May 11, 1965 G. T. R. CAMPBELL ET AL 3,182,669

COMBINED TANKER SERVICE UNIT

Filed May 7, 1963 4 Sheets-Sheet 1

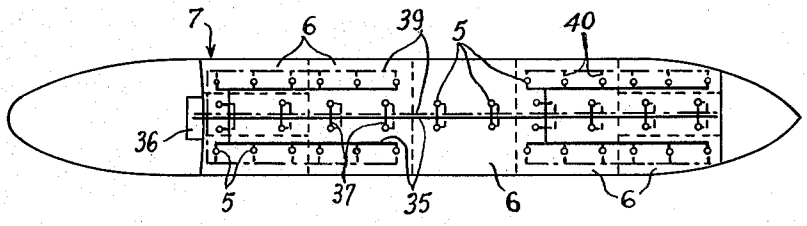

Fig. 1

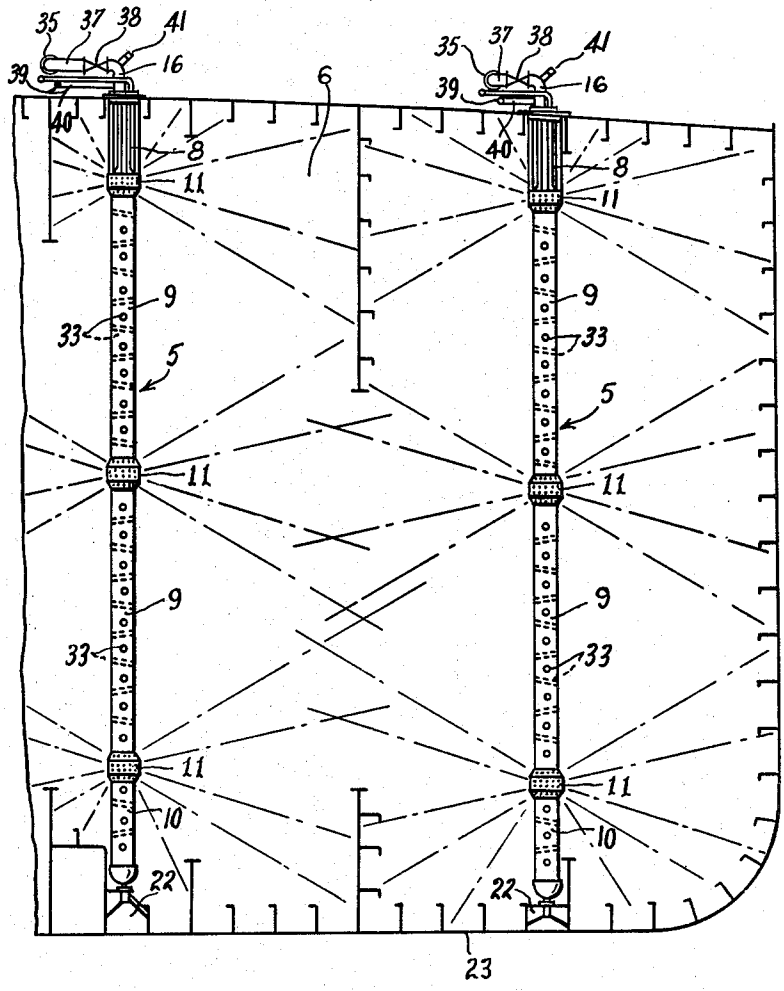

Fig. 2

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COMBINED TANKER SERVICE UNIT

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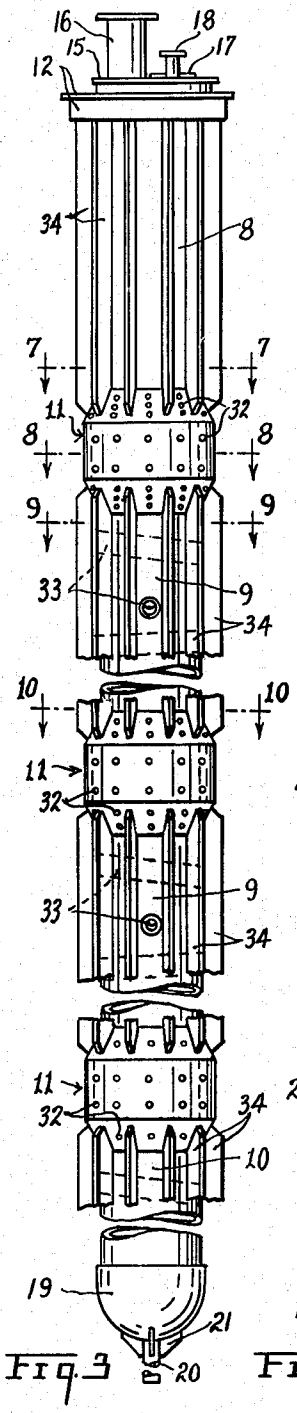

