct transfer into the wellbore. Upon activation, the plunger assembly **130** is designed to displace the pill out of the apparatus with very little by-pass across the seal ring **135** and deploy the pill to the desired pit or vessel. After deployment, the plunger assembly **130** is designed to allow disassembly, refill, and reassembly. Once the reassembly step is completed, the apparatus is ready to deploy another pill.

[0031] In certain embodiments, dish head **140** may comprise flange **141**, one or more pressure detection devices **142**, propellant port **143**, lift eye **144**, one or more pressure gauges **145**, and one or more vents **146**. Dish head **140** and the entire apparatus may be of a metal construction and certified to meet a specified operating pressure. In certain embodiments, dish head **140** may be a removable lid. The removable lid may be sealed to the cylinder **110** by the use of a flange connection, a screw connection, a clamped connection, or a welded connection. The removable lid provides access to the cylinder **110** and allows for plunger assembly **130** to be removed, cylinder **110** to be charged with a pill, and plunger assembly **130** to be re-installed. The removable lid may are may not be a dished head and may or may not be attached to the container with a hinge.

[0032] In certain embodiments, strainer bowl **150** may comprise flange **151** and discharge port **152**. Strainer bowl **150** may be of a metal construction. For some pills, a shredder screen may be needed in or just below the discharge port in order to break gelled clumps up before reaching transfer lines. The shredder screen may be comprised of a course grid or a course strainer that is designed to break large gelled clumps into smaller clumps as the pill is extruded through the shredder. The detailed specifications of the shredder element may be set to eliminate gelled clumps of excessive size while minimizing the pressure drop across the element. For easy access and inspection, the shredder screen may be mounted near discharge outlet.

[0033] In certain embodiments, the apparatus may further include instrumentation for safe and reliable operations, such as pressure gauges, plunger position sensors, vacuum and pressure relief devices, propellant flow indicators, propellant flow totalizers, and instrument mounting and control panel boards.

[0034] FIG. **2** shows an example of an assembled fluid deployment system **200**. As can be seen by FIG. **2**, plunger assembly **130** may be inserted inside cylinder **110** such that a pill **210** is on the discharge side of the plunger assembly **130**. Once pill **210** and plunger assembly **130** are installed in the cylinder **110**, propellant may be introduced into propellant port **143** such that a pressure differential is created across plunger assembly **130** causing the plunger assembly **130** to push pill **210** out of cylinder **110**. Seal ring **135** mounted in machine groove **132** contacts cylinder wall **111** and prevents pill **210** from by-passing plunger assembly **130**. Suitable propellant fluids may include gaseous propellants such as compressed air, nitrogen, or carbon dioxide or liquid state propellants such as water, hydraulic fluids, completion fluids, or drilling fluids. In certain embodiments, suitable operating pressures for gaseous and liquid state propellants may be from 30 to about 120 psi. In other embodiments, suitable operating pressures for gaseous and liquid state propellants may be from 30 to about 5000 psi or higher.

[0035] Upon activation, propellant enters the apparatus under pressure through propellant port **143** and causes plunger assembly **130** to move against pill **210** resulting in pill **210** being transferred out of cylinder **110** through strainer **115** and out opening **113** into a receiving vessel, pit, or wellbore. The propellant continues to move plunger assembly **130** until plunger assembly **130** contacts stop ring **120** near opening **113**.

[0036] Referring now to FIG. **3**, FIG. **3** shows an example of the skid frame **300** with protective cage for housing an assembled fluid deployment system. The apparatus may be skid mounted for safe handling, transport, and storage. Skid frame **300** may comprise cage **310**, one or more skid lift eyes **320**, a ladder **330**, and one or more fork truck lift slots **340**. The use of a skid mounted apparatus may simplify the supply chain for special pills, simplifies operations at the drilling rig site, improves safety at the rig site, and eliminates the need to clean and dispose of numerous empty ~5 gallon plastic buckets as well as pallet wrap and other packaging materials.

[0037] In certain embodiments, an assembled apparatus as discussed herein may be used to store a pill. The apparatus may be disassembled, filled with pill, and reassembled as follows. Flange bolts and nuts attaching the dish head to the cylinder may be removed. A cable assembly may be attached to lift eye of the dish head and the dish head may be lifted off of the cylinder. The discharge port may be opened to allow for equalization of pressure across plunger assembly. A cable assembly may be attached to cable pull eye of the plunger assembly, and the plunger assembly may be removed from the cylinder. The plunger assembly may be inspected and cleaned and the plunger seal may be replaced as needed. The interior of the cylinder may be cleaned and inspected and polished as needed. The discharge port may then be closed and a pill may be transferred into the cylinder to a desired level. The pressure equalization port of the plunger assembly may then be opened and the plunger assembly may be slid into the cylinder until the plunger assembly is on top of the pill. The pressure equalization port may then be closed by screwing in the plug. The dish head may be repositioned on top of the cylinder and sealed to the cylinder with flange bolts and nuts. The instrumentation on the skid mounted apparatus can then be checked and the apparatus may be labeled to meet all transport requirements.

