patent number 2,283,008 filed September 22, 1999. The CNG barge described in this patent had installed on its deck a gas storage assembly, which included a stack of horizontally oriented, long pipes stretching approximately the full length of the barge deck. The stacking was close spaced and one aspect of the invention was that the pipe could be stacked hexagonally together touching one another thus creating a friction bond.

While the barge and ship described in Canadian patent no. 2,283,008 is a possible way to transport CNG, the invention did not take into account the motions of a barge or ship as pitches, yaws, and heaves in response to waves, currents and winds. Nor did it take into account the deflection of the barge or ship itself as it bends, twists and otherwise deflects as it is subjected to the loads caused by the waves. Nor did it take into account the expansion and contraction of the pipes as they are exposed to pressure and temperature changes that will occur as the pipes are loaded and emptied of compressed gas. The flexing and accelerations caused by the sea conditions and the differential temperatures and pressures caused by loading and unloading the pipe will cause the pipes to slide and move relative to each other and relative to the barge or ship.

SUMMARY

According to an aspect, the present disclosure refers to an assembly for transporting fluid comprising: a cargo hold in or on a transport vessel, said cargo hold including a lower support, a first side support on a first side of the lower support, and a second side support on a second side of said lower support; a plurality of pipes for fluid containment received in said cargo hold, wherein said plurality of pipes is stacked in multiple rows, wherein adjacent pipes have two points of contact between adjacent rows and wherein adjacent pipes in a same row are separated from one another by a space; a forcing member above said plurality of pipes; a forcing mechanism for applying a sufficient compressive force to said plurality of pipes with said forcing member so that friction between the pipes will prevent any significant relative movement of the pipes caused by motions of the transport vessel, or by flexing of the transport vessel, or by

strains caused by differential temperature or pressure; and a fluid line system connected to said plurality of pipes for filling and unloading fluid to the pipes.

According to another aspect, the present disclosure refers to a method of transporting gas in a plurality of stacked pipes carried on or in a vessel comprising the steps of: locating a plurality of pipes in a cargo hold of a vessel; maintaining a space between adjacent pipes in a same row of said plurality of stacked pipes; forcing the pipes together so strongly that any motion of the vessel, including flexing of the vessel itself, does not induce relative motion between the pipes themselves or between the pipes and the vessel.

According to another aspect, the present disclosure refers to a fluid transport assembly comprising: a lower support having a first side and a second side; a first side support adjacent to said first side of said lower support; a second side support adjacent to said second side of said lower support; wherein said first side support, said lower support and said second side support define a pipe receiving area; a row of spacers adjacent said lower support; a plurality of pipes stacked in multiple rows between said first side support and said second side support in said pipe receiving area, said plurality of pipes defining an upper side, a lower side, a first side and a second side, said lower side supported by said row of spacers; a top support above said pipe receiving area; wherein said adjacent pipes in said plurality of pipes having two points of contact between adjacent rows and where adjacent pipes in the same row are separated from one another by a space; a forcing member adjacent one of said sides of said plurality of pipes, said forcing member for forcefully applying pressure to said plurality of pipes for applying compressive force to said plurality of pipes for increasing static friction between adjacent ones of said plurality of pipes and between ones of said plurality of pipes and adjacent structure selected from said lower support, said first side support, said second side support and said top support.

According to another aspect, the present disclosure refers to an assembly for transporting fluid comprising: a cargo hold on or in a transport vessel, said cargo hold including a lower support having a first side and a second side, a first side support on said first side of said lower support, and a second side support on said second side of said lower support; a plurality of pipes for fluid containment received in said cargo hold wherein said plurality of pipes is stacked in multiple rows, wherein adjacent pipes of said

plurality of pipes have two points of contact between adjacent rows of said multiple rows; a forcing member above said plurality of pipes; a forcing mechanism for applying a compressive force to said plurality of pipes via said forcing member, said compressive force being sufficient so that friction between pipes of said plurality of pipes prevents any significant relative movement of pipes of said plurality of pipes; a load equalizer below said forcing member, said load equalizer engaging said forcing member and at least two pipes of said plurality of pipes for distributing said compressive force to said at least two pipes of said plurality of pipes; a fluid line system connected to said pipes of said plurality of pipes for filling and unloading fluid to the pipes.

According to another aspect, the present disclosure refers to a method of transporting gas in a plurality of stacked pipes carried on or in a vessel comprising the steps of: locating the plurality of stacked pipes in a cargo hold of the vessel; placing a load equalizer above said plurality of stacked pipes; forcing said pipes of said plurality of stacked pipes together so strongly that any motion of the vessel, including flexing of the vessel itself, substantially eliminating relative motion between said pipes of said plurality of said stacked pipes, or between said pipes, and the vessel.

The present disclosure relates particularly to the marine gas transportation of non-liquefied compressed natural gas, although it could be used to transport other gases. It is an objective of the present disclosure to reduce the cost of ships or barges designed to carry compressed gases, such as CNG.

The present disclosure relates to a gas storage system particularly adapted for the transportation of large quantities of compressed gases, such as CNG, in or on a ship or a barge, primarily by means of long, straight hexagonally stacked lengths of pipe that are so strongly forced together that they cannot move relative to each other or to the ship. The lengths of pipe are connected by a manifold. In one example, i.e., a ship application, CNG is carried below the top deck. However, the invention could also be employed on the top deck of a ship or on the top deck of a barge or below the top deck of a barge. The invention could also be employed to carry compressed gases other than CNG.

The pipe runs almost the entire length of the ship in continuous straight lengths and is hexagonally packed and firmly pressed together by a forcing mechanism. As described in Canadian patent number 2,283,008, the ship can be designed so that the