SUMMARY OF THE INVENTION

[0007] The invention 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 object of the present invention to reduce the cost of ships or barges designed to carry compressed gases, such as CNG.

[0007a] According to a first aspect, there is provided an assembly for transporting fluid comprising: a cargo hold including a lower support and a side support on each side of the lower support; and a plurality of pipes for fluid containment, each pipe of the plurality of pipes having at least one end that is open, the plurality of pipes being supported on the lower support between the side support; and the plurality of pipes is stacked in a hexagonal manner with linear contact between adjacent pipes; and an upper forcing member that is configured to forcefully bear down on the plurality of pipes via a forcing mechanism to apply sufficient compressive force to the plurality of pipes stacked in the cargo area so that friction between the pipes will prevent any significant relative movement of the pipes caused by motions of the barge or ship, or by flexing of the barge or ship, or by strains caused by differential temperature or pressure; and a fluid line system connected to the open ends of the plurality of pipes for filling and unloading fluid to the pipes; and a barge or ship upon or within which the plurality of pipes is installed to allow the stored fluid to be transported.

[0007b] According to a second aspect, there is provided a method whereby a plurality of hexagonally stacked pipes carried on or in a vessel are forced 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. In other words, the plurality of pipes contributes to the strength of the vessel and so they move together as though they were one.

[0007c] According to a third aspect, there is provided a fluid transport assembly comprising: a lower support having a first side and a second side; a first side support affixed to said first side of said lower support, said first side support approximately perpendicular to said lower support; a second side support affixed to said second side of said lower support, said second side support approximately perpendicular to said lower support; wherein said first side support, said lower support and said second side support define a pipe receiving area; a plurality of pipes stacked in a hexagonal pattern on said lower support, between said side supports, in said pipe receiving area; a top support above said pipe receiving area; a forcing member adjacent of said lower support, said first side support, said second side support and said top support, 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.

[0007d] According to a fourth aspect, there is provided a fluid transport assembly comprising: a ship having a hull, a forward cargo bulkhead, an aft cargo bulkhead, a centerline longitudinal bulkhead for diving said hull into a starboard cargo hold and a port cargo hold; a plurality of bottom support members incorporated in a bottom of said hull; a plurality of side support members comprising starboard hull side support members, starboard centerline side support members, port hull side support members, port centerline side support members; wherein said plurality of side support members and said plurality of bottom support members are equally spaced and aligned with one another along a length of said hull; a plurality of pipes in said starboard hull, said pipe extending from proximate said forward cargo bulkhead to proximate said aft cargo bulkhead, said plurality of pipe stacked in a hexagonal pattern, said plurality of pipe defining an outer layer of pipe and an interior grouping of pipe; a plurality of pipes in said port hull, said plurality of pipes having a first end proximate said forward cargo bulkhead, said plurality of pipes having a second end proximate said aft cargo bulkhead, said plurality of pipe stacked in a hexagonal pattern, said plurality of pipe defining a an outer layer of pipe and an interior grouping of pipe; a top support member (fixed)

above said plurality of pipes in said starboard hull and above said plurality of pipes in said port hull; a forcing beam adjacent to an upper portion of said plurality of pipes; a plurality of top forcing mechanisms, e.g., jacks, in between said top support member and said forcing beam, each of said plurality of top forcing mechanisms aligned with one of said plurality side support members, wherein said top forcing mechanisms are provided with bracing arms for preventing longitudinal loads from pushing said forcing beam out of alignment, wherein the bracing arms are affixed at a first end to said forcing beam and at a second end to said forcing mechanism; wherein said outer layer of pipe for remaining empty and for distributing loads generated by said forcing mechanism; a manifold system adjacent at least one of said first end and said second end of said plurality of pipes for filling and emptying said pipe.

[0007e] According to a fifth aspect, there is provided a fluid transport assembly comprising: a plurality of bottom support members; a plurality of side support members; wherein said plurality of side support members and said plurality of bottom support members are equally spaced and aligned with one another along a length of the assembly, said side support members and said bottom support members defining a pipe receiving area; a plurality of pipes in said pipe receiving area, said plurality of pipe stacked in a hexagonal pattern, said plurality of pipe defining an outer layer of pipe and an interior grouping of pipe; a top support member (fixed) above said plurality of pipes in said pipe receiving area and above said plurality of pipes; a forcing beam adjacent to an upper portion of said plurality of pipes; a plurality of top forcing mechanisms, e.g., jacks, in between said top support member and said forcing beam, each of said plurality of top forcing mechanisms aligned with one of said plurality side support members, wherein said top forcing mechanisms are provided with bracing arms for preventing longitudinal loads from pushing said forcing beam out of alignment, wherein the bracing arms are affixed at a first end to said forcing beam and at a second end to said forcing mechanism; wherein said outer layer of pipe for remaining empty and for distributing loads generated by said forcing mechanism; a manifold system adjacent at least one of said first end and said second end of said plurality of pipes for filling and emptying said pipe.

[0008] 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 and are connected by a manifold. Hereinafter the description will focus on a ship application to carry CNG below the top deck but it is obvious to one skilled in the art that this invention could also be employed on the top deck of the ship or on the top deck of a barge or below the top deck of a barge. It is also obvious to one skilled in the art that this invention could also be employed to carry compressed gases other than CNG.

[0009] The pipe runs the 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 holds of ship can be the entire length of the ship with the watertight transverse bulkheads being accommodated by filling the gaps between the hexagonally stacked pipes with a watertight material at the required intervals. The pipe diameter can be of any reasonable dimension, e.g., from approximately 8 inches to approximately 36 inches or other diameters. The precise diameter and length of pipe will depend on the economics of the system taking into account the cost of the various