(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
21 May 2004 (21.05.2004)

PCT

(10) International Publication Number
WO 2004/041682 A2

(51) International Patent Classification[7]: B65G

(21) International Application Number:
PCT/US2003/014299

(22) International Filing Date: 7 May 2003 (07.05.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10/142,543 8 May 2002 (08.05.2002) US

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(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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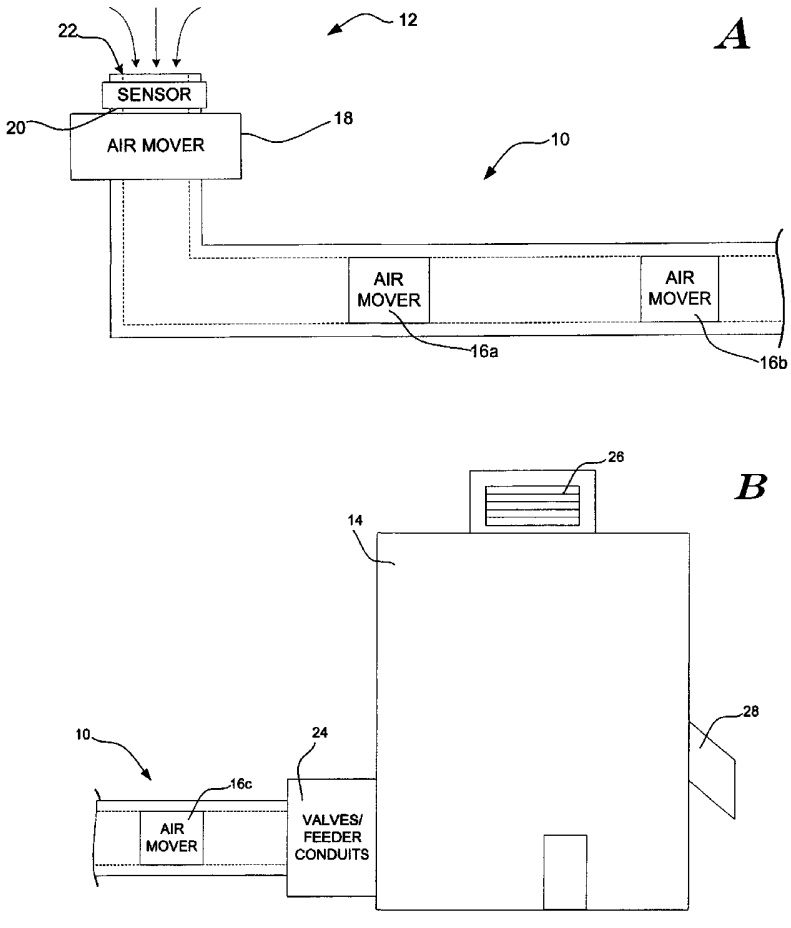
(54) Title: METHOD AND APPARATUS FOR TRANSPORTING AIR TO BUILDINGS



(57) Abstract: Methods and systems are provided for enhancing the air quality in buildings during a chemical and/or biological attack and/or when the air quality around a building drops to unacceptable levels. Preferably, relatively uncontaminated (i.e. clean) air is retrieved from a remote location and transported to one or more buildings using, for example, a pipeline, a ship, a truck or any other suitable method. The air is provided to the one or more buildings to enhancing the air quality in the buildings during a chemical and/or biological attack and/or when the air quality around a building drops to unacceptable levels.

WO 2004/041682 A2

Published:

— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

METHOD AND APPARATUS FOR TRANSPORTING AIR TO BUILDINGS

Cross-Reference to Co-Pending Applications

This invention is related to co-pending U.S. Patent Application Serial No. _____, filed _____, entitled "Methods And Apparatus For Storing And Delivering Air To Buildings", which is incorporated herein by reference.

Field of the Invention

This invention generally relates to methods and apparatus for enhancing the air quality in buildings, and more specifically, to methods and apparatus for enhancing the air quality in buildings during a chemical and/or biological attack and/or when the air quality around a building drops to unacceptable levels.

