# United States Patent [19]

**De Gregorio**

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[45] **Dec. 16, 1975**


[54] **MULTIPURPOSE PIPELINE SYSTEM FOR HANDLING FLUIDS ON LIQUID CARGO VESSELS**


[75] Inventor: **Paul V. De Gregorio,** Armonk, N.Y.

[73] Assignee: **Stolt-Nielsen, Inc.,** Greenwich, Conn.



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[52] **U.S. Cl.** ..... **114/74 R;** 137/255; 141/104; 141/388

[51] **Int. Cl.**[2] ..... **B63B 25/08**

[58] **Field of Search** ..... 114/74 R, 74 A; 137/255, 137/262, 266; 141/387, 388, 99, 104



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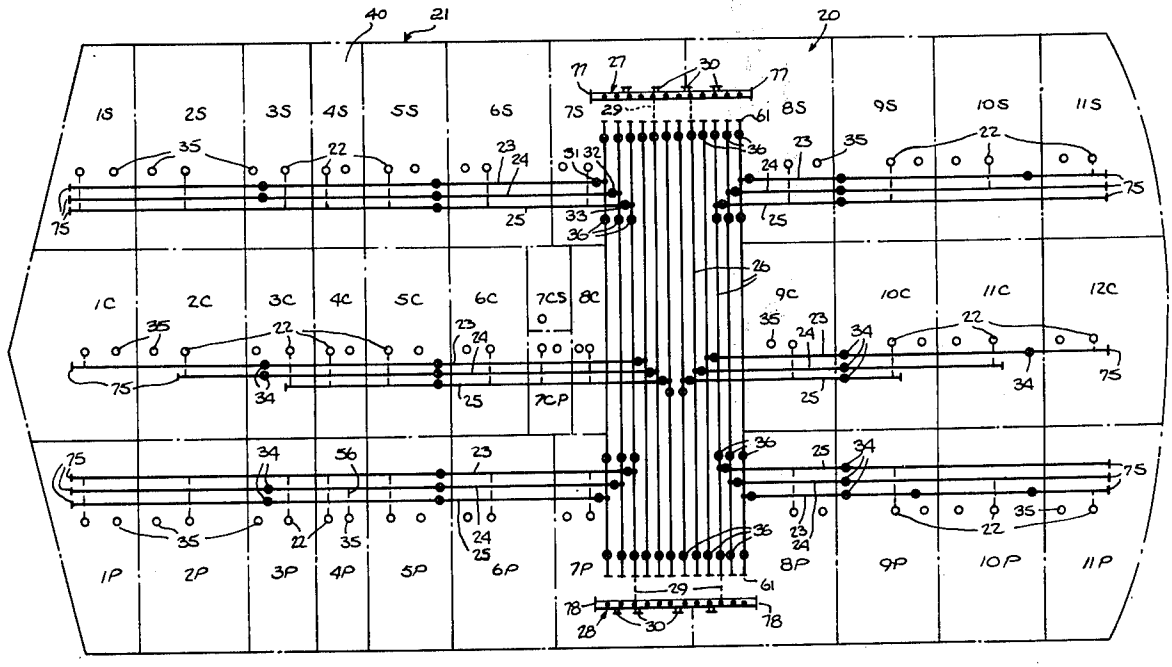
*Primary Examiner*—Trygve M. Blix
*Assistant Examiner*—Sherman D. Basinger
*Attorney, Agent, or Firm*—Brooks Haidt Haffner & Delahunty

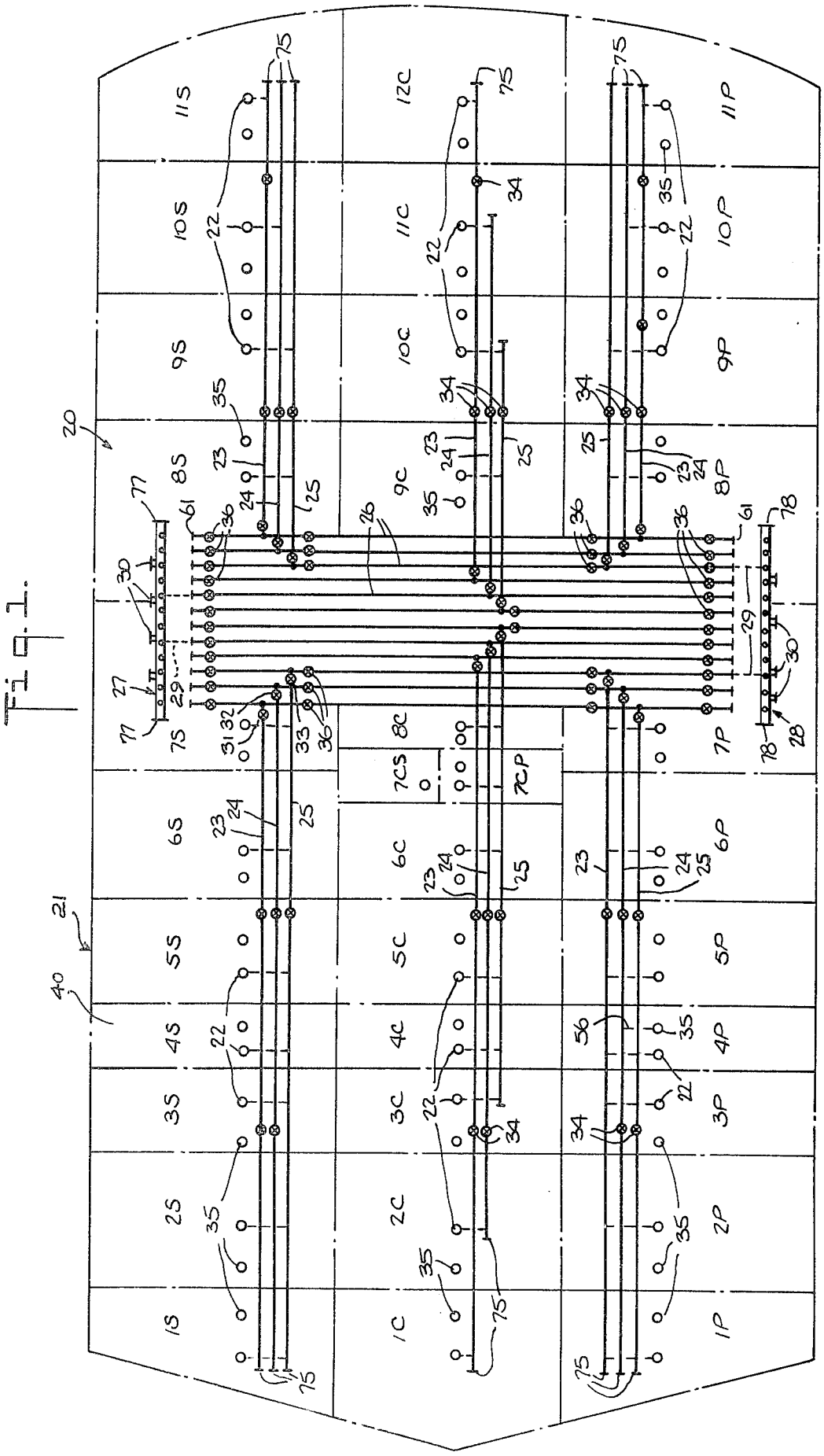


[57] **ABSTRACT**

Pipeline system and pumping arrangement for handling liquid cargo, vapor return, water ballast, cleaning-chemicals, insert gases or the like between dockside and any of a plurality of holds or tanks in a vessel, or for transferring liquids or gases between such tanks, and providing fewer pipelines than the number of tanks serviced by the system. Three longitudinal transfer pipelines extend along main deck over each of six rows of individual tanks, half the number of tank rows extending respectively forward and aft on either side of amidship. Each tank has deep-well pump whose pumpstack may be selectively connected, using a removable flexible piping, or a universal arm, or pipe-elbow connection, to any of the three adjacent transfer pipelines. The vapor relief opening of a tank may be selectively connected by similar devices to another of the transfer pipelines. Each transfer pipeline extends from the ends of the vessel and connects to one of several transverse pipe headers, located amidship, the number of headers being fewer than the number of transfer pipelines. Headers are connected by removable flexible elbows to either of a pair of longitudinal collecting manifolds located respectively on opposite sides of the main deck. Shutoff valves in the lines provide versatility in use of the system. All pipelines are generally straight, have removable endplates, and are vertically displaced from adjacent pipelines, for convenient cleanout.