[0038] In certain embodiments, an assembled apparatus containing a stored pill may be used to discharge the pill as follows. The receiving vessel, pit, or wellbore and fluid transfer lines may be checked to ensure they are ready to make the transfer. The plunger may be checked to confirm that the plunger assembly is in the loaded position ready to make the

transfer. The propellant port may be opened to confirm that acceptable operating pressures may be reached inside the container. The discharge port may then be opened to allow the pill to flow into the desired receiving vessel. The propellant port may be closed once the desired quantity of pill is transferred or the plunger reaches the travel stop ring. The discharge port may then be closed. The container vent ports may then be opened to bleed off all pressure from the container. Optionally, the container may be attached to another loaded apparatus and repeat the process until the desired quantity of pill is transferred. The empty apparatus may then be tagged and stored until return shipment is possible.

[0039] Therefore, the present disclosure is well adapted to attain the ends and advantages mentioned as well as those that are inherent therein. The particular embodiments disclosed above are illustrative only, as the present disclosure may be modified and practiced in different but equivalent manners apparent to those skilled in the art having the benefit of the teachings herein. Furthermore, no limitations are intended to the details of construction or design herein shown, other than as described in the claims below. It is therefore evident that the particular illustrative embodiments disclosed above may be altered or modified and all such variations are considered within the scope and spirit of the present disclosure. Also, the terms in the claims have their plain, ordinary meaning unless otherwise explicitly and clearly defined by the patentee. The indefinite articles "a" or "an," as used in the claims, are defined herein to mean one or more than one of the element that it introduces.

What is claimed is:

1. An apparatus for building, transporting, storing, and deploying viscous fluids, comprising:
- a cylinder comprising a full bore opening and a discharge outlet;
- a plunger assembly mounted within the cylinder; and
- a shredder screen mounted within the discharge outlet.

2. The apparatus of claim **1**, wherein the cylinder comprises a cylinder wall that defines an inner chamber.

3. The apparatus of claim **2**, wherein the plunger assembly comprises a seal ring in contact with the cylinder wall.

4. The apparatus of claim **1**, wherein the plunger assembly comprises a propellant port that defines a first opening within the plunger assembly.

5. The apparatus of claim **1**, wherein the plunger assembly comprises a discharge side having a convex shape.

6. The apparatus of claim **1**, wherein the cylinder comprises a plunger stop ring mounted within the cylinder.

7. The apparatus of claim **1**, wherein the plunger assembly comprises a pressure equalization port that defines a second opening within the plunger assembly.

8. The apparatus of claim **1** further comprising a lid removably engageable with the cylinder.

9. A method for transporting and storing viscous fluids, comprising:
- providing a viscous fluid;
- providing a fluid container, wherein the fluid container comprises:
  - a cylinder comprising a full bore opening and a discharge outlet;
  - a plunger assembly mounted within the cylinder; and
  - a shredder screen mounted within the discharge outlet;
- storing the viscous fluid in the fluid container.

10. The method of claim **9**, wherein the cylinder comprises a cylinder wall that defines an inner chamber.

11. The method of claim **10**, wherein the plunger assembly comprises a seal ring in contact with the cylinder wall.

12. The method of claim **9**, wherein the plunger assembly comprises a propellant port that defines a first opening within the plunger assembly.

13. The method of claim **9**, wherein the plunger assembly comprises a discharge side having a convex shape.

14. The method of claim **9**, wherein the cylinder comprises a plunger stop ring mounted within the cylinder.

15. The method of claim **9**, wherein the plunger assembly comprises a pressure equalization port that defines a second opening within the plunger assembly.

16. The method of claim **9** further comprising a lid removably engageable with the cylinder.

17. A method for transporting, storing and deploying viscous fluids, comprising:
- providing a viscous fluid;
- providing a fluid container, wherein the fluid container comprises:
  - a cylinder comprising a full bore opening and a discharge outlet;
  - a plunger assembly mounted within the cylinder; and
  - a shredder screen mounted within the discharge outlet;
- storing the viscous fluid in the fluid container; and
- passing the viscous fluid through the shredder screen by activating the plunger.

18. The method of claim **17**, wherein the plunger assembly comprises a propellant port that defines a first opening within the plunger assembly.

19. The method of claim **18**, wherein the plunger is activated by introducing a propellant into the propellant port.

20. The method of claim **17**, wherein the plunger assembly comprises a seal ring in contact with the cylinder wall.

* * * * *