Background of the Invention

The recent demise of the cold war and decline in super-power tensions has been accompanied by an increase in concern over the viability of weapons of mass destruction such as chemical and biological (CB) weapons. CB weapons include chemical agents such as phosgene, nerve agents such as Sarin, and biological agents such as anthrax, botulism, plaque, tularemia, and small pox. CB weapons may be delivered to occupants of a building in any number of ways, including the release of agents in or around the building. In some cases, the building's heating, ventilating, and air conditioning (HVAC) system may be used to help deliver the released agent into the building. Agents may also be released within public spaces of a building, and dispersed to other, private areas of the building via the buildings HVAC system.

In addition, and especially in urban settings, smog or other environmental contaminates can be present in and around buildings. Smog may be generated from cars, industrial plants, and other sources. To this end, the United States Environmental Protection Agency (EPA) often issues smog alerts when high concentrations of ground-level ozone (the main component of smog) are predicted in a given geographical area. Chemical spills or leaks may also be a source of released contaminates. Despite filtration, a building's HVAC system can deliver some of the smog and/or other contaminates into the building.

What would be desirable, therefore, are methods and apparatus for enhancing the air quality in buildings, and more specifically, methods and apparatus for enhancing the air quality in buildings during a chemical and/or biological attack and/or when the air quality around a building drops to unacceptable levels.

Summary of the Invention

The present invention provides methods and apparatus for enhancing the air quality in buildings during a chemical and/or biological attack and/or when the air quality around a building drops to unacceptable levels. In a preferred embodiment, relatively uncontaminated (i.e. clean) air is retrieved from a remote location and transported to one or more buildings. The air is provided to the one or more buildings to enhancing the air quality in the buildings during a chemical and/or biological attack and/or when the air quality around a building drops to unacceptable levels.

In one illustrative embodiment, the air is transported through a pipeline. The pipeline may be a pipeline specifically built for transporting air, or may be adapted from an existing, perhaps abandoned, pipeline. In either case, the air is preferably retrieved from a remote location, pumped through the pipeline, and ultimately delivered to the one or more buildings. In some embodiments, the remote location may be a substantial distance from the one or more buildings, such as greater than one mile. In one example, the pipeline may extend out from a city to a location outside of the city, and may transport relatively uncontaminated (i.e. clean) air from the location outside of the city to the one or more buildings in the city. To increase the amount of air that can be passed through the pipeline, one or more air movers (e.g. high velocity fans) may be provided at spaced locations along the pipeline. The pipeline may be above ground, below ground, or a combination of both.

Rather than retrieving the air using a single pipeline, it is contemplated that the air may be transported through a system of pipelines. The pipeline system may have multiple pipelines that extend out in various directions. Air may be transported through all of the pipelines to the one or more buildings, or selected pipelines. Under some circumstances, it may be desirable to only select those pipelines that have access to relatively uncontaminated (i.e. clean) air. One or more valves, dampers and/or

feeder conduits may be provided to direct the air through the pipeline system, and into the one or more buildings.

In another illustrative embodiment, relatively uncontaminated (i.e. clean) air may be transported from a remote location to one or buildings via a ship. The ship may have one or more holds for holding air, one or more compressors for compressing air into the one or more holds, and one or more valves for releasing the compressed air from the one or more holds. In some cases, the one or more holds may include a sealing layer to help improve the air-tightness of the one or more holds. Alternatively, or in addition, one or more air bladders may be provided in the one or more of holds. The air bladders may be a tough, elastic material that can be made to fit the holds of the ship. The holds may provide support to the air bladder, particular when the air bladder is pressurized with air.

During use, the ship may sail out into a body of water that is adjacent one or more buildings. Once at a remote location, which has relatively uncontaminated (i.e. clean) air, the compressor of the ship may pump air into the one or more holds. Once filled, the ship may sail back to a location near the one or more buildings, wherein the one or more valves on the ship may release the compressed air from the one or more holds, preferably into one or more conduits that can delivery the air to the one or more buildings. The one or more conduits may be part of a pipeline system, as described above, or some other delivery conduit.