**20 Claims, 11 Drawing Figures**




Fig. 1.
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11P
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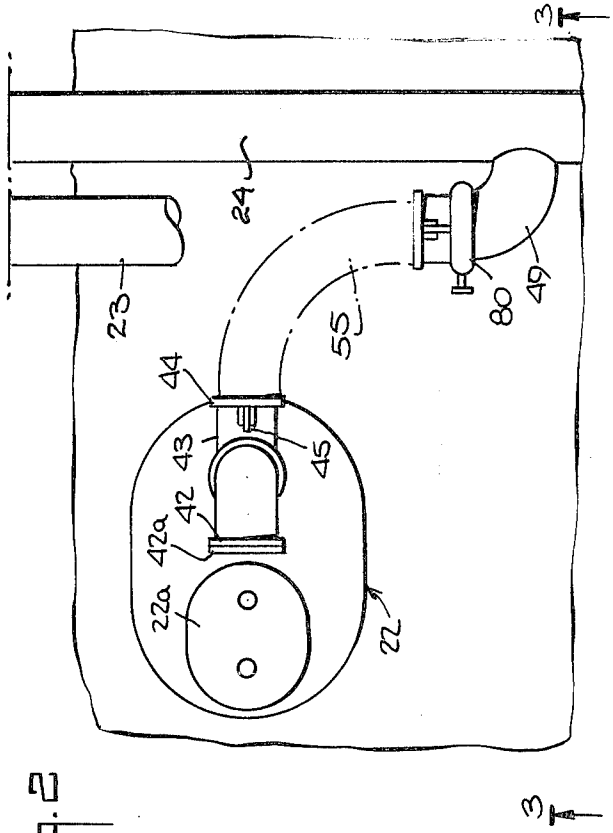



Fig. 2

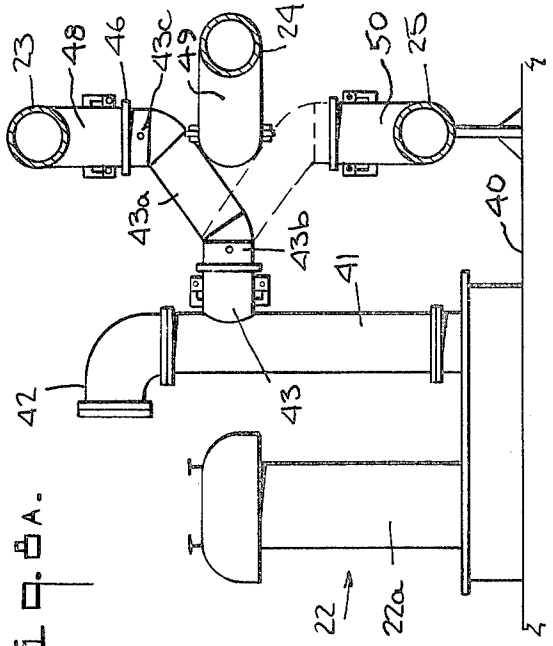



Fig. 4A.