Fig. 3

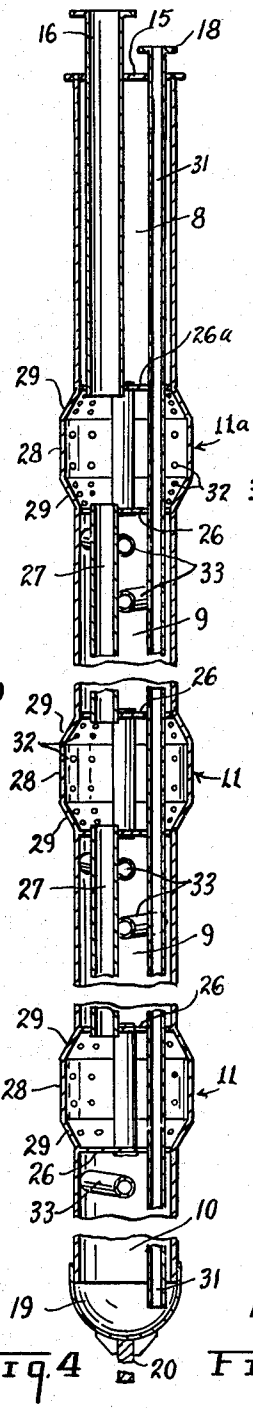

Fig. 4

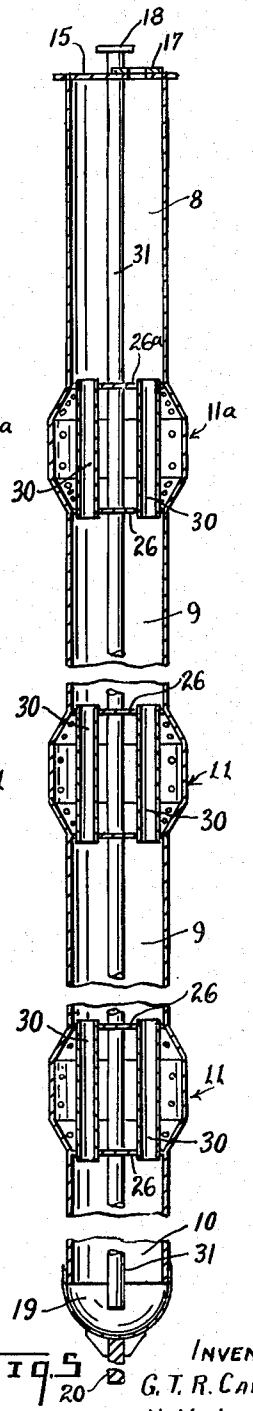

Fig. 5

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COMBINED TANKER SERVICE UNIT

