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"A ventilation unit"

THIS INVENTION relates to a ventilation unit and more particularly to a ventilation unit for use in a ventilation system for a confined space, such as a cargo or ballast tank of a tanker.

Tankers or very large crude carriers (VLCC) have a number of large cargo tanks or ballast tanks. During their lifetime, it is essential to carry out repairs and maintenance work on the cargo and ballast tanks. The tanks are confined spaces which have very little ventilation, there being only a limited number of openings or hatches from the tanks on to the deck of the tanker.

Repair work may involve welding and other similar activities which can result in large quantities of smoke, fumes, dust and heat being generated. This results in very difficult, uncomfortable and unhealthy working conditions with particle concentrations exceeding recommended levels (as much as three times the recommended levels) and uncomfortable working temperatures.

One attempt to provide a solution to this problem has been to feed a number of air hoses into the tank. An air blower or compressor is provided adjacent a deck opening or hatch and the air hose connected thereto. Clean atmospheric air from outside the tanker is blown down the air hoses, the ends of which are situated where repair work is being carried out. The flow of air from the end of each air hose is directed at a person carrying out the repairs so as to provide a flow of clean air intended to blow away smoke, fumes, dust and heat from the repair area. A

schematic representation of this arrangement is shown in Figure 1 of the accompanying drawings.

Unfortunately, this known arrangement results in a number of confused air flows which, rather than providing a ventilation system, simply cause a re-distribution of the smoke, fumes, dust and heat within the tank. The smoke, fumes, dust and heat are simply re-distributed to other areas within the tank where it may be that a worker is carrying out repair work without the benefit of an air hose.

It is an object of the present invention to provide a better solution to the above-mentioned problems.

Accordingly, one aspect of the present invention provides a ventilation unit for providing a first air supply in a confined space comprising: an air supply hose for delivering a supply of fresh air; and a housing connected to a free end of the hose locatable, in use, on or near a bottom floor surface of the confined space to be ventilated, the supply of fresh air entering the housing in a first direction, the housing having a first set of outlets through which the fresh air is discharged from the housing, which first set of outlets are arranged to discharge the fresh air from the housing in a plane substantially perpendicular to the first direction.

A further aspect of the present invention provides a ventilation system incorporating a ventilation unit according to the first aspect of the present invention.

In order that the present invention may be more readily understood, embodiments thereof will now be

described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic representation showing a known ventilation system in operation;

Figure 2 is a schematic representation of a ventilation system incorporating a ventilation unit in accordance with a first embodiment of the present invention shown, in operation, situated in a cargo tank;

Figure 3 is a perspective view of the embodiment of the ventilation unit shown in Figure 2 and an end of an air hose for connection thereto;

Figure 4 is a perspective view of a second embodiment of a ventilation unit according to the present invention;

Figure 5 is a cross-section through the ventilation unit of Figure 4 taken along line V-V of Figure 4;

Figure 6 is a cross-section through the ventilation unit of Figure 4 taken along line VI-VI of Figure 4; and

Figure 7 is a partial cross-section through a third embodiment of a ventilation unit according to the present invention.

The arrows shown in the Figures represent air flows.

Referring to Figure 1, a known ventilation system is shown in operation in a cargo tank 1 of a tanker 2. A number of access hatches 3 or openings are provided in a

deck 4 of the tanker 2. A blower or air compressor 5 is located adjacent each hatch 3. One or more air hoses 6 are connected to the blower 5 and fed through the respective hatch 3 into the tank 1. The free end 7 of each air hose 6 is pointed in the general direction of a worker 8 within the tank 1. The arrows in Figure 1 show typical air flows within the tank 1.

Unfortunately, this arrangement results in a number of confused air flows in the tank 1 which, rather than providing a ventilation system, simply cause a re-distribution of the smoke, fumes, dust and heat within the tank 1. The smoke, fumes, dust and heat blown away by each air hose 6 are simply re-distributed to other areas within the tank 1 where it may be that a worker 8 is carrying out repair work without the benefit of an air hose 6.