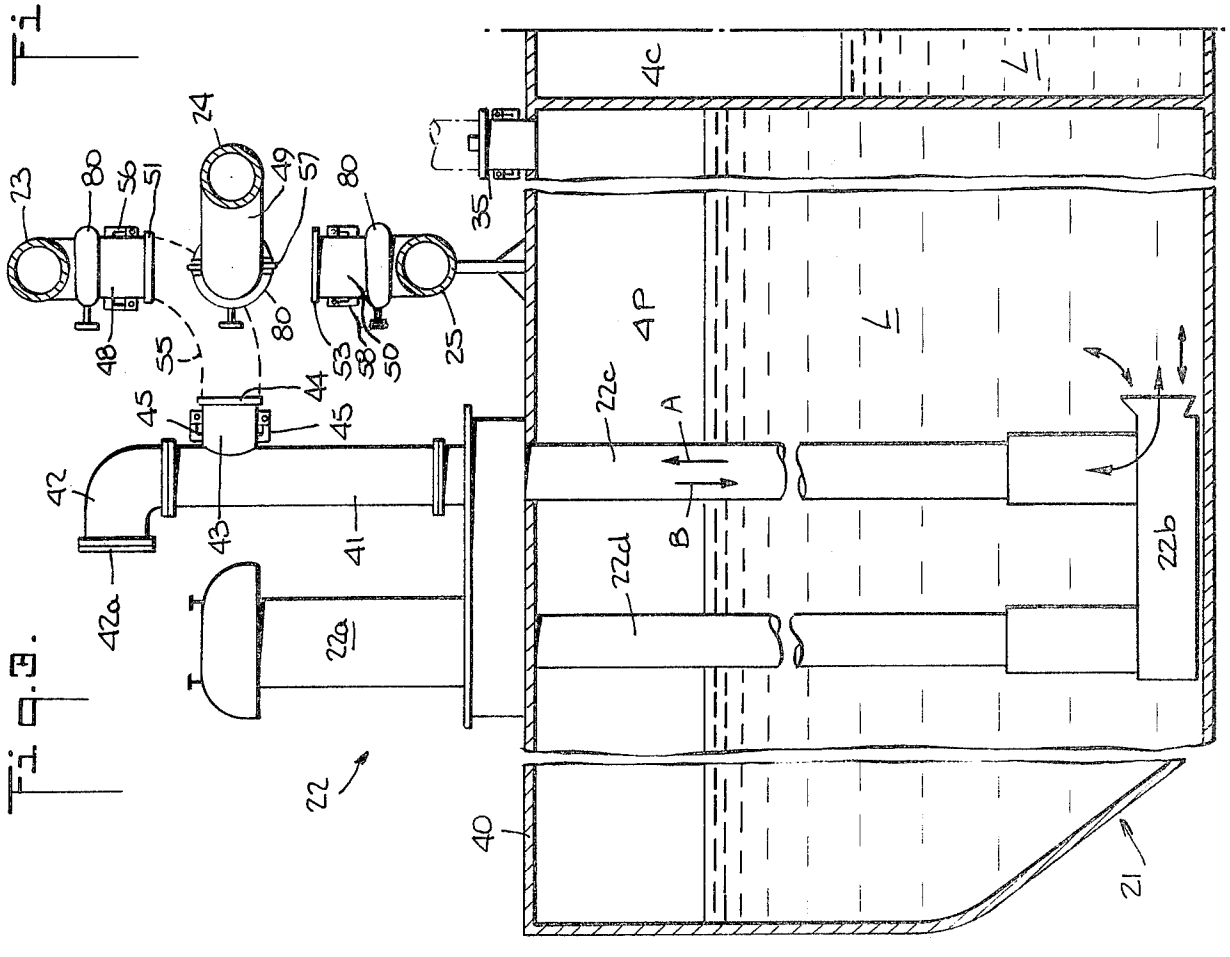



Fig. 3

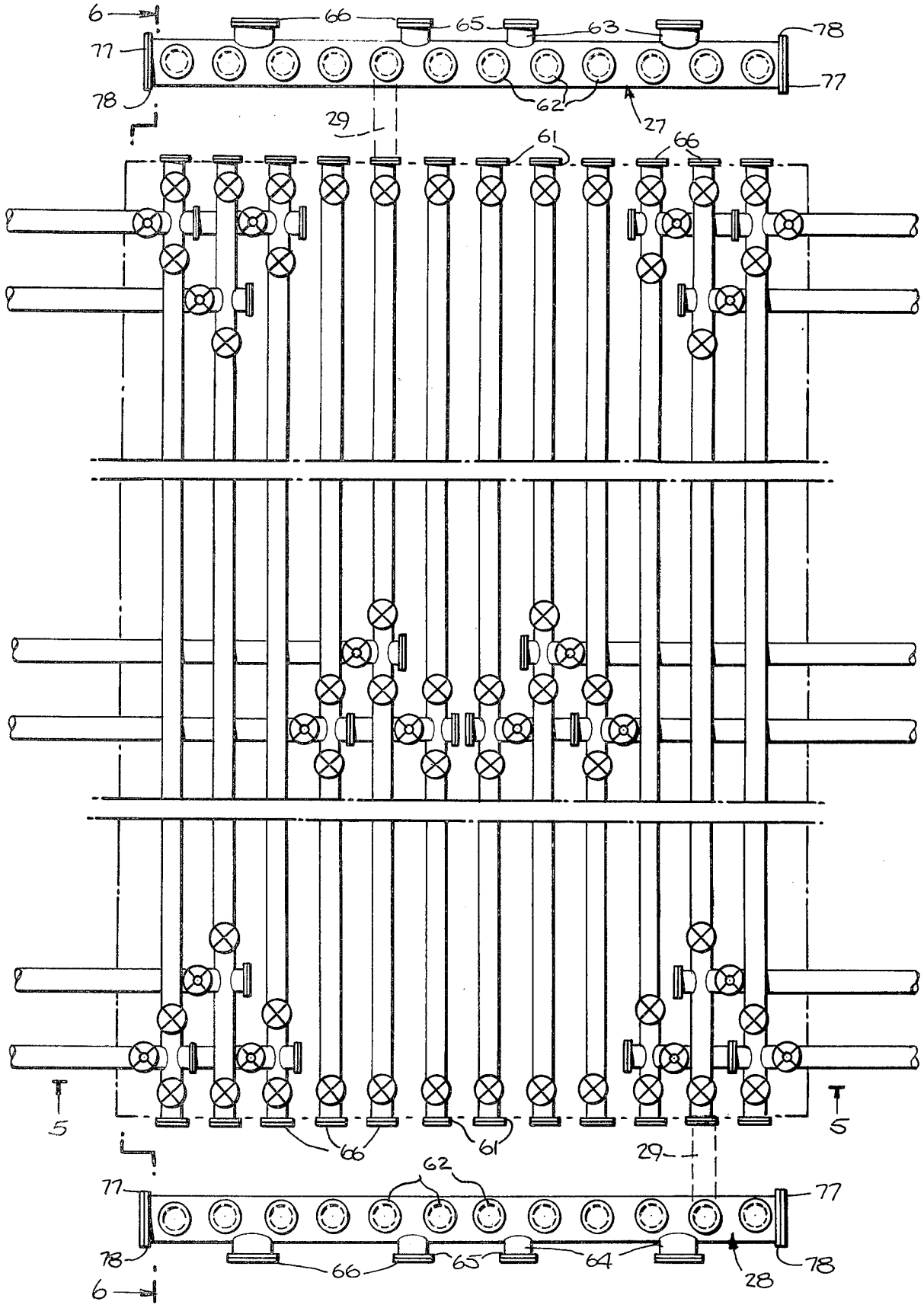

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Fig. 4.

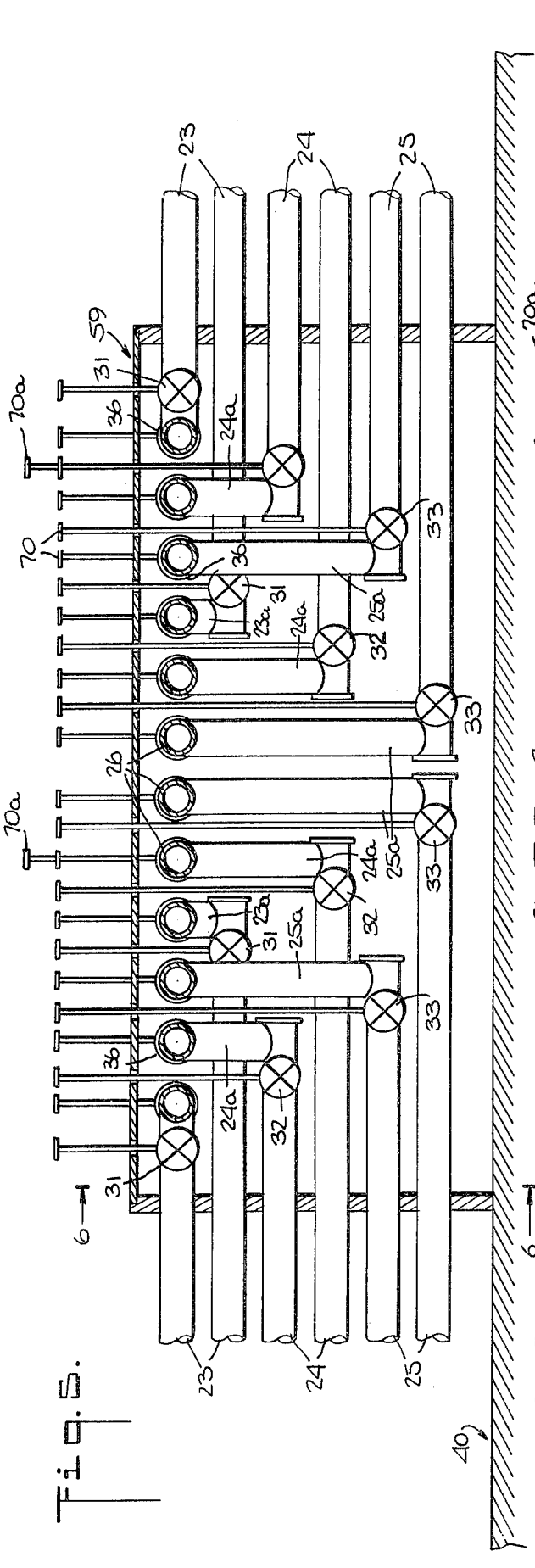

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24a
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23a
25a
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Fig. 5.

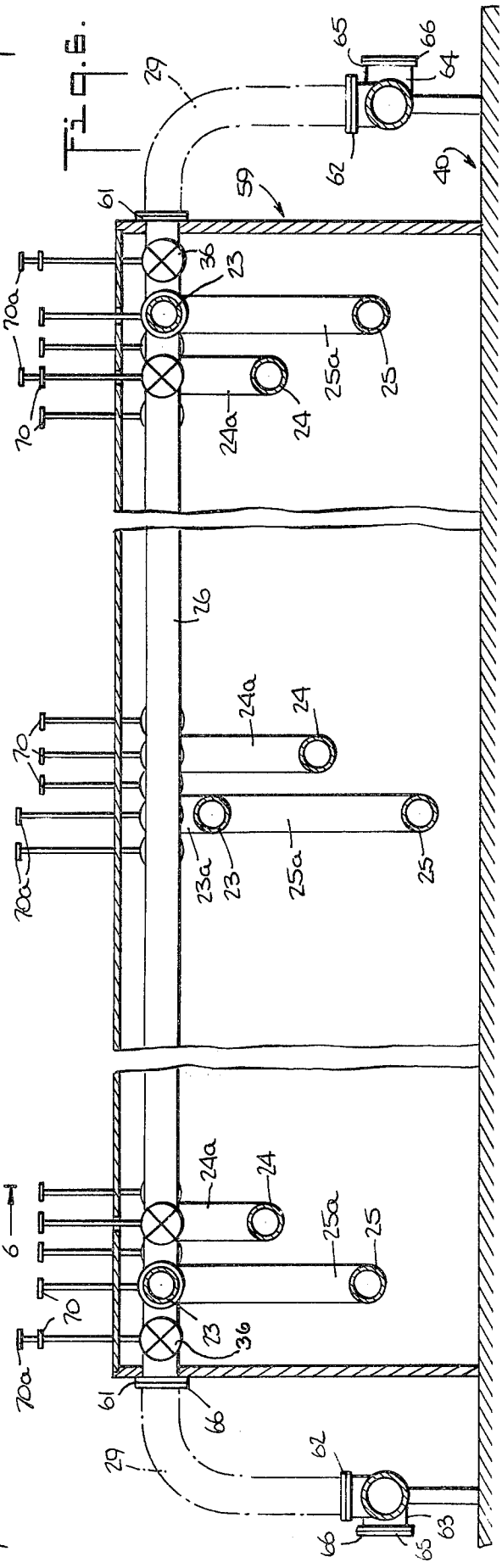

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Fig. 6.

Fig. 7.

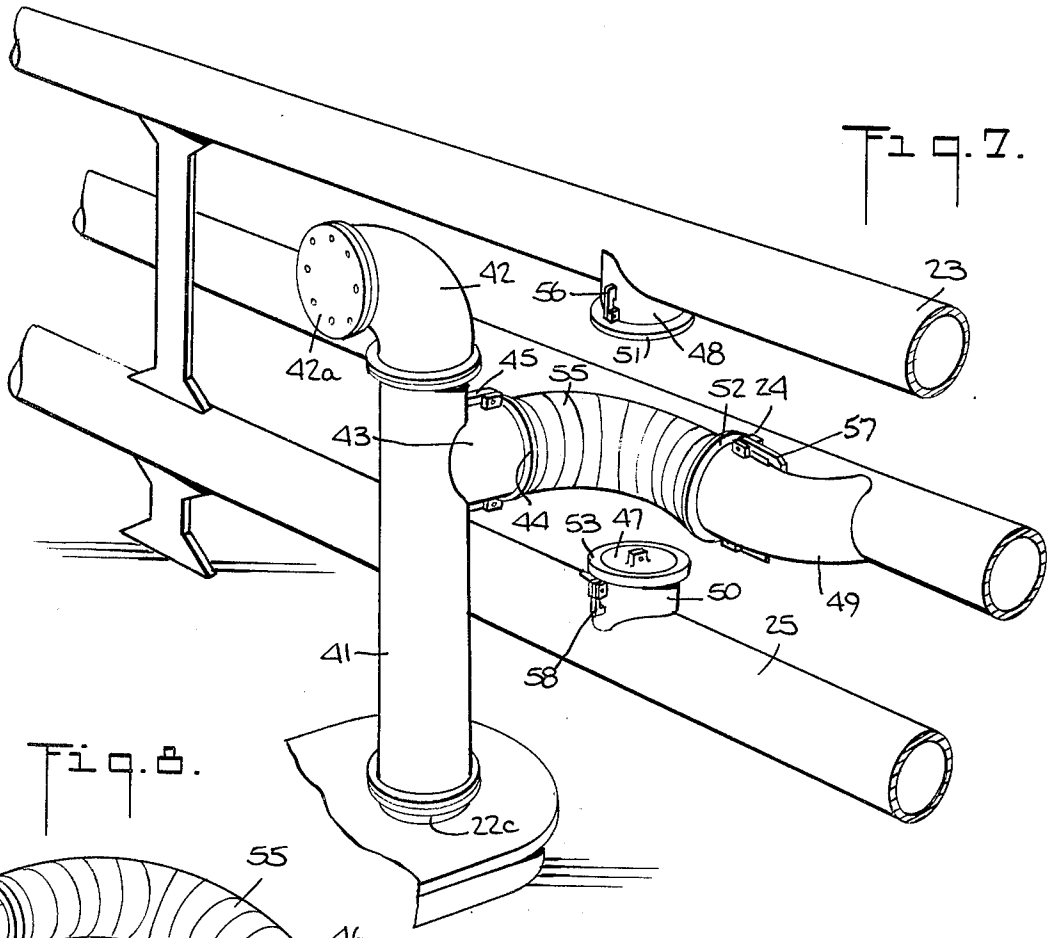



Fig. 8.