Filed May 7, 1963 4 Sheets-Sheet 3

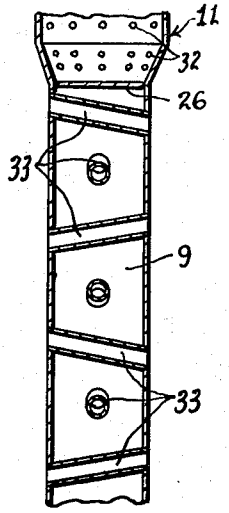

Fig. 6

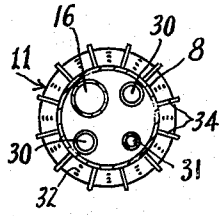

Fig. 7

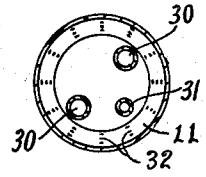

Fig. 8

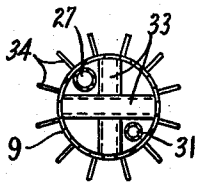

Fig. 9

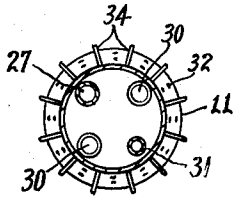

Fig. 10

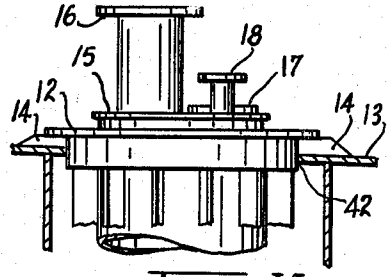

Fig. 11

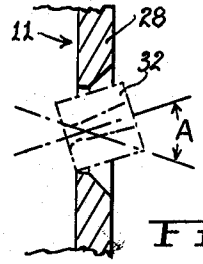

Fig. 14

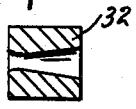

Fig. 15

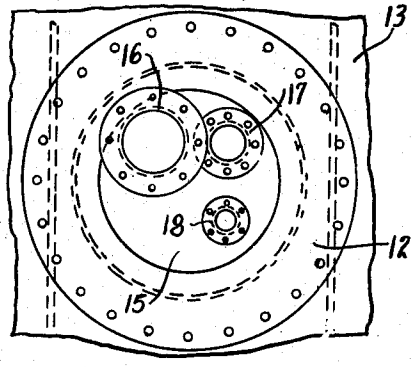

Fig. 12

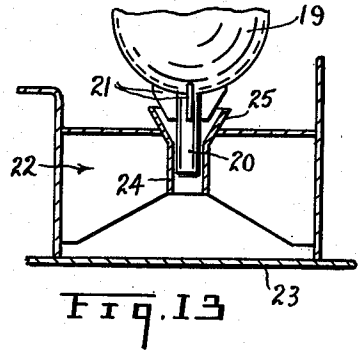

Fig. 13

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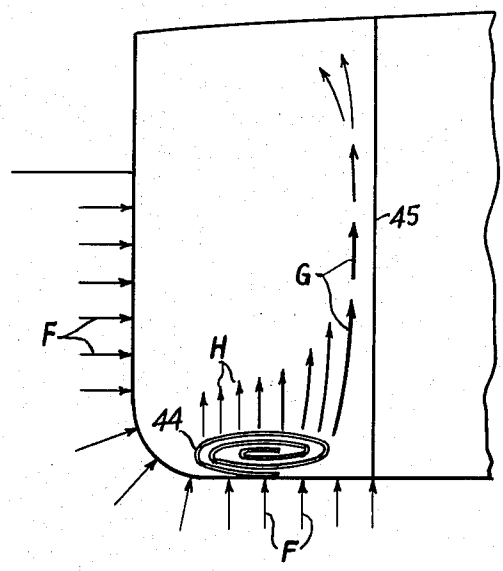

FIG. 16
PRIOR ART

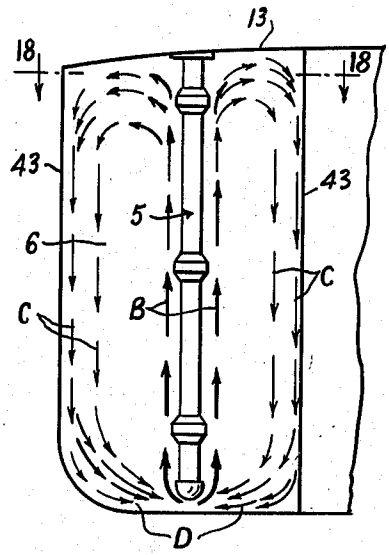

FIG. 17

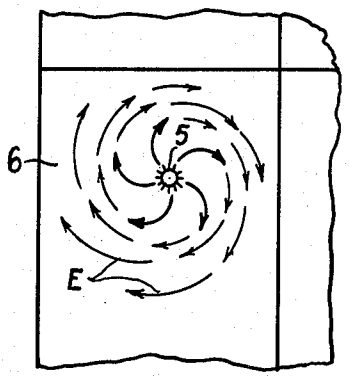

FIG. 18

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United States Patent Office 3,182,669 Patented May 11, 1965

3,182,669

COMBINED TANKER SERVICE UNIT

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Filed May 7, 1963, Ser. No. 278,622
Claims priority, application Canada, Mar. 30, 1963, 872,164
10 Claims. (Cl. 134—105)

This invention relates to service units for tanker vessels and particularly to combining in single service units the normal heating, cleaning and steam smothering systems provided in vessels equipped for the carriage of liquid petroleum products and liquid chemicals in bulk.