When the ship is stationed near the buildings, the ship may become contaminated, particular during a chemical and/or biological attack. When the ship sails back into the body of water to retrieve more relatively uncontaminated (i.e. clean) air, decontamination equipment may be used to decontaminate the ship before the holds are filled again.

In another illustrative embodiment, relatively uncontaminated (i.e. clean) air is transported from a remote location to one or buildings via a truck. The truck may have a tank for holding air, one or more compressors for compressing air into the tank, and one or more valves for releasing the compressed air from the tank.

The tank of the truck is preferably an air-tight tank that is capable of holding compressed air. In some cases, one or more sealing layers may be provided in the

tank of the truck to help increase the air-tightness of the tank. Alternatively, or in addition, the tank may include an air bladder. The air bladder may be a tough, elastic material that can be made to fit the tank of the truck, and the tank of the truck may provide support to the air bladder, particular when the air bladder is pressurized.

During use, the truck may drive out to a remote location, which has relatively uncontaminated (i.e. clean) air. Once at the remote location, the compressor of the truck may pump air into the tank. The truck may then drive back to a location near the one or more buildings, wherein the one or more valves on the truck may release the compressed air, preferably into one or more conduits that can delivery the air to the one or more buildings. The one or more conduits may be part of a pipeline system, as described above, or some other delivery conduit.

Brief Description of the Drawings

Figures 1A-1B show a schematic view of an illustrative system that uses a pipeline to transport air from a remote location to one or more buildings to enhance the air quality in the buildings during a chemical and/or biological attack and/or when the air quality around the buildings drops to unacceptable levels;

Figure 2 is a schematic view of an illustrative system that uses a pipeline system to transport air from a remote location to one or more buildings to enhance the air quality in the buildings during a chemical and/or biological attack and/or when the air quality around the buildings drops to unacceptable levels;

Figure 3 is a schematic view of a ship that has been adapted to store air in accordance with the present invention; and

Figure 4 is a schematic view of a truck that has been adapted to store air in accordance with the present invention.

Detailed Description of the Invention

Figures 1A-1B show a schematic view of an illustrative system that uses a pipeline to transport air from a remote location to one or more buildings to enhance the air quality in the buildings during a chemical and/or biological attack and/or when the air quality around the buildings drops to unacceptable levels. A pipeline 10 is shown that extends from a remote location 12 to one or more buildings 14. The pipeline 10 may be a pipeline specifically built for transporting air, or may be adapted

from an existing, perhaps abandoned, pipeline. In either case, the air is preferably retrieved from a remote location 12, pumped through the pipeline 10, and ultimately delivered to the one or more buildings 14.

In some embodiments, the remote location 12 may be a substantial distance from the one or more buildings 14, such as greater than one mile or greater than five miles. This separation distance may increase the likelihood that the air retrieved at the remote location 12 is of higher quality than in or around the one or more buildings 14. For example, the remote location 12 may be sufficiently far from the one or more buildings 14 such that smog that is present around the one or more buildings 14 is substantially reduced or non-existent at the remote location 12. In another example, the remote location 12 may be sufficiently far from the one or more buildings 14 such that chemical and/or biological agents released in or around the one or more buildings 14 is substantially reduced or non-existent at the remote location 12.

In some embodiments, it is contemplated that the pipeline 10 may extend from a city to a remote location 12 outside of the city. The pipeline 10 may then transport relatively uncontaminated (i.e. clean) air from the remote location 12 outside of the city to the one or more buildings 14 in the city.