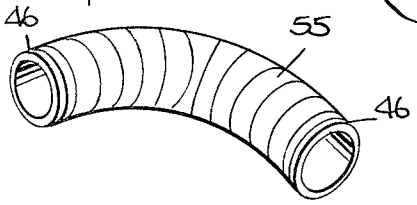
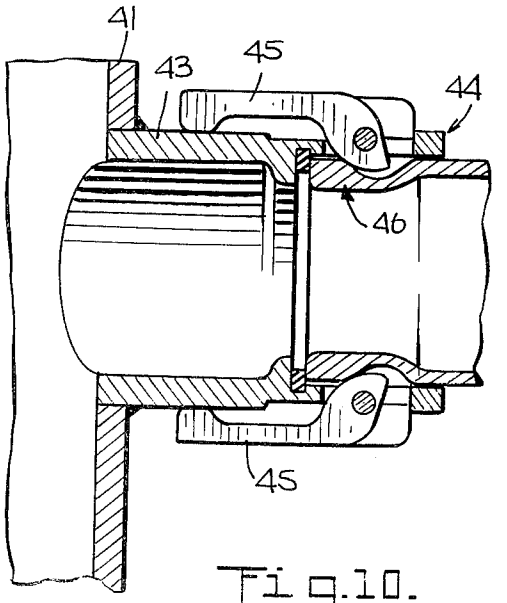



Fig. 9.



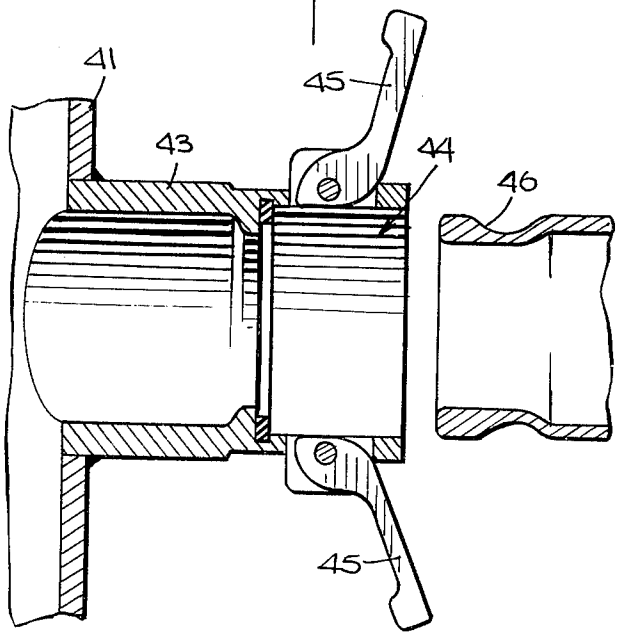




Fig. 10.

# MULTIPURPOSE PIPELINE SYSTEM FOR HANDLING FLUIDS ON LIQUID CARGO VESSELS

This invention relates to pipeline systems for carrying liquids, and vapors, and more particularly to such systems as are installed on liquid cargo carrying vessels, such as "parcel" tankers, barges, or similar vessels, primarily for the loading and off-loading of their liquid cargoes.

A "parcel" tanker is a seagoing tanker ship having a relatively large number (e.g., **36**) of individual and isolated liquid cargo-carrying holds or tanks, thus adapting it to carry several liquid cargoes (i.e., as many different cargoes as there are cargo tanks), any one or more of which must be off-loaded at a port of call, and still different liquid cargo taken on board, sometimes concurrently with the off-loading, without disturbing the remaining cargo. It is apparent, and required by shippers, charterers, and government and other regulations, that emptied holds and the piping used for loading and unloading those holds must be thoroughly cleaned before taking on a new and different cargo. Accordingly, and because of the manifest difficulty of attempting to rapidly and repeatedly clean a single pipeline as would service all of the tanks after each relatively small quantity of liquid cargo is handled, it has been thought necessary and is therefore conventional to provide each separate cargo hold or tank with its own individual pump and pipeline network to facilitate concurrent or rapid sequence handling of several different liquid cargoes as they are loaded and unloaded from dockside, or barges, etc. This results in a veritable myriad of pipes and valves mounted and extending longitudinally on the main deck of the ship leading to a common midship location where the cargo is conventionally brought and, by transversely extending lines, delivered over the side. For example, thirty-six complete and separate pipeline networks are presently installed to service thirty-six tanks of a ship. As parcel tanker ships are made larger, or the quantity of liquid in the average cargo is smaller, the number of cargo holds or tanks provided in such ships will normally be increased, and, but for the present invention, the number of separate pipelines on their decks would be expected to increase correspondingly and prohibitively.

It is therefore intended by the present invention to provide a pipeline system by which the number of such separate pipelines, and consequently the quantities of pipes and valves necessary to service such numerous and separate tanker holds, will be significantly reduced. For example, in a tanker intended to have 46 cargo holds extending in three rows throughout the length of the ship, the present invention would provide as few as 12, but preferably 18, longitudinally extending transfer pipelines, and as few as eight, but preferably 16, transversely extending pipe headers located amidship, as compared with the 46 longitudinal transfer lines and 46 transfer header lines previously believed necessary, yet will provide equivalent, and in some instances better service to and from each hold. Especially considering that most such pipelines and their valves and fittings are made from high-cost stainless steel, the proportionately lower cost of initial installation of such fewer lines, and of subsequent maintenance of the system is apparent.



It is also intended by the invention that the pipeline arrangement be such as will facilitate rapid and thorough cleaning and confirming inspection of both the pipes leading to any tank and the cargo tank itself, so that they will be readied for receiving another liquid cargo within only a few hours time.

It appears that no pipeline system which significantly reduces the number of pipelines, yet achieves all of the objects and advantages of the present invention has been known in the past. United States patent No. 2,314,555 (Preuss) discloses a barge or ship for carrying liquid cargo in individual, unconnected liquid cargo holds, in each of which a standpipe extends downwardly to a deepwell at the bottom of a hold. In each of the port and starboard aligned series of cargo holds, each vertical standpipe connects through a shut-off valve to a single longitudinally extending header or transfer line. These longitudinal transfer lines connect to common transversely extending headers at both ends, these transverse headers having end caps for easy cleaning. A common suction pump is connected to one of the transverse headers for pumping out the contents of one or more of the cargo holds, depending upon whether the shut-off valve at any cargo hold has been opened. However, the single pump is not capable of simultaneously off-loading two different liquid cargoes without admixing the cargoes, as is possible using the present invention, and it is apparent that the single longitudinal transfer line extending over each series of cargo holds as disclosed in the Preuss patent is incapable of loading or unloading two different liquid cargoes simultaneously in different cargo holds of the series, as may be done using the present invention.

To remedy the deficiencies of the Preuss system, and as is now conventional on parcel tankers in actual use, separate longitudinally extending transfer lines are provided to each and every of the several cargo holds, and individual cargo pumps are provided at each cargo hold. However, such does not achieve the results afforded by the present invention, as aforesaid.

U.S. Pat. No. 2,984,198 (Atkinson et al) shows the employment of a flexible hose connection to selectively load or offload liquid cargo from any vertical standpipe of several which project upwardly from the respective cargo holds of a ship. However, neither the objects nor the advantages of the present invention are achieved.