Standard type tank heating

At the present time liquids carried in bulk in tank vessels are heated by a series of grids of piping approximately evenly distributed over and as close as possible to the bottom of the compartment, permanently installed and supplied with steam flowing through the inside of the pipes. In some cases the grids also extend partway up the sides of the compartments. Other systems also incorporate the use of a series of spiral coils fed from the bottom grids and such spiral coils extend vertically an average of about 4 feet above the bottom of the compartment. The steam supply to these coils is led from a common steam main on deck and thence to the coils in each compartment by the supply line through the deck. The exhaust returns from these coils are similarly piped to a common exhaust main on deck.

The use of these horizontal heating coils at the bottom of a tank or compartment is satisfactory when the depth of fluid to be heated above the coil is not large.

When the depth is large and particularly when a viscous fluid is being heated it is not always possible to set up satisfactory convection currents in the fluid, particularly when the heating elements are entirely located at the bottom.

Standard type tank cleaning

The tanks are usually cleaned by using a series of rotating water jets provided through what are known as "Butterworth Machines." These machines are of a portable type and are connected to a hot sea water supply line on deck by long portable rubber hoses. There are a number of holes provided in the deck of each compartment and known as "Butterworth" openings. Bolted cover plates are provided to seal these openings when carrying fluids in the compartments. To clean a compartment the plate is removed, the "Butterworth" head placed in the compartment and positioned just below the deck. The water is then supplied to the "Butterworth" head and the head gradually lowered into the tank compartment as the internal structure of the compartment becomes clean by the application of the hot water on the surfaces. In order to fully cover all areas of the surfaces to be cleaned a rope is attached to the "Butterworth" head and the head is manually directed into areas not covered by the head when operating in a vertical direction in line with the hole. This is applied in order to keep the number of heads at a practical quantity. The operation requires two men per head to handle the equipment. A large vessel carries up to a total of eight "Butterworth" heads for cleaning purposes and these are transported from one compartment to another in the process of tank cleaning. Smaller vessels have a smaller number of heads. The "Butterworth" cleaning system is used in conjunction with a seawater heater and a large independent pump having a discharge pressure of about 220 lbs./sq. in. gauge and both units are usually located in the engine room of the ship.

Steam smothering

Steam smothering for use in the event of a fire occurring in a compartment carrying fluid bulk cargoes is usually provided in the form of a separate permanently mounted pipe line supplied by steam from a common main steam line located on the main deck. The pipe to the compartment is led through the main deck and extended in the compartment a short distance and having a separate shut off valve external to the compartment, for each compartment steam supply.

The present invention which incorporates all three services, heating, cleaning and steam smothering, consists essentially of a series of vertical tubular structure to which independent steam and water supply lines are connected from the respective supply sources.

Each of the tubular structures extend vertically downwards from the main deck or compartment top of the vessel to bottom shell of the vessel and are secured to the main deck or compartment top by bolting or studs through a flange and at the bottom end are held in position by a large round guide which fits into a socket permanently attached to the structure of the compartment. The steam and water supply lines are secured to fittings on top of the units external to and above the compartment. It is, therefore, possible to remove any one of the units from the compartments when fully loaded with fluid or empty as required. The units may be removed or replaced without entering or gas freeing the compartments. In the event that a unit fails for any reason it can be shut off without completely shutting off the heating, cleaning or smothering systems from the compartment as the units are all operated independently.

The three systems required are provided within each unit in the following manner.

Tank cleaning

There are three (more or less as required) circular spray diffuser belts constructed within the tubular structure units. Each belt is provided with a series of spray nozzles so arranged and in sufficient number to provide jets of water in sufficient quantity and at such a pressure as to cause the removal of other fluid and foreign matter from a predetermined area of the structure within the fluid carrying compartment. Each unit incorporating three diffuser belt units requires about the same amount of water per hour as a normal "Butterworth" head. Each belt is supplied with water simultaneously by means of supply pipes permanently built into the unit and decreasing in size between each progressive belt to suit the volume of water required at equal pressure in each belt, as illustrated. When water is supplied under the required design pressure the entire area of the compartment covered by the unit is cleaned simultaneously. The water supply lines to each unit are permanently piped up to the respective units. Either the cargo lines on deck, the fire line or a separate line may be used for this purpose. Either the main cargo pumps or a separate pump may be used to supply the water to the units. The water to each unit is controlled independently and can be operated from a central control system or by individual shut off arrangements at the top of each unit as desired. By this arrangement it is possible to clean all or any selected number of the compartments simultaneously. The operation is not dependent upon the weather conditions, to the same extent as with the "Butterworth" system and one man can operate the entire system. Correspondingly the system is safer for ship's personnel to operate under bad weather conditions than is the case with the conventional system.