To increase the amount of air that can be passed through the pipeline 10, one or more air movers 16a-16c may be provided at spaced locations along the pipeline 10. The air movers may be any suitable air mover, including for example high velocity fans, air compressors, or the like. In some embodiments, the air movers 16a-16c are similar to those air movers currently used to pressurize and move large volumes of gasses through existing gas pipelines. A number of additional air movers 18 may be provided at the remote location to compress the received air into the pipeline, preferably in stages, to raise the velocity of the air moving through the pipeline 10. One or more sensors 20 may be provided in fluid communication with the pipeline 10, preferably near the inlet 22, to detect chemical and/or biological agents and/or air quality at the remote location 12. The pipeline may be above ground, below ground, or a combination of both.

One or more valves and/or feeder conduits 24 may be provided to direct the air from the pipeline 10 into the one or more buildings 14. The valves 24 may be

activated when one or more of the buildings 14 become exposed or potentially exposed to air of reduced air quality. Feeder conduits may be used to distribute the air provided by the pipeline 10 to distinct buildings.

When receiving air from the pipeline 10, it is contemplated that both the air intake 26 and air exhaust 28 of the building 14 may be closed. The clean air supply from the pipeline 10 may be accepted, and a positive air pressure may be maintained in the building. Maintaining a positive pressure in building 14 may help keep external contaminates from entering the building 14. This may be particularly useful when a chemical and/or biological attack is suspected or underway.

Alternatively, or in addition, the clean air from the pipeline 10 may be directed into the ventilation system of building 14 to help improve the air quality in the building 14. In this embodiment, the air intake 26 of the building 14 may be left open, partially closed, or closed altogether. The clean air supply from pipeline 10 may be used to replace or supplement the air that is normally drawn from the air intake 26. The remainder of the building's HVAC system may operate in a conventional manner, if desired.

Rather than retrieving and transporting air through a single pipeline, it is contemplated that air may be transported through a system of pipelines. Figure 2 is a schematic view of an illustrative pipeline system that may be used to transport air from a remote location to one or more buildings to enhance the air quality in the buildings during a chemical and/or biological attack and/or when the air quality around the buildings drops to unacceptable levels.

The illustrative pipeline system is generally shown at 40, and includes multiple pipelines 42a-42f that extend out in various directions from a city 44. Air may be transported through all of the pipelines 42a-42f to the one or more buildings in the city 44, or selected pipelines. Under some circumstances, it may be desirable to only select those pipelines 42a-42f that have access to relatively uncontaminated (i.e. clean) air at their remote ends 46a-46f. A sensor, such as sensor 20 of Figure 1A, may be used to determine which pipelines 42a-42f have access to relatively uncontaminated (i.e. clean) air. One or more valves, dampers and/or feeder conduits

may be provided to direct the air through the pipeline system 40, and into the one or more buildings in the city 44.

Figure 3 is a schematic view of a ship that has been adapted to store air in accordance with the present invention. In the illustrative embodiment, ship 50 is used to transport relatively uncontaminated (i.e. clean) air from a remote location to one or buildings. The ship may have one or more holds 52a-52e for holding air, one or more compressors 54 for compressing air into the one or more holds 52a-52e, and one or more valves 56 for releasing the compressed air from the one or more holds 52a-52e. To make the holds 52a-52d more air-tight, one or more sealing layers may be provided in the holds 52a-52e. The sealing layer may be an elastomeric sealing layer, or any other type of sealing layer that will provide an air-tight surface or seal. Alternatively, or in addition, an air bladder, such as air bladder 58, may be provided in the one or more of holds 52a-52e. The air bladder 58 may be a tough, elastic material that can be made to fit the holds 52a-52e of the ship 50. The holds 52a-52e of the ship 50 may provide support to the air bladder 58, particular when the air bladder 58 is pressurized.

The compressor 54 may be used to pressurize the air that is stored in the one or more holds 52a-52e. Pressurizing the air may increase the amount of air that is available by several times. A controller 62 may be used to control the compressor 54 and/or valve 56. The controller 62 may, for example, control the valve 56 so that the pressure of the air that is released from the one or more holds 52a-52e remains relatively constant over time. A pressure sensor 64 may be provided for measuring the air pressure of the released air through the valve 56. The output of the pressure sensor 64 may be provided to the controller 62, which can then adjust the valve 56 accordingly.