Briefly describing a pipeline system in accordance with the invention and as installed on a parcel tanker, a plurality of so-called "transfer pipelines" are installed extending longitudinally along the main deck above the top of an aligned plurality or row of liquid cargo holds or storage tanks, the number of transfer pipelines being fewer than the number of tanks in the row. In the preferred embodiment, three spaced-apart and parallel transfer pipelines extend along any such aligned series of tanks. Each tank has its own pump for pumping liquids between the tank and any one of the transfer pipelines to which the pumpstack is connected via a removable hose, universal arm, or elbow. The remaining transfer pipelines, each of which has a connection opening adjacent to the tank, remain capped excepting if provision must be made for returning vapors, in which case any conventional opening in the tank preferably the vapor opening, is similarly connected to a second of the transfer pipelines. So that a common length of flexible steel pipe or common universal arm or elbow can be used to connect the cargo line of each pumpstack to any one of the adjacent transfer pipe-

lines, and as seen in end view, the pipe connection openings of the several transfer pipelines associated with any tank are disposed within a vertical plane and face inwardly from their arcuately spaced apart locations along an imaginary circumference generated by the outer end of a 90° pipe elbow whose inner end is mounted and swiveled on the laterally facing pumpstack connection opening. Thus, in end view, the three transfer lines are vertically spaced apart.

The transfer pipelines are separate and independent of each other and, excepting for necessary expansion loops and the like, each is made perfectly straight, and has removable closures at both of its ends for easy cleanout and inspection. At one end, each of the two lowermost of the three parallel transfer lines is connected by a 90°-branch elbow or the like to one of a plurality of transversely extending pipe headers which are vertically displaced above the transfer lines. The branch opening of the 90° branch elbow is capped by a removable cap or plug, thus providing for easy cleaning of the pipeline. The uppermost of the three transfer lines is at the same elevation as the bank of transverse headers, and a removable cleanout plug is located on the far side of the connection of the line to its header. The transverse headers are also perfectly straight and openable at both ends for easy cleaning and inspection.

At either end, each of these transverse pipe headers may be connected by a removable hose or 90° pipe elbow to a collecting manifold pipe having a limited number of other openings for hose connections to dockside. These longitudinal collecting manifolds, one at either side of the ship, are vertically displaced below the plane of the several transverse headers to facilitate cleaning of the latter from their ends, and each is perfectly straight and is itself openable at its opposite ends to facilitate its cleaning and inspection.

For convenience, and as is conventional, the bundle of transverse headers is situated amidships, and similar pluralities of transfer pipelines, as previously described with respect to any single row of tanks, extend at right angles from these transverse headers in the forward and aft directions along and over each longitudinally extending row of cargo tanks as seen from the midship location. For example, in a typical large tanker ship, centerline tanks as well as port and starboard tanks are provided, resulting in three adjacent rows of tanks extending in the forward direction of the ship, and three adjacent rows of tanks extending in the aft direction, from the midship location. Each of these six rows of tanks is provided with at least two, and preferably three, transfer pipelines, thus requiring a total of at least 12, and preferably 18, transfer pipelines servicing all of the ship's liquid cargo storage tanks which may total 36 or more.

Similarly, the number of transverse header pipelines may be less than the total number of transfer lines by connecting two or even more of the transfer lines to each transverse header. For example, in a typical arrangement which provides 18 transfer lines, the six transfer pipelines associated with the center tanks may be singularly connected to respective header pipes, and pairs of the remaining 12 transfer lines may be connected to respective common headers, thus requiring a total of only 12 transverse pipe headers to service the 18 transfer lines. However, for greater flexibility in the use of the system, only two paairs of the remaining twelve transfer lines are connected to respective common headers, so that a total of 16 transverse pipe headers are used in the presently preferred system. At either of their ends, all of the transverse pipe headers may be selectively connected to a common collecting manifold, as aforesaid.

The several liquid cargo carrying tanks or holds may be of varying capacities, from very small to very large, but the number and sizes of the cargo tanks themselves do not affect the usefulness of the present invention.

Each cargo tank is provided with its own deepwell pump so that the tank may be filled or emptied independently of all other tanks in the system. However, to facilitate maintenance, the deepwell pump for each tank has its drive and control mechanisms mounted on the main deck, so that only its impeller is located within the tank itself. Preferably, a hydraulically driven Frank Mohn type deepwell pump is used.

The vertically projecting cargo line of the pumpstack through which the liquid cargo flows into or out from the tank preferably has two outlet openings, the first being a swivel-mounted cappable elbow at the extreme top end of the pumpstack for offloading or receiving liquid cargo directly from shore, and thus bypassing the pipeline system of the invention. The second is a preferably fixed position opening which also faces laterally, preferably inboard, and which is provided with a quick-connect type coupler for making a removable hose or elbow-connection to one of the previously mentioned three adjacent transfer pipelines of the invention. Alternatively, a universal arm might be mounted on this second opening. Of course, the second opening might also be arranged to swivel to face any point within the horizontal plane of its movement.

As they extend longitudinally past each pumpstack the three transfer pipelines are laterally spaced away from the pumpstack cargo line and vertically spaced away from each other a short distance such that, by a 90°-pipe elbow, universal arm, or a similar short length of flexible hose connected to the referred to second pumpstack cargo line outlet, a connection may be made to any of the transfer pipelines. For making such connection, each transfer pipeline has a pipe connection opening which is provided with a quick-connect type pipe coupler, and which is located near the pumpstack. In this regard, and so that a universal arm of fixed length, or a rigid, 90°— pipe elbow might be used, the middle one of the three vertically spaced apart transfer lines is also displaced in the inboard direction with respect to the plane of the other two transfer pipelines and has an elbow-type branch opening extending back into the plane of the connection openings of the other transfer lines, to which the elbow or other fixed length connection is made to the pumpstack cargo line, all as will be described in greater detail.

These and other objects, features, and advantages of the invention will become apparent from the following detailed description of the invention, when taken together with the accompanying drawings, in which:

FIG. 1 is a diagrammatic plan view of a multi-purpose pipeline system in accordance with the invention as installed in a parcel tanker vessel, the view being of the main deck;

FIG. 2 is an enlarged and fragmentary plan view showing details of the same pipeline system in the vicinity of a pumpstack, as is associated with each liquid cargo hold of the vessel;

FIG. 3 is a fragmentary and sectional end view of the pipeline system as seen from line 3—3 in FIG. 2;

FIG. 4 is an enlarged fragmentary plan view showing only the manifold header connections of the same pipeline system at the midship location on the vessel;

FIG. 5 is a fragmentary side sectional elevation of the pipeline system as seen from line 5—5 of FIG. 4, certain portions being omitted for clarity;

FIG. 6 is a fragmentary and sectional end elevation of the pipeline system as seen from line 6—6 in either of FIGS. 4 or 5, certain portions being omitted for clarity;

FIG. 7 is a fragmentary perspective view showing further details of the same pipeline system, in the vicinity of the pumpstack at each cargo tank location;

FIG. 8 is a perspective showing of a removable flexible steel pipe connection piece which is used in the system;

FIG. 8A is a diagrammatic showing of a universal arm which might be used as an alternative to the pipe connection piece of FIG. 8; and

FIGS. 9 and 10 are enlarged and fragmentary side sectional showings of the details of a conventional quick-connect type pipe coupling used in the pipeline system, FIG. 9 showing the coupling in open position and FIG. 10 showing the coupling as it appears when a connection is made and the coupling is locked.

Referring first to FIG. 1, a multipurpose pipeline system in accordance with a preferred embodiment of the invention, generally indicated by reference numeral 20, is shown diagrammatically as installed on a parcel tanker vessel or ship which is generally indicated by reference numeral 21. The parcel tanker 21 has a numerous plurality of liquid cargo storage holds or tanks of various capacities, these being arranged in respective aligned rows of tanks located along the port side, the starboard side, and the centerline of the ship and designated respectively by their tank numbers 1P through 11P, 1S through 11S, and 1C through 12C. As indicated at tank 7C in FIG. 1, any of the center tanks may be divided into two smaller tanks 7CS and 7CP, or perhaps into three smaller tanks (not shown). Each of these liquid cargo storage tanks is totally enclosed by its vertical bulkhead structure below the main deck so as to be isolated from its adjacent tanks, thus adapting the tanks for concurrently carrying different liquids without contaminating or mixing one liquid cargo with another. These storage tank division bulkheads are indicated by unnumbered dashed lines in FIG. 1. Also as indicated, these tanks have different capacities, ranging from about 225 to about 2500 cubic meters.

As shown, the ship 21 is an ocean-going vessel of size on the order of about 30,000 tons deadweight or more, but the multipurpose pipeline system of the invention might also be installed on smaller vessels, such as barges, lighter ships, and the like which have only a single line of tanks. Conceivably, the system might also be installed as the pipeline system of a dockside tank farm having numerous aligned storage tanks on land for temporarily storing different liquid cargoes for subsequent ocean transport in parcel tankers such as the vessel 21. It should also be understood that the pipeline system 20 may at times carry vapors rather than liquids, such as return air, or returning volatile or toxic vapors from the liquid storage tanks which are being filled with liquids using other lines of the system, as will be seen. Such a multipurpose pipeline system may also be used for distributing liquid ballast between ballast tanks (not shown) or for carrying inert purging gases, slops from tank washings, liquid or gaseous cleaning chemicals, or air between cargo or ballast tanks. Moreover, and although not illustrated, any of the several pipelines of the system may be steam traced so that the flow may be heated.