Tank heating

Steam is supplied to each unit in a similar manner to that provided for the standard heating coil systems de-

scribed above. Thereafter the steam is admitted to the top of each unit and the entire tubular structure is subjected to heat simultaneously. The diffuser belts are heated and the compartments between each diffuser made common by pipes connected through each diffuser. The exhaust is returned from the head of the unit to the condensate system of the ship in a similar manner to the normal heating coil system. The heating quality of the unit is completely maintained by the particular arrangement of exhaust line within each unit. To accomplish this the exhaust line is lead to the bottom of the unit and thereby all condensing water formed from the heating steam is collected in the bottom of the unit and forced up the exhaust line within the unit before any steam can pass up the exhaust. A separate heating coil of the standard construction may be provided round the suction drop pipe of any compartment, with separate steam and exhaust for use when pumping or draining a compartment when desired.

A test cock is provided on the exhaust riser pipe at the head of the unit in order to provide easy testing for leaks and for drainage by the use of compressed air in cold weather, when the heating system is not in use.

With this vertical type of heating unit a continuous convection current is ensured. This condition is obtained by the fact that the hot outer surface of the tube forms a "vehicle" or means of escape for the passage of the warmed belt of fluid is available adjacent thereto by virtue of the tube being vertical and extending to the surface of the fluid within the compartment. By this arrangement, a strong convection current is initiated and maintained at all times as long as heat is provided within the heating unit. The motion of the vessel in a seaway also positively assists in the uniform heating of the fluid under such conditions. The heating surface area required per cubic foot of fluid stowage space is consequently much less than the surface area required for the standard grid system and the fuel required for cargo heating on a voyage is correspondingly reduced.

Steam smothering and fire extinguishing

The tank cleaning section of the unit may be used to extinguish a fire within the compartment as the jets in the upper diffuser provide a water spray above the stored liquid, except when the compartment is almost filled. In the event that a fire occurs within a full compartment it is usually possible to draw off some of the fluid quickly and thus make available the top diffuser for fire extinguishing.

For steam smothering a steam line is connected to the inlet to the water washing downcomer inside the unit. By admitting steam in this manner a complete blanket of steam can be quickly distributed over the surface of the liquid within the compartment. This also avoids an extra piercing of the deck which is necessary when the conventional steam smothering system is provided.

The primary object of the invention is to provide one or more service units in a fluid carrying compartment or tank which will combine tank heating, cleaning and steam smothering services.

A further object of the invention is to provide combined service units for fluid carrying tanks which can readily be withdrawn and replaced regardless of whether the tank is full or empty.

A further object of the invention is to provide a series of combined service units which are individually serviced from sources of supply external of the fluid carrying compartments or tanks.

A further object of the invention is to provide a series of combined service units which will eliminate the necessity of fixed individual heating, cleaning and steam smothering services.

A further object of the invention is to provide combined service units which will induce more effective and efficient convention currents during heating of the fluid contained within the compartment or tank.

A further object of the invention is to provide combined service units which will counteract to a greater extent the effect of cold sea water on the walls of the fluid compartment or tank.

These and other objects of the invention will be apparent from the following detailed description of the invention and the accompanying drawings, in which:

FIG. 1 is a deck plan view of a tank vessel showing the layout of service pipes connected to individual combined service units.

FIG. 2 is a partial cross section of a tanker vessel showing the installation of two combined service units.

FIG. 3 is an enlarged partial vertical elevation of one of the combined service units shown in FIG. 2.

FIG. 4 is a vertical sectional view of the unit shown in FIG. 3 taken on a vertical plane at 45° from the plane of FIG. 3.

FIG. 5 is a vertical sectional view similar to FIG. 4 but taken on a vertical plane at right angles to the plane of FIG. 4.

FIG. 6 is a partial vertical sectional view showing the arrangement of cross pipes permitting passage of fluid through the unit for heating purposes, in this view service pipe connections have been omitted.

FIG. 7 is a horizontal section taken on the line 7—7 of FIG. 3.

FIG. 8 is a horizontal section taken on the line 8—8 of FIG. 3.

FIG. 9 is a horizontal section taken on the line 9—9 of FIG. 3.