The controller 62 may shut down the compressor 54 when the air at the inlet 66 of the compressor 54 has a chemical and/or biological agent or when the air quality drops below unacceptable levels. One or more sensors 68 may be provided in fluid communication with the inlet 66 of the compressor 54 to detect chemical and/or biological agents and/or air quality. The controller 62 may also receive control signals via interface 70, which may, among other things, indicate a chemical and/or

biological attack and/or poor air quality. Shutting down the compressor 54 may help prevent the air in the one or more holds 52a-52e from becoming contaminated. Shutting down the compressor 54 may include turning off the compressor 54 completely, disengaging the air pump of the compressor from the power source (e.g. engine), or redirecting the air provided by the compressor to somewhere other than the one or more holds 52a-52e. It is also contemplated that the space containing the compressor 54 may have a filtered air supply to keep the space positively pressured and free from contamination. A filter 68 may also be provided on the inlet 66 of the compressor 54 to filter the air that is provided by the compressor 54 to the one or more holds 52a-52e.

One or more air movers 72 may be provided along an output conduit 76 to help increase the air velocity in the conduit 76, if desired. The air movers referred to herein may be any suitable air mover, including for example, high velocity fans, air compressors, etc. The number of air movers that are provided may depend on a number of factors, including the length and cross-section of the conduit 76.

During use, it is contemplated that the ship 50 may sail out into a body of water that is adjacent one or more buildings. Figure 2 shows a body of water 80 that is situated adjacent a city 44. Once at a remote location in the body of water 80, where the remote location has relatively uncontaminated (i.e. clean) air, the compressor 54 may pump air into the one or more holds 52a-52e. Once filled, the ship may sail back to a location 46d near the one or more buildings, wherein the one or more valves 56 on the ship 50 may release the compressed air from the one or more holds 52a-52e, preferably into one or more conduits 42d that can delivery the air to the one or more buildings. The one or more conduits 42d may be part of a pipeline system, as described above, or some other delivery conduit.

When the ship 50 is stationed near the buildings, the ship 50 may become contaminated, particular during a chemical and/or biological attack. When the ship 50 sails back into the body of water to retrieve more relatively uncontaminated (i.e. clean) air, the ship 50 may use decontamination equipment 60 to decontaminate the ship 50 before the holds 52a-52e are filled again.

Figure 4 is a schematic view of a truck 90 that has been equipped to store air in accordance with the present invention. The illustrative truck 90 has a tank 92 for holding air, one or more compressors 94 for compressing air into the tank, and one or more valves 96 for releasing the compressed air from the tank 92.

The tank 92 of the truck 90 is preferably an air-tight tank that is capable of holding compressed air. The truck 90 may be a tanker truck, or any other truck that can store air or can be adapted to store air. One or more sealing layers may be provided in the tank 92 of the truck 90 to help improve the air sealing capabilities of the tank, if desired. Alternatively, or in addition, the tank 92 may include an air bladder. The air bladder may be a tough, elastic material that can be made to fit the tank 92 of the truck 90. The tank 92 of the truck 90 may provide support to the air bladder, particular when the air bladder is pressurized.

The compressor 94 may be used to pressurize the air that is stored in the tank 92. Pressurizing the air may increase the amount of air that is available by several times. A controller (not shown) may be used to control the compressor 94 and/or valve 96, as described above with respect to Figure 3. The controller 62 may, for example, control the valve 96 so that the pressure of the air that is released from the tank remains relatively constant over time. A pressure sensor (not shown) may be provided for measuring the air pressure of the released air through the valve 96. The output of the pressure sensor may be provided to the controller, which can then adjust the valve 96 accordingly.