In general, and with reference to FIG. 1, the multipurpose pipeline system 20 includes a liquid-cargo pump generally indicated by reference numeral 22 associated with each cargo hold or tank 1S-11S, 1C-12C, and 1P-11P, and a plurality of transfer pipelines, such as the three transfer pipelines 23, 24 and 25, associated with each row of tanks extending in either the forward or aft direction of the ship as seen from the midship location. There are six such rows of tanks indicated in FIG. 1, these being the row of tanks 7S out to 1S; row 8S out to 11S; row 8C to 1C; row 9C to 12C; row 7P to 1P; and row 8P to 11P. Of course, there may be more or less than six rows of tanks. As will be noted, there are fewer transfer pipelines associated with each tank row than the number of tanks in the row. Further, and as indicated at each of the port and starboard tank rows in FIG. 1, all of the transfer pipelines may extend the full length of the tank row or, as indicated at each of the center tank rows in FIG. 1, one or more of the transfer pipelines servicing the row may be terminated short of the one or two outermost tanks in the row as seen from amidships, depending upon the anticipated circumstances of use of the system. Moreover, the mounting of all of the piping in the system on the main deck 40, rather than below decks, avoids the piercing of bulkheads in the way of cargo lines.

The liquid cargo line of each cargo pump 22 may be selectively connected to an adjacent pipe connection opening of any one of its three associated transfer pipelines 23, 24 or 25 via a removable flexible steel pipe connection, universal arm, or even a rigid 90° pipe elbow, as will be described. It will be noted that the system eliminates the need for a liquid cargo handling pumproom, and can afford either local control of each pump, or overall control of all pumps.

The pipeline system 20 also includes a plurality of transverse header pipelines, commonly called transverse headers 26. As seen in FIG. 1, the system 20 may include twelve such headers 26 servicing a total of eighteen transfer pipelines 23, 24 and 25, although fewer or more headers 26 might have been included. That is, it will be noted that, whereas each of the transfer pipelines 23, 24 25 which service the two centerline tank rows 1C-8C and 9C-12C is connected to only one transverse header 26, the two port and starboard transfer pipelines 23 servicing tank rows 1S-7S and 1P-7P are connected to a common transverse header, as are the respective port and starboard transfer pipelines 24 and the respective port and starboard transfer pipelines 25 which service the same tank rows, and that common transverse headers 26 are similarly provided for each of the similar pairs of port and starboard transfer pipelines 23, 24 and 25 which service the tank rows 8S-11S and 8P-11P. Were the similar port and starboard pairs of transfer pipelines 23, 24 and 25 of each of the centerline tank rows 1C-8C and 9C-12C similarly connected to respective common headers 26, the number of transverse headers 26 would be reduced to nine, and it is apparent that the number of headers would be further reduced were more than two transfer pipelines connected to each. And, of course, were each of the transfer lines 23, 24 and 25 in the entire system to be provided with its own header 26, the number of transverse headers 26 would total eighteen. Although not illustrated, a presently preferred embodiment has sixteen

transverse headers, only two pairs of transfer lines having their respective common header. In this arrangement the 16 headers might be placed in two banks of eight headers, placed one over the other, instead of alongside of each other as illustrated.

The pipeline system **20** as shown in FIG. **1** also includes a pair of longitudinal extending, collecting manifold pipes **27** and **28**, each being at opposite sides of the vessel **21**, and to each of which the transverse headers **26** may be connected by separate and removable pipe elbows or flexible pipe connection pieces as generally indicated by dotted lines **29** and as will be further described. The longitudinal headers **27** and **28** each have shore hose connection outlets **30**, which are fitted with standard ASA **150** flanges.

The longitudinal transfer lines **23, 24 25**, the transverse headers **26**, and the longitudinal collecting manifolds **27, 28** are of appropriate diameter pipe, and made of appropriate material for their contemplated use. Preferably, they are made of 6 inch or 8 inch diameter stainless steel **316-L** pipe.

In addition, each transfer pipeline **23, 24, 25** has a shutoff valve **31, 32, 33**, respectively, also preferably of stainless steel, at its end which connects with one of the transverse headers **26**. One or more further shutoff valves **34** are spaced about 50 feet apart along its length to limit the extent of flow through the line to the vicinity of the tank being serviced, thus to reduce the length of pipe which must be cleaned under certain obvious conditions. These valves **34** may be of an automatic shutoff type actuated by high level alarm, as may be required by any pertinent regulation. Quick-connect plugs or shutoff valves, not shown in FIG. **1** but as will be described, close all pipe connection openings in each of the transfer lines **23, 24, 25** other than the one or more of such openings which at that time are flow-connected to a corresponding one or more of the pumpstack cargo lines or tank vapor openings. In this regard, it should be noted that each liquid cargo tank **1S-11S. 1C-12C**, and **1P-11P** has a vapor vent opening **35** which, as indicated in dashed lines at tank **4P**, may also be connected by a removable flexible pipe or the like to one of the three transfer lines **23, 24, 25** associated with the tank.

To control the flow through any transverse header **26** to or from either of the longitudinal collecting manifolds **27** or **28**, and to limit the flow in the header to the vicinity of the transfer line **23, 24**, or **25** being serviced, each transverse header **26** is provided with two or four shutoff valves **36**, as located and appearing in FIG. **1**.

Thus, by opening the appropriate shutoff valves **36, 34** and one or more of the transfer pipeline valves **31, 32** and **33**, and by uncapping and connecting the appropriate transfer line opening to one or more of the cargo tank pumpstacks as necessary, flow of liquid cargo between the dockside at either or both sides of the vessel **21** and any one or more of the cargo tanks **1S-11S, 1C-12C** and **1P-11P** can be established via the collecting manifolds **27** and/or **28**, one or more of the transverse headers **26**, and one or more of the transfer lines **23, 24** and/or **25**, as will be apparent from FIG. **1**. It will be apparent that returning vapors from each tank being filled can be concurrently handled through an appropriate one of the remaining transfer pipelines **23, 24** or **25** and its associated transverse header **26** to dockside from an end of the latter, without need for passing the vapor through one of the collecting manifolds **27** or **28**.

Turning now to the details of the system **20**, and with reference to any liquid cargo hold or storage tank such as the typical tank **4P** (FIGS. **1** and **3**), the control mechanisms **22***a* of its deepwell pump **22** are mounted on the upper or main deck **40** of the vessel **21** above the storage tank **4P**, only the pump impeller **22***b* being situated at the bottom of the tank **4P** to induce upward movement, as indicated by arrow A, of the liquid cargo to discharge through the cargo line **22***c* of the pumpstack. During loading, dockside pumps pump the liquid cargo L to and down the cargo line **22***c*, as indicated by arrow B. Location of the pump drive on the main deck makes it easily accessible for maintenance and repair. Although other types of pumps might be employed, a conventional hydraulically driven, Frank Mohn centrifugal type deep well pump is suitable for the purpose. Its hydraulic lines are indicated by reference numeral **22***d*. Although not illustrated, it will also be understood that the impeller **22***b* might actually be disposed within a sump at the bottom of the tank **4P** for more complete discharge of the liquid cargo, as is known. The pump **22** is preferably located towards the inboard side and at the aft end of the cargo tank **4P**. Since only the pump impeller, hydraulic line, and cargo line are located within the hold, it will be noted that the individual cargo tanks can be easily cleaned.

The pumpstack cargo line extension **41**, which is a continuation of the cargo line **22***c*, projects upwardly from the main deck **40** and has two pipe openings or outlets for receiving and discharging liquid cargo L, or ballast, inert gas, etc. The first of these is the 90° pipe elbow outlet **42** at its top which is swivelable in the horizontal plane, or which faces outboard, to facilitate direct connection to dockside loading or discharge hoses, if desired. This outlet **42** has a standard ASA **150** flange fitting and is normally closed by a flange cover **42***a*. It is provided as a means to by-pass the remainder of the pipeline system with respect to any tank, if desired.

The second hose connection opening in the cargo line extension **41** is an outlet **43** which faces inboard although it might also be swivelable, and which is preferably fitted with a quick-connect type female coupler **44**. Although it may be of another type, the coupler **44** is preferably a conventional coupler as sold under the trademark EVER-TITE by the EVERTITE Coupling Co., Inc. of New York, New York, which is illustrated in detail in FIGS. **9** and **10**. The coupler **44** has locking handles **45** for coupling a co-mating male coupler **46** (FIGS. **8–10**), or a co-mating male plug which, though not shown in the coupler **44**, would be similar to the plug **47** shown in FIG. **7** positioned within a similar female coupler **53** on the pipe connection opening **50** of the transfer line **25**. Alternatively, and as illustrated in FIG. **8A**, the outlet **43** may have a fixed pipe length or arm **43***a* mounted thereon via a universal connection joint **43***b*. The outer free end of the pipe arm **43***a* has a universal joint outlet **43***c* carrying a male quick-connect coupler **46** for connection to a female coupler on any of the transfer lines **23, 24** or **25**, as will be understood.