FIG. 10 is a horizontal section taken on the line 10—10 of FIG. 3.

FIG. 11 is an enlarged vertical elevation of the top end of the unit showing the deck mounting.

FIG. 12 is a plan view of FIG. 11.

FIG. 13 is an enlarged vertical elevation of the lower end of the service unit showing the method of locating and supporting the unit on the bottom hull structure.

FIG. 14 is a partial sectional elevation of the wall of a diffuser belt showing the adjustable angle of setting of the nozzle.

FIG. 15 is a vertical section of one of the nozzles.

FIG. 16 is a diagram of a transverse section of a tanker vessel showing the effect of cold sea water when a standard heating coil is used at the bottom of a fluid containing compartment.

FIG. 17 is a diagram similar to FIG. 16 but showing the convection currents induced by the use of the service unit of the present application.

FIG. 18 is a plan view diagram on the line 18—18 of FIG. 17.

Referring to the drawings the service units 5 are disposed in the tanks 6 of the vessel 7 in any suitable arrangement which will permit the maximum in efficiency in heating, cleaning and steam smothering within the individual tanks of the vessel. In small tanks one service unit 5 may be sufficient while in large tanks a number of service units may be employed, in which case they would be disposed within the tank to the best advantage.

Referring particularly to FIGS. 3 to 13 inclusive each service unit 5 is a vertical tubular structure comprising an upper tubular section 8, intermediate tubular sections 9 and a lower tubular section 10. A diffusion belt 11 is interposed between adjacent ends of the tubular sections 8, 9 and 10.

The upper end of the tubular section 8 is supported by the collar plate 12 which, in turn, is supported on the deck plate 13 by the spacers 14 which are cut to compensate for the camber of the deck plate 13 and maintain the service unit 5 parallel with the vertical centre-line of the vessel. The upper end of the tubular section 8 is sealed off by the plate 15. A seawater tank cleaning pipe connection 16, a steam heating connection 17 and

an exhaust line connection **18** are fitted to the plate **15** for a purpose which will be described later.

A semi-spherical member **19** seals the lower end of tubular member **10**. This member **19** is provided with a centering pintle **20** braced by the brackets **21**. A lower support bracket **22** is secured to suitable internal structure on the bottom of the hull **23**. This support bracket **22** is provided with a sleeve **24** having a flared upper end **25** to guide and receive the pintle **20** as shown in detail in FIG. 13.

The diffusion belts **11** are sealed at their upper and lower ends by the walls **26**.

The seawater connection **16** extends down through the top closure plate **15** of the unit **5** and through the top plate **26***a* of the upper diffusion belt **11***a* to make direct connection with the interior of the diffusion belt **11***a* as seen in FIG. 4. The interior of each of the diffusion belts **11** are interconnected with each other by means of the open ended pipes **27** whereby seawater for cleaning purposes can be directed from the connection **16** into each of the diffusion belts.

Each of the diffusion belts are here shown as having circular side walls **28** of larger diameter than that of the heating sections and conical end walls **29** whose smaller diameter is the same as the diameter of the heating sections. However, it is to be understood that these diffusion belts could take any other convenient shape to suit any particular pattern of spray cleaning.

The steam heating connection **17** makes direct communication with the top end of the upper tubular section **8** of the service unit. Open ended pipes **30** set in the end walls **26** to permit passage of heating steam from the tubular section **8** directly to the tubular sections **9** and **10**. Exhaust steam and condensate are drawn off from the lower end of the lower tubular section **10** by the pipe **31** which extends down through the entire length of the service unit **5** from the connection **18** to within a short distance of the inner surface of the semi-spherical member **19**.

A series of nozzles **32** are set in the side walls **28** and end walls **29** of the diffusion belts **11**. Each of the nozzles **32** are preferably adjusted to an angular setting over an angular range A, after the service units **5** have been set up within the tanks **6** of the vessel in order to provide the best pattern for cleaning the adjacent surfaces of the tanks **6**. Preferably the upper diffuser belt is provided with a greater number of nozzles **32** than the intermediate diffuser belt, and the intermediate diffuser belt has a greater number of nozzles than the lower diffuser belt.

The tubular sections **9** and **10** are provided with a series of open ended pipes **33** set diagonally at right angles to each other and at a slight angle to permit a flow of cargo oil to pass through the tubular sections and thereby pick up additional heat from the steam passing through the sections. In addition these angled pipes assist in setting up convection current within the oil cargo.