The controller may also shut down the compressor 94 when the air at the inlet 100 of the compressor 94 has a chemical and/or biological agent or when the air quality drops below unacceptable levels. One or more sensors 102 may be provided in fluid communication with the inlet 100 of the compressor 94 to detect chemical and/or biological agents and/or air quality. Shutting down the compressor 94 may help prevent the air in the tank 92 from becoming contaminated. Shutting down the compressor 94 may include turning off the compressor 94 completely, disengaging the air pump of the compressor from the power source (e.g. engine), or redirecting the air provided by the compressor to somewhere other than the tank 92.

During use, the truck 90 may drive out to a remote location to gain access to relatively uncontaminated (i.e. clean) air. Once at the remote location, the compressor 94 of the truck may pump air into the tank 92. The truck 90 may then drive back to a location near one or more buildings, wherein the one or more valves 96 on the truck 90 may release the compressed air, preferably into one or more conduits that can delivery the air to the one or more buildings. The one or more conduits may be part of a pipeline system, as described above, or some other delivery conduit.

Numerous advantages of the invention covered by this document have been set forth in the foregoing description. It will be understood, however, that this disclosure is, in many respects, only illustrative. Changes may be made in details, particularly in matters of shape, size, and arrangement of parts without exceeding the scope of the invention. The invention's scope is, of course, defined in the language in which the appended claims are expressed.

WHAT IS CLAIMED IS:

1. A method for providing air to a building that is exposed or potentially exposed to air of a reduced air quality, the method comprising the steps of:

transporting air to the building from a remote location that has enhanced air quality; and

providing the transported air into the building.

2. A method according to claim 1 wherein the air is transported via a pipeline.

3. A method according to claim 2 wherein the pipeline includes one or more air movers for moving the air through the pipeline.

4. A method according to claim 2 wherein the pipeline extends a substantial distance from the building.

5. A method according to claim 4 wherein the pipeline extends greater than one mile from the building.

6. A method according to claim 4 wherein the pipeline extends greater than five mile from the building.

7. A method according to claim 2 wherein the pipeline is part of a pipeline system that extends out in multiple directions from the building.

8. A method according to claim 1 wherein the air is transported at least in part via a ship.

9. A method according to claim 1 wherein the air is transported at least in part via a truck.

10. A method for providing air to a number of buildings in a city, the method comprising the steps of:

transporting air to the city from a location outside of the city; and

providing the transported air into one or more of the buildings in the city.

11. A method according to claim 10 wherein the air is transported via a pipeline.

12. A method according to claim 11 wherein the pipeline includes one or more air movers for moving the air through the pipeline.

13. A method according to claim 11 wherein at least a portion of the pipeline is underground.

14. A method according to claim 10 wherein the air is transported at least in part via a ship.

15. A method according to claim 14 wherein the ship sails out into a body of water to collect the air, and transports the air to the city.

16. A method according to claim 14 wherein the air is compressed in the ship when collected.

17. A method according to claim 10 wherein the air is transported at least in part via a truck.

18. A method according to claim 17 wherein the truck drives out of the city to collect the air, and transports the air to the city.

19. A method according to claim 17 wherein the air is compressed in the truck when collected.

20. A system for providing air to a number of buildings in a city, the system comprising:

a pipeline for transporting air to the city from a location outside of the city; and

means for providing the transported air to one or more of the buildings in the city.

21. A system according to claim 20, wherein the means for providing the transported air to one or more of the buildings includes one or more feeder conduits.

22. A system according to claim 21, wherein the means for providing the transported air to one or more of the buildings includes one or more valves.

23. A system according to claim 21, wherein the means for providing the transported air to one or more of the buildings includes one or more fans.

24. A system according to claim 20, wherein the means for providing the transported air to one or more of the buildings is activated when a chemical and/or biological attack is detected and/or suspected.

25. A system according to claim 20, wherein the means for providing the transported air to one or more of the buildings maintains a positive air pressure in an interior of the one or more buildings.

26. A system for providing air to a building that is exposed or potentially exposed to air of a reduced air quality, the system comprising:

air transporting means for transporting air to the building from a remote location that has enhanced air quality; and

means for providing the transported air into the building.