Referring to Figures 2 and 3, a ventilation unit 9 embodying the present invention comprises a substantially cylindrical hollow housing 10 which is formed with a number of equi-spaced slits 11 around the circumference of the housing 10. The slits 11 are substantially parallel to the central axis of the cylindrical housing 10. In use, the central axis of the housing 10 is substantially vertical.

An upper end of the housing 10 forms a collar 12 which receives, in airtight connection, a free end 7 of an air hose 6.

Referring to Figure 2, in use, the ventilation unit 9 is located at the bottom of the tank 1, on or near the tank floor 1A substantially halfway between the side walls 1B of the tank 1. An air hose 6 runs from a hatch 3 in the deck 4 and connects into the collar 12 of the ventilation unit 9. A centrifugal fan 13 is located adjacent the hatch

3 and pumps air down the air hose 6 into the ventilation unit 9. The hatches or openings 3 in the deck 4 near the side walls 1B of the tank 1 are fitted with axial flow fans 14. These fans 14 act to draw air from the tank 1. The slits 11 in the housing 10 of the ventilation unit 9 are arranged to provide an air flow radiating out from the ventilation unit 9 substantially perpendicular to the central axis of the housing 10, i.e. substantially horizontally. The axial flow fans 14 draw a substantially vertical air flow toward the axial flow fans 14 and out of the tank 1. The combined effect of these two air flows, in combination with the horizontally radiating air flow from the ventilation unit 9 hitting the side walls 1B of the tank 1 and being deflected upwards, promotes a main air flow from the floor 1A of the tank 1 toward the axial flow fans 14 and out of the axial flow fans 14 thereby ventilating the tank 1.

Whilst the ventilation system described with reference to Figures 2 and 3 is adequate, a further embodiment of the present invention provides an improvement over this design. The improvement lies in the form of the ventilation unit 9. A preferred embodiment of the ventilation unit 9 is shown in Figures 4, 5 and 6. The same reference numerals used in Figures 1, 2 and 3 are used in Figures 4, 5 and 6 to denote the same components or components carrying out the same function.

The housing 10 of the ventilation unit 9 of Figures 4, 5 and 6 is fitted with three annular tiers 15, 16, 17 of exhaust ports 18, 19, 20, the exhaust ports being mounted on the exposed outer surface of the tiers, and a collar 12 for connection to a free end 7 of an air hose 6.

Referring to Figure 5, the housing 10 is fitted with a flow divider 21 consisting of a central inner tube 22 and concentric outer tube 23. The flow divider 21 divides the flow of air from the air hose 6. A central flow of air down the central inner tube 22, a second flow of air passes down the annular space defined between the concentric outer tube 23 and the central inner tube 22 and a third flow of air passes down the annular space defined between the concentric outer tube 23 and the inner surface 10A of the housing 10.

A base or bottom part of the housing 10 defines a hollow chamber 24. The first flow of air is directed into the chamber 24 at the base of the housing 10. The centre of the chamber 24 is provided with an upwardly facing cone 25 which deflects the downward flow of air into a radially outward flow of air. The radially directed air is channelled into the horizontally directed exhaust ports 18 of the first and lower tier 15. The outer surface of the first and lower tier 15 is parallel to the central axis of the housing 10, i.e substantially vertical. The air flow from the first and lower tier 15 exits the exhaust ports 18 in a radial flow from the ventilation unit 9 which is substantially horizontal and parallel to the floor 1A of the tank 1.

The second flow of air passes down the annular space between the central inner tube 22 and the concentric outer tube 23. The bottom of the central inner tube 22 terminates in an outwardly directed lip 26 between the first and second tiers 15,16 of exhaust ports 18,19. Thus, before reaching the chamber 24, the second flow of air impinges on the lip 26 and is directed into the second and middle tier 16 of exhaust ports 19. The outer surface of the second tier 16 is frusto-conical and is angled slightly

upwards with respect to the central axis of the housing 10 so that the flow through the exhaust ports 19 in the second tier 16 is radially outward and slightly upward.