Each of the tubular members **8**, **9** and **10** are provided with a series of vertically disposed, radially projecting fins **34** each of which are extended to make contact with the conical end surfaces **29** of adjacent diffuser belts **11**. These fins **34** are spaced radially about the tubular members and avoid blocking off the nozzles **32** and the open ends of the pipes **33**.

The salt water mains **35** leading from the pump room **36** are shown in solid lines in FIG. 1 and are provided with branches **37** leading to the connection **16** at each of the service units **5** through the control valve **38**.

The steam supply lines **39** are shown in chain dot lines in FIG. 1 and are provided with branches **40** leading to the connections **17** at each of the service units **5**.

A steam connection **41** is fitted at each of the seawater connections **16** for the purpose of supplying fire smothering service to the unit.

In the operation of this invention, each individual service unit **5** is complete in itself and can be set in place by lowering through the deck openings **42**, seen in FIG. 11, until the pintle **20** enters the sleeve **24** in the bracket **22** at the bottom of the tank. The collar plate **12** is then secured to the deck. While it is preferable that the service units are secured in place while the tanks **6** are empty, it is possible for a service unit to be withdrawn up through the deck and another service unit be lowered into place while the tank is full, provided the vessel is on a fairly even keel which would permit the pintle **20** to be centered in the sleeve **24** by means of its flared upper end **25**.

While the tanks are full of cargo oil or other fluids, steam is allowed to enter the tubular members **8**, **9** and **10** through the connection **17** and is exhausted from the bottom of the unit through the exhaust pipe **31**. The entire tubular structure is therefore heated including the diffuser belts **11** as the steam passes through the pipes **30** from one tubular member to another. In addition, the steam passes over the angled pipes **33** and transmits additional heat to the cargo oil as it moves through these pipes.

The effect of heating this large vertical column extending from the bottom of the cargo compartment **6** to the deck level is illustrated diagrammatically in FIGS. 17 and 18. In FIG. 17 the arrows B indicate the upward moving convection currents induced in the cargo oil around and adjacent to the service unit **5**. These convection currents continue an upward flow towards the deck level **13** where they spread outwards and take a downward course along the vertical walls **43** of the compartment, as indicated by the arrows C. The convection currents then flow along the bottom wall of the compartment to converge at the lower end of the unit **5** with the currents as indicated by the arrows D.

The convection currents indicated in FIG. 17 are supplemented by the cross flow of cargo oil through the angled pipes **33** in the unit **5**. These supplemented convection currents tend to give a swirling flow to the convection currents indicated in FIG. 17 as indicated by the arrows E in FIG. 18. This is due to the fact that the pipes **33** are set at an angle to the horizontal and are alternatively set at right angles to each other in the manner shown in FIG. 9.

A comparison between FIG. 16 showing the currents induced by a heating coil **44** set at the bottom of the cargo oil compartment, following present day practice and directly affected by the cold seawater outside the compartment, indicated by the arrows F, and FIGS. 17 and 18, brings out the positive advantages of the present invention over standard present practice. In FIG. 16 the effect of the cold seawater is to maintain cold a large volume of cargo oil adjacent the outer shell of the vessel so that maximum heating is confined to the inner walls **45** of the compartment as indicated by the arrows G and effective heating is gradually diminished towards the outer shell of the vessel as indicated by the arrows H. Furthermore, the effect indicated by the arrows E in FIG. 18, is entirely absent in FIG. 16.

The concentration of heating effect in a centrally located vertical column is only one advantage of the present invention.

For tank cleaning, the valve **38** is opened allowing a flow of seawater under pressure from the mains **35** to pass through the connection **16** down into the upper diffusion belt **11** and thence through the pipes **27** into the lower diffusion belts **11**. This pressure water passes through the nozzles **32** which are located in large number in both the side walls **28** and angled end walls **29**. The nozzles **32** in each diffusion belt **11** form a spray pattern directed towards adjacent walls and internal structure of the cargo compartment to provide a maximum of cleaning in a minimum of time. This spray pattern is illustrated by chain dot lines in FIG. 2. As will be noted

in FIG. 14 each individual nozzle 32 can be set, preferably at the time of installation of the unit in the vessel, to provide the most effective spray pattern for the surrounding area in the compartment. The nozzles 32 can be permanently fixed in their adjusted position by welding or other suitable means. On the other hand, the nozzles can be made adjustable by any well known means.