27. A ship for transporting air, the ship comprising:

one or more holds for holding air;

one or more compressors for compressing air into the one or more holds; and

one or more valves for releasing the compressed air from the one or more holds.

28. A ship according to claim 27 wherein the one or more holds include an air bladder.

29. A ship according to claim 28 wherein the air bladder is supported by the holds of the ship.

30. A ship according to claim 27 further comprising a decontamination system to decontaminate the ship.

31. A truck for transporting air, the truck comprising:

a tank for holding air;

one or more compressors for compressing air into the tank, the one or more compressors having a chemical and/or biological sensor on a compressor air inlet, whereby the compressor ceases to provide air into the tank if the sensor detects a chemical and/or biological agent; and

one or more valves for releasing the compressed air from the tank.

32. A tanker truck trailer for transporting air, the tanker truck trailer comprising:

a tank for holding air;

one or more compressors for compressing air into the tank; and

one or more valves for releasing the compressed air from the tank.

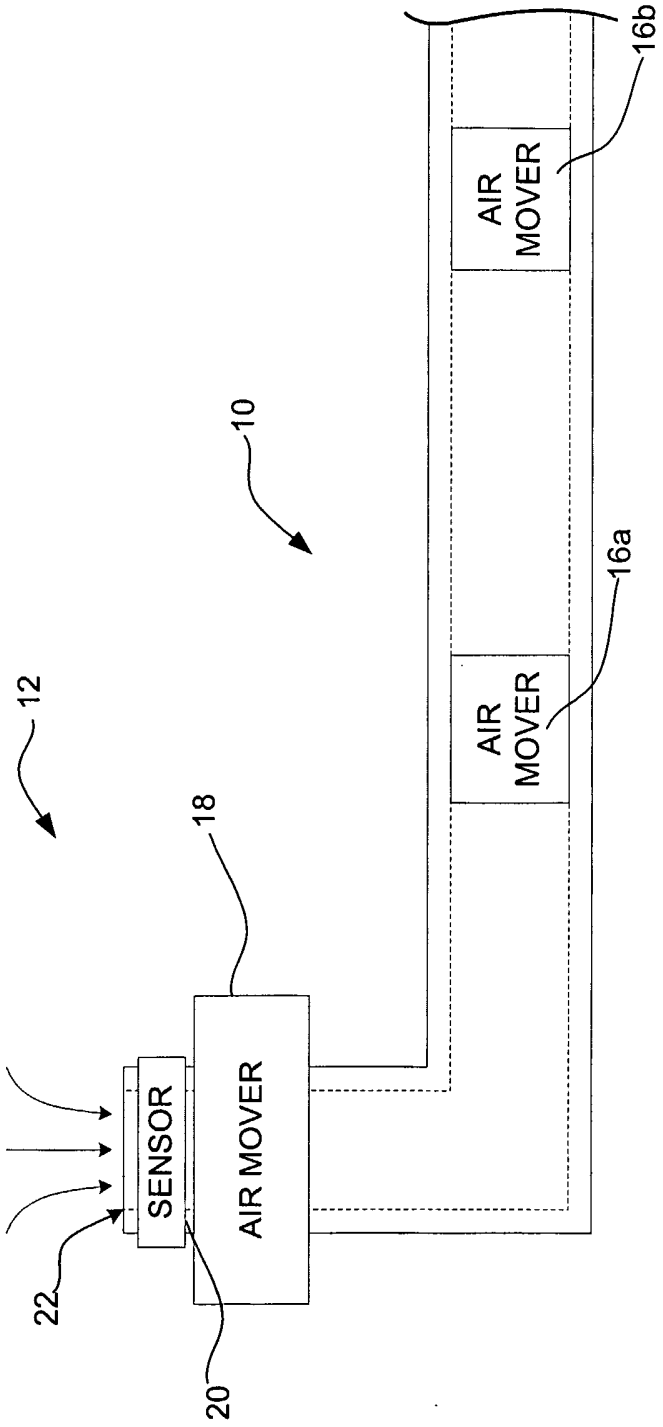


FIG. 1A