Referring to the FIG. **3** embodiment and as shown in FIG. **8**, a quick-connect male coupler **46** is attached on each of the opposite ends of a flexible, stainless steel pipe connection piece **55** which is used to connect the cargo line extension outlet **43** to any selected one of the adjacent transfer pipelines **23, 24** or **25** via their respective pipe connection openings **48, 49** and **50**

(FIGS. 3 and 7) to which respective quick-connect female couplers **51, 52** and **53** are attached. These female couplers have respective locking handles **56, 57** and **58.**

Although diagrammatically illustrated in FIG. **1** as being laterally adjacent to each other, as shown particularly in FIGS. **2, 3** and **7,** the middle transfer pipeline **24** is laterally offset in the inboard direction of the ship, about **21** inches from the vertical plane of alignment of the other transfer pipelines **23** and **25** whose respective downward and upwardly facing openings **48** and **50** lie within the same vertical plane. As particularly shown in FIGS. **2** and **7,** the pipe opening **49** of the middle transfer pipeline **24** is formed by a 90°-pipe elbow, oriented in a horizontal plane, thus to align all three of the transfer line pipe openings **48, 49, 50** within the same vertical plane. Further, and as will be understood from a comparison of FIGS. **2, 3** and **7,** the mouths of all of the pipe openings **48, 49, 50** are spaced an equal distance away from the mouth of the pumpstack opening **43** at respective points which are arcuately spaced 90° apart along an imaginary circle whose center lies on the horizontal axis of the pumpstack opening **43,** the radius of the circle being equal to the spacing distance, about 21 inches, between the mouth of the pumpstack opening **43** and the plane of the transfer pipeline openings **48, 49, 50.** Accordingly, as indicated by the dashed line or full line showings in FIGS. **2, 3** and **7,** this same pipe connection piece **55** is used to connect the pumpstack openings with any of its adjacent transfer pipeline openings and, because such uniform spacing distance is employed at all pumpstacks, the same connection piece **55** might be carried from one pumpstack to another and used to form the same connections at each, as required. Also, it will be noted that, instead of being a flexible pipe as illustrated, the connection piece **55** might be in the form of a rigid, 90°-pipe elbow. In either instance it might be provided with handles (not shown) for easy carrying and handling when making the required connection.

Returning briefly to FIG. **8A,** it will be understood from the dotted line showings that the universal arm **43***a* is pivotable at its end **43***b* for connection of its outer end male coupler **46** to any of the couplers **51, 52** or **53** of the transfer lines **23, 24** or **25.**

Thus, upon connection of the pumpstack cargo discharge and loading line extension opening **43** with any one of the transfer pipeline openings **48, 49, 50** by means of the pipe connection piece **55** as illustrated in FIGS. **2, 3** and **7,** or the universal arm as illustrated in FIG. **8A,** liquid cargo L from the tank **4P** may be pumped by the deepwell pump **22** upwardly through its cargo discharge and loading line **22***c* and its extension **41,** and thence through the outlet **43** into the selected one of the transfer lines **23, 24** or **25.**

The liquid may be conveyed by the transfer line either to its associated transverse header **26** and thence to dockside either directly from an end of the latter or via one of the collecting manifolds **27** or **28** as previously mentioned, or to the cargo line extension **41** of any other tank to which the liquid is to be transferred, either in the same aligned series of tanks or in any other series of tanks depending upon the flow connection made using the transverse and longitudinal headers **26, 27, 28** as necessary.

Of course, all transfer pipeline openings **48, 49, 50** throughout the pipeline system as are not being used remain capped, as by removable plugs **47** (FIG. **7**). Either additionally or alternatively each of the openings **48, 49, 50** may be closed by a gate or ball type shutoff valve **80,** as illustrated only in FIGS. **2** and **3.**

Similarly, liquid cargo L can be pumped from dockside to any tank using the pump **22** at the tank to which the liquid is directed, and appropriate flow connections between the longitudinal and transverse headers and one of the transfer pipelines, as will be apparent. Concurrent vapor return to dockside from the tank being filled can be effected by a similar hose connection **56** (FIG. **1**) between its vapor vent opening **35** and another of the transfer lines, and thence by appropriate flow connections to dockside.

The preferred arrangement and possible connections between all of the transfer pipelines **23, 24, 25,** transverse headers **26,** and collecting manifolds **27** and **28** in the preferred pipeline system **20** are best understood by a comparison of FIGS. **1** and **4–6.**

Especially from FIG. **5,** it will be noted that all of the transverse headers **26** are preferably disposed within a common imaginary plane at the same elevation, about 5 feet above the vessel's main deck **40,** as are the highest ones of the vertically spaced apart transfer pipelines whose vertical spacing is about 21 inches. Alternatively, the headers **26** may be disposed in two or more banks or tiers, as previously noted.

The collecting manifolds **27** and **28** are disposed at a lower elevation than the headers **26** to that an elbow-shaped or flexible steel pipe connection piece **29** can be used to connect any of the upwardly facing longitudinal header openings **60** to the open end of its associated transverse header **26.**

To connect with their respective transverse headers thereabove, each of the transfer pipelines **23, 24, 25** below the level of the transverse headers has a 90° upward extension **23***a*, **24***a*, **25***a*, respectively. The banks of headers **26** and pipelines **23, 24, 25** are supported on the main deck **40** by suitable frame supports **59.**

The collecting manifolds **27** and **28** further have several outboard facing dockside connection openings **63, 64,** respectively, each of these having a standard dockside ASA **150** flange fitting **65** thereon, and it will be understood that all of the header and manifold openings **61, 62** and **65** remain capped, as by respective flange plates **66** (FIG. **4**) when not being employed to make a flow connection. Although not specifically illustrated it will also be understood that any open pipe end to which a shore or barge line connection might be made, such as the ends **61** of the transverse headers **26,** the collecting manifold openings **62, 63** and **64,** and the ends of the transfer lines **23, 24** and **25** nearest the bow and stern ends of the vessel **21,** are fitted with standard ASA **150** flanges.

As previously mentioned, all of the transfer pipelines **23, 24, 25** have their respective shut-off valves **31, 32,** and **33,** and all of the transverse headers **26** have their respective shut-off valves **36** at each end, and also between the transfer pipeline connection points where more than one transfer pipeline is connected to the header. These valves are all normally kept closed, and in such condition all of their valve stem handwheels **70** will be disposed at a common elevation as illustrated in FIGS. **5** and **6.** However, when any valve is opened its handwheel **70** will be higher than the others, as the handwheels **70***a* also shown in FIGS. **5** and **6,** and such will afford visual display at the main deck of the flow connections which have been made. Of course, any of

these valves may be of an automatic closing type, as previously mentioned.

So that every pipeline and header in the system **20** may be easily and thoroughly cleaned and inspected, and referring briefly to FIG. **1**, it will be noted that at the outer ends of each transfer pipeline **23, 24, 25** (the ends thereof opposite those which connect with the headers **26**) are capped by removable flange covers **75** and, referring to FIGS. **4** and **5**, at their inner ends (those connected to the transverse headers **26**) are capped by removable flange covers or end caps **76.** Similarly, collecting manifolds **27** and **28** have removable flange covers **77** covering their standard ASA **150** flange fittings **78.** Moreover, it will be noted that all of the pipelines and headers are perfectly straight, excepting for expansion loops as may be necessary. Thus, every pipeline and header can be cleaned and inspected by removal of end plugs or end flanges or caps **47, 75, 76,** or **77,** as the case may be.

It will be noted that only standard pumps, valves, couplers and the like, and no special machinery, are required in the system **20.** The system is therefore very reliable in operation and uncomplicated so that no special training of personnel is required for its operation or maintenance.

Thus, a multi-purpose pipeline system has been described which achieves all of the objects of the invention.

What is claimed is:

**1.** A fluid storage tank and pipeline system comprising a plurality of storage tanks, a plurality of transfer pipelines extending adjacent to and between said plurality of tanks for conducting fluids to and from selected ones of the tanks, said plurality of transfer pipelines being fewer in number than said plurality of storage tanks, each of said storage tanks having means providing a pipe connection opening of the tank, each of said plurality of transfer pipelines having respectively opposite ends and further having means providing pipe connection openings thereof respectively associated with, but spaced from each said storage tank pipe connection opening, means for closing selected ones of said transfer pipeline pipe connection openings, movable pipe connection means for connecting said pipe connection opening on any storage tank to a selected one of said transfer pipeline pipe connection openings associated with the tank, removable cap means on each of said respectively opposite ends of each said transfer pipeline, and a plurality of shutoff valves in each of said transfer pipelines, one of said shutoff valves in each said transfer pipeline being adjacent to an end thereof which is common to such valved end of each other of said plurality of transfer pipelines, and the others of said shutoff valves being at respective locations between two of said pipe connection openings in the transfer pipeline with which the valve is associated.