During the cleaning operation the service unit can be maintained in a heated state in the manner previously described. The heating of the cleaning water may have advantages in cleaning certain types of cargo residue from the walls of the compartment.

The above described method of cleaning can be carried out under any operating conditions, either at sea or in port and, due to the fact that no part of the apparatus need be manually handled during the cleaning operation the system is safer for ship's personnel to operate under bad weather conditions than is the case with conventional systems such as the "Butterworth" system, where units must be inserted into the cargo compartment and be located therein and operated manually to achieve even moderate results.

In the event of fire within the cargo compartment, the valve 38 in the seawater connection is closed and steam is allowed to enter the connection 16 through the steam smothering connections 41. Steam entering the connection 16 passes down through the connection 16 into the upper diffuser belt 11 and thence through the pipes 27 into the lower diffusion belts 11. The steam then is projected through the nozzles 32 to provide a complete blanket of steam distributed quickly over the surface of the liquid within the compartment. The steam spray for fire extinguishing is the same as that for cleaning and is as illustrated in FIG. 2. This utilization of the service unit for fire extinguishing avoids an extra piercing of the deck which is necessary when conventional steam smothering systems are provided. In the event that a fire occurs within a full compartment it is usually possible to draw off some of the cargo fluid quickly and thus make the upper diffuser belt available for fire extinguishing.

The fins 34 whose primary purpose is for the transfer of heat from the service unit to the surrounding cargo fluid also have the effect directing the jets of either water or steam from the nozzles 32 which are located in the end walls 29 of the diffuser belts 11 and also have some effect in inducing the flow of cargo fluid in the manner shown in FIG. 18.

While the service units 5 have been shown as applied to tanker vessels it is to be understood that such service units could equally well be used in land based storage of liquids.

What we claim is:

1. A service unit for installation within fluid containing tanks, the said service unit comprising a vertically disposed tubular structure anchored within the said tank, the said tubular structure having one or more heating sections, and one or more diffusion sections, nozzles in said diffusion sections directed exteriorly of the sections, means to supply a heating medium to said heating sections, means to exhaust heating medium condensate from said heating sections, and means to supply a cleaning fluid to the said diffusion sections for ejection through the said nozzles.

2. A service unit as set forth in claim 1, in which the said heating, exhaust and cleaning fluid means are connected to the top of the said tubular structure externally of the fluid containing tank.

3. A service unit as set forth in claim 1, in which the said diffusion sections are interposed between the heating sections and pipe connections connect the heating sections with each other and pipe connections connect the diffuser sections with each other.

4. A service unit as set forth in claim 1, in which the said diffuser sections have a cylindrical mid portion and conical end portions defining the outer walls of the diffuser sections, the smaller diameter of the said conical end portions connecting with adjacent ends of the said heating sections and the said nozzles are disposed in both the cylindrical and conical sections of the diffuser sections.

5. A service unit as set forth in claim 1, in which a series of open ended pipes extend diagonally across the said heating sections and through the walls thereof.

6. A service unit as set forth in claim 5, in which alternate open ended pipes are disposed at right angles to each other and spaced apart vertically from each other.

7. A service unit as set forth in claim 5, in which each of the open ended pipes are disposed at an angle to a plane at right angles to the axis of the heating sections.

8. A service unit as set forth in claim 4, in which the said nozzles are adjustable to an angle from an axis at right angles to the plane of the walls in which the nozzles are set.

9. A service unit for installation within fluid containing tanks, the said service unit comprising a closed end tubular structure vertically disposed within the said tank and having its top end projecting through the said tank, the said tubular structure comprising one or more heating sections and one or more diffusion sections, the said diffusion sections being interposed between said heating sections and sealed from said heating sections, a heating connection, an exhaust connection and a water connection each connected through the closed top end of said tubular structure, the said heating connection communicating with the topmost of said heating sections, open ended pipes through said diffusion sections communicating with the heating sections longitudinally on either side of said diffuser sections, an exhaust pipe connected to said exhaust connection and passing downwards through said heating and diffusion sections to within a short distance of the bottom end of the lowermost of said heating sections, a water pipe connected to said water connection and having its lower end communicating with the uppermost of said diffuser sections, an open ended pipe connecting the interior of said diffuser sections with each other, a series of nozzles in the walls of said diffuser sections for projecting jets of water externally of said diffuser sections, and means to permit passage of fluid transversely through the said heating sections.

10. A service unit as set forth in claim 1, in which the said tubular structure is provided with a series of vertically disposed heat transfer fins.

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