The end of the concentric outer tube 23 terminates in an outwardly directed lip 27 between the second and third tiers 16,17 of exhaust ports 19,20. Thus, the third flow of air passing down the annular space between the concentric outer tube 23 and the inner surface 10A of the housing 10 passes down this annular space until it impinges on the lip 27 and is directed by the lip 27 into the third and upper tier 17 of exhaust ports 20. The outer surface of the third and upper tier 17 is frusto-conical and is angled upwardly more than the outer surface of the second and middle tier 16.

Thus, the second and middle tier 16 of exhaust ports 19 and the third and upper tier 17 of exhaust ports 20 are directed to exhaust air both radially and upwardly toward the ceiling 1C of the tank 1. These second and third air flows thereby promote a general air flow toward the axial flow fans 14. To a certain extent, the second and third air flows also entrain the first horizontal air flow upwardly toward the ceiling 1C of the tank 1.

The preferred embodiment of the ventilation unit according to the present invention provides three radial air flows: a first substantially horizontal air flow; a second air flow directed slightly upwardly from the floor 1A of the tank 1; and a third air flow directed even further upwardly toward the ceiling 1C of the tank 1.

The second and third air flows create a flow of air specifically directed toward the axial flow fans 14 in the hatches 3 adjacent the side walls 1B of the tank 1 in the

ceiling 1C. The second and third air flows thereby promote a general air flow toward the axial flow fans 14. The average air speed within the tank is in the region of 0.2m/s.

Figure 7 shows a fully improved version of a ventilation unit similar to the one shown in Figures 4, 5 and 6. Thus, the sharp transitions from the central inner tube 22 to the lip 26 and from the concentric outer tube 23 to the further lip 27 and from the cone 25 to the floor 24A of the chamber 24 tend to cause a turbulent flow of air within the housing 10. This turbulent flow creates a certain amount of resistance to the air flow through the ventilation unit 9. The resistance places a strain on the centrifugal fan 13. Accordingly, as shown in Figure 7, in the further improved ventilation unit these sharp transitions are smoothed out as much as possible. The smoother transitions reduce the resistance to the air flow through the ventilation unit 9 thereby reducing the load on the centrifugal fan 13 and providing a more efficient ventilation system.

In the third embodiment of Figure 7, the first air flow from the first and lower tier 15 of exhaust ports 18 is substantially horizontal and parallel to the floor of the tank (perpendicular to the central axis of the housing 10), the outer surface of the first tier 15 being substantially vertical. The second and middle tier 16 of exhaust ports 19 is angled at approximately 25° from the horizontal (65° from the central axis of the housing 10) and the third air flow from the third and upper tier 17 of exhaust ports 20 is angled at approximately 50° from the horizontal (40° from the central axis of the housing 10) to direct the radial air flow at this angle from the ventilation unit 9.

In the specific example of Figure 7, the radius of the central inner tube 22 is 0.21m to provide a cross-sectional area of 0.139m^2 for the first air flow. The annular space between the central inner tube 22 and the concentric outer tube 23 defines a cross-sectional area of approximately 0.16m^2 for the second air flow. The annular space between the concentric outer tube 23 and the inner surface 10A of the housing 10 provides a cross-sectional area of approximately 0.204m^2 for the third air flow. Thus, the main air flow is through the first and lower tier 15 of exhaust ports 18.

It is envisaged that a number of ventilation units 9 would be used along the length of a tanker within a tank 1 and a corresponding pair of axial flow fans 13 would be provided for each ventilation unit 9 being used in the ventilation system.

A ventilation system and unit according to the present invention are not limited to being used in cargo or ballast tanks 1 of tankers 2 but can also be used in any other confined spaces requiring ventilation, such as warehouses.