**2.** A system according to claim **1,** wherein at least some of said storage tanks further have respective means providing a vapor vent presenting a second pipe connection opening of the tank, and which further comprises movable pipe connection means for connecting said second pipe connection opening of any storage tank to any selected one of said transfer pipeline pipe connection openings associated with the tank.

**3.** A system according to claim **1** wherein said transfer pipeline pipe connection openings associated with each said storage tank are disposed at respective, substantially equal distances away from said pipe connection opening of the tank.

**4.** A system according to claim **3** wherein said pipe connection means for connecting said pipe connection opening of any said storage tank to any selected one of its said associated transfer pipeline pipe connection openings comprises a pipe arm having a free end carrying a universally mounted, quick-connect pipe coupler, and means pivotally connecting the opposite end of said pipe arm to said storage tank pipe connection opening.

**5.** A system according to claim **3** wherein said pipe connection means comprises a length of piping having a quick-connect pipe coupler on each of its ends, and each of said pipe connection openings of said storage tanks and of said transfer pipelines has a co-mating quick-connect pipe coupler thereon.

**6.** A system according to claim **5** wherein said length of piping comprises flexible pipe.

**7.** A system according to claim **5** wherein said length of piping comprises a substantially elbow-shaped, rigid pipe connection piece.

**8.** A system according to claim **3** wherein each of said transfer pipeline pipe connection openings associated with any one of said tanks is disposed within a plane and at an arcuately spaced apart location with respect to any other of said transfer pipeline pipe connection openings along the circumference of an imaginary circle whose center is on the axis of said pipe connection opening of the tank.

**9.** A system according to claim **8** wherein said transfer pipeline pipe connection openings associated with any one said tank are disposed within a plane extending transversely with respect to the axis of said pipe connection opening of the tank.

**10.** A system according to claim **9** wherein said plane of said transfer pipeline pipe connection openings associated with any said storage tank is spaced from said pipe connection opening of the tank along its said axis.

**11.** A system according to claim **1** wherein said storage tanks are substantially aligned with each other, and said transfer pipelines extend substantially parallel to each other, each said transfer pipeline having one of said pipe connection openings thereof associated with each of said storage tanks.

**12.** A fluid storage tank and pipeline system comprising a plurality of storage tanks, a plurality of transfer pipelines extending adjacent to and between said plurality of tanks for conducting fluids to and from selected ones of the tanks, said plurality of transfer pipelines being fewer in number than said plurality of storage tanks, each of said storage tanks having means providing a pipe connection opening of the tank, each of said plurality of transfer pipelines having means providing pipe connection openings thereof respectively associated with, but spaced from each said storage tank pipe connection opening, each of said transfer pipeline pipe connection openings associated with any one of said tanks being disposed at an arcuately spaced apart location with respect to any other of said transfer pipeline pipe connection openings along the circumference of an imaginary circle whose center is on the axis of said pipe connection opening of the tank and whose plane extends transversely with respect to said axis of, and is spaced from said pipe connection opening of the tank, means for closing selected ones of said transfer pipeline pipe connection openings, and movable pipe connection means for connecting said pipe connection

opening on any storage tank to any selected one of said transfer pipeline pipe connection openings associated with the tank, said plane of said imaginary circle along which said transfer pipeline pipe connection openings are disposed being a vertical plane, said plurality of transfer pipelines comprising three longitudinally extending and vertically spaced apart transfer pipelines, the upper and lower of said three transfer pieplines being disposed within said vertical plane of their said pipe connection openings, the middle one of said three transfer pipelines being spaced in lateral direction a farther distance away from said pipe connection opening of said associated tank and having a substantially elbow-shaped section of pipe connected thereto, said elbow-shaped pipe section having an open end disposed within said plane of said transfer pipeline pipe connection openings to thereby provide said pipe connection opening of said middle transfer pipeline.

**13.** A fluid storage tank and pipeline system comprising a plurality of storage tanks, a plurality of transfer pipelines disposed along substantially the tops of and extending between said plurality of storage tanks for conducting fluids to and from selected ones of the tanks, said plurality of transfer pipelines being fewer in number than said plurality of storage tanks, each of said storage tanks having means providing a pipe connection opening of the tank, each of said plurality of transfer pipelines having means providing pipe connection openings thereof respectively associated with, but spaced from each said storage tank pipe connection opening, means for closing selected ones of said transfer pipeline pipe connection openings, movable pipe connection means for connecting said pipe connection opening on any storage tank to any selected one of said transfer pipeline pipe connection openings associated with the tank, and a deepwell pump associated with each said storage tank for pumping said fluids out from the tank, each said pump having a liquid cargo line through which said fluids flow to and from the tank, said liquid cargo line having means defining a pipe connection opening which provides said pipe connection opening of the tank with which the pump is associated.

**14.** A system according to claim **13** wherein each said pump has control means disposed substantially on the top of said tank with which the pump is associated, and an impeller disposed within, and substantially at the bottom of the tank.

**15.** A system according to claim **13** wherein said storage tanks are fluid cargo holds of a water-borne vessel, said plurality of transfer pipelines being mounted on and extending in longitudinal direction of the vessel along its main deck, and which further comprises a plurality of transverse header pipelines mounted on the main deck of said vessel, each of said transfer pipelines being connected at one of its ends to one of said transverse header pipelines, the opposite end of each of said transfer pipelines having a pipe connection means including removable closure means, and each said transverse header pipeline having a pipe connection means including openable closure means at an end thereof adjacent to a side of said vessel.

**16.** A fluid storage tank and pipeline system comprising first and second pluralities of storage tanks, first and second pluralities of transfer pipelines respectively associated with and extending adjacent to and between the respective of said first and second pluralities of tanks for conducting fluids to and from selected ones of the tanks in each of said pluralities thereof, said first and second pluralities of transfer pipelines each being fewer in number than said first and second pluralities of storage tanks with which they are respectively associated, each of said tanks having means providing a pipe connection opening of the tank and each of said first and second pluralities of transfer pipelines having means providing pipe connection openings thereof respectively associated with, but spaced from each said storage tank pipe connection opening of said plurality of tanks with which the plurality of transfer pipelines is associated, means for closing selected ones of said pipe connection openings of said first and second pluralities of transfer pipelines, movable pipe connection means for connecting said pipe connection opening on any of said storage tanks to any selected one of said transfer pipeline pipe connection openings associated with the tank, and a plurality of transverse header pipelines, each of said transfer pipelines in said first and second pluralities of transfer pipelines being connected at one of its ends to one of the said transverse header pipelines, the number of said transverse header pipelines being fewer than the number of transfer pipelines in said first and second pluralities of transfer pipelines.

**17.** The system according to claim **16** which further comprises a collecting pipe manifold having means providing a plurality of pipe connection openings thereof, means for closing selected ones of said collecting pipe manifold pipe connection openings, each of said transverse header pipelines having means providing a pipe connection opening adjacent to said collecting pipe manifold, movable pipe connection means for connecting a selected one of said collecting pipe manifold pipe connection openings to a selected one of said adjacent transverse header pipeline pipe connection openings, and shut-off valve means in each of said transfer pipelines and transverse header pipelines, whereby a fluid flow connection can be made between any of said storage tanks, said pipe connection openings at the ends of said transverse header pipelines, and said pipe connection openings of said collecting pipe manifold and any other.

**18.** The system according to claim **17** wherein said storage tanks are fluid cargo holds of a water-borne vessel, said transfer pipelines being mounted on and extending in longitudinal direction of the vessel along its main deck above the tanks with which they are respectively associated, said transverse header pipelines being mounted on and extending transversely across said main deck of the vessel at a midship location, and said collecting pipe manifold being mounted on and extending in said longitudinal direction at one side of said vessel.

**19.** The system according to claim **18** which further comprises a second collecting pipe manifold mounted on and extending in said longitudinal direction at the other side of said vessel, said second collecting pipe manifold having means providing a plurality of pipe connection openings thereof and means for closing selected ones of said second collecting pipe manifold pipe connection openings, each of said transverse header pipelines having means providing a pipe connection opening adjacent to said second collecting pipe manifold, and movable pipe connection means for connecting selected ones of said second collecting pipe manifold pipe connection openings to selected ones of said adjacent transverse header pipeline pipe connection openings.

20. The system according to claim 19 wherein said transfer pipelines and said transverse header pipelines and said first and second collecting pipe manifolds are substantially straight and have cappable clean-out and inspection openings at each of their respective ends.

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