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CLAIMS

1. A ventilation unit for providing a first air supply in a confined space, comprising: an air supply hose for delivering a supply of fresh air; and a housing connected to a free end of the hose locatable, in use, on or near a floor surface of the confined space to be ventilated, the supply of fresh air entering the housing in a first direction, the housing having a first set of outlets through which the fresh air is exhausted from the housing, which first set of outlets are arranged to discharge the fresh air from the housing in a plane substantially perpendicular to the first direction.
2. A ventilation unit according to Claim 1, wherein the first direction is substantially vertical and the plane in which the fresh air discharges from the housing is substantially horizontal.
3. A ventilation unit according to Claim 1 or 2, wherein the first set of outlets are equispaced around the housing.
4. A ventilation unit according to any preceding claim, wherein the housing is substantially cylindrical and the supply of fresh air enters the housing in the first direction which is substantially parallel to the central axis of the housing.
5. A ventilation unit according to any preceding claim, wherein the housing has a collar which receives the free end of the air supply hose in airtight connection.
6. A ventilation unit according to any preceding claim, wherein the housing is provided with a second set of



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outlets which are arranged to discharge the fresh air from the housing at an exhaust angle between the first direction and the plane perpendicular to the first direction.

7. A ventilation unit according to Claim 6, wherein the housing is provided with a third set of outlets which are arranged to discharge the fresh air from the housing at an exhaust angle between the first direction and the plane perpendicular to the first direction.

8. A ventilation unit according to Claim 7, wherein the exhaust angle of the second set of outlets is different from the exhaust angle of the third set of outlets.

9. A ventilation unit according to Claim 7 or 8, wherein the exhaust angle of the third set of outlets is between the first direction and the exhaust angle of the second set of outlets.

10. A ventilation unit according to any one of Claims 6 to 9, wherein a flow divider is fitted in the housing to divide the air flow from the air supply hose into a first air flow directed to the first set of outlets and a second air flow directed to the second set of outlets.

11. A ventilation unit according to Claim 10, wherein the flow divider comprises a tube fitted in the housing, the first air flow being through the tube and the second air flow being through the space between the tube and the housing.

12. A ventilation unit according to Claim 11, wherein the tube terminates in an outwardly directed lip between the first and second set of outlets, which lip acts to



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deflect the second flow of air toward the second set of outlets.

13. A ventilation unit according to any one of Claims 7 to 9, wherein a flow divider is fitted in the housing to divide the air flow from the air supply hose into three air flows, the first air flow being directed to the first set of outlets, the second air flow being directed to the second set of outlets and the third air flow being directed to the third set of outlets.

14. A ventilation unit according to Claim 13, wherein the flow divider comprises a pair of concentric tubes fitted in the housing, the first air flow being through the first tube, the second air flow being through the space between the first tube and the second tube and the third air flow being through the space between the second tube and the housing.

15. A ventilation unit according to Claim 14, wherein the first tube terminates in an outwardly directed lip between the first and second set of outlets, which lip acts to deflect the second air flow toward the second set of outlets.

16. A ventilation unit according to Claim 14 or 15, wherein the second tube terminates in an outwardly directed lip between the second and third set of outlets, which lip acts to deflect the third air flow towards the third set of outlets.

17. A ventilation system incorporating a ventilation unit according to any preceding claim.



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18. A ventilation system according to Claim 17 including means to extract air from the confined space.

19. A ventilation system according to Claim 18, wherein the ventilation unit is located on or near the floor surface of the confined space and the extraction means are located on or near a ceiling surface of the confined space, the air flow from the ventilation unit creating a general air flow through the confined space and toward the extraction means.

20. A ventilation system according to Claim 19, wherein two extraction means are provided, one at either side of the confined space on or near the ceiling of the confined space, the ventilation unit being located on or near the floor surface of the confined space substantially midway between side walls of the confined space.

21. A ventilation system according to Claim 20, wherein the confined space is elongate and a plurality of such ventilation systems are provided along the length of the confined space.

22. A ventilation unit substantially as hereinbefore described with reference to and as shown in Figures 2 to 7 of the drawings.

23. A ventilation system substantially as hereinbefore described with reference to and as shown in Figure 2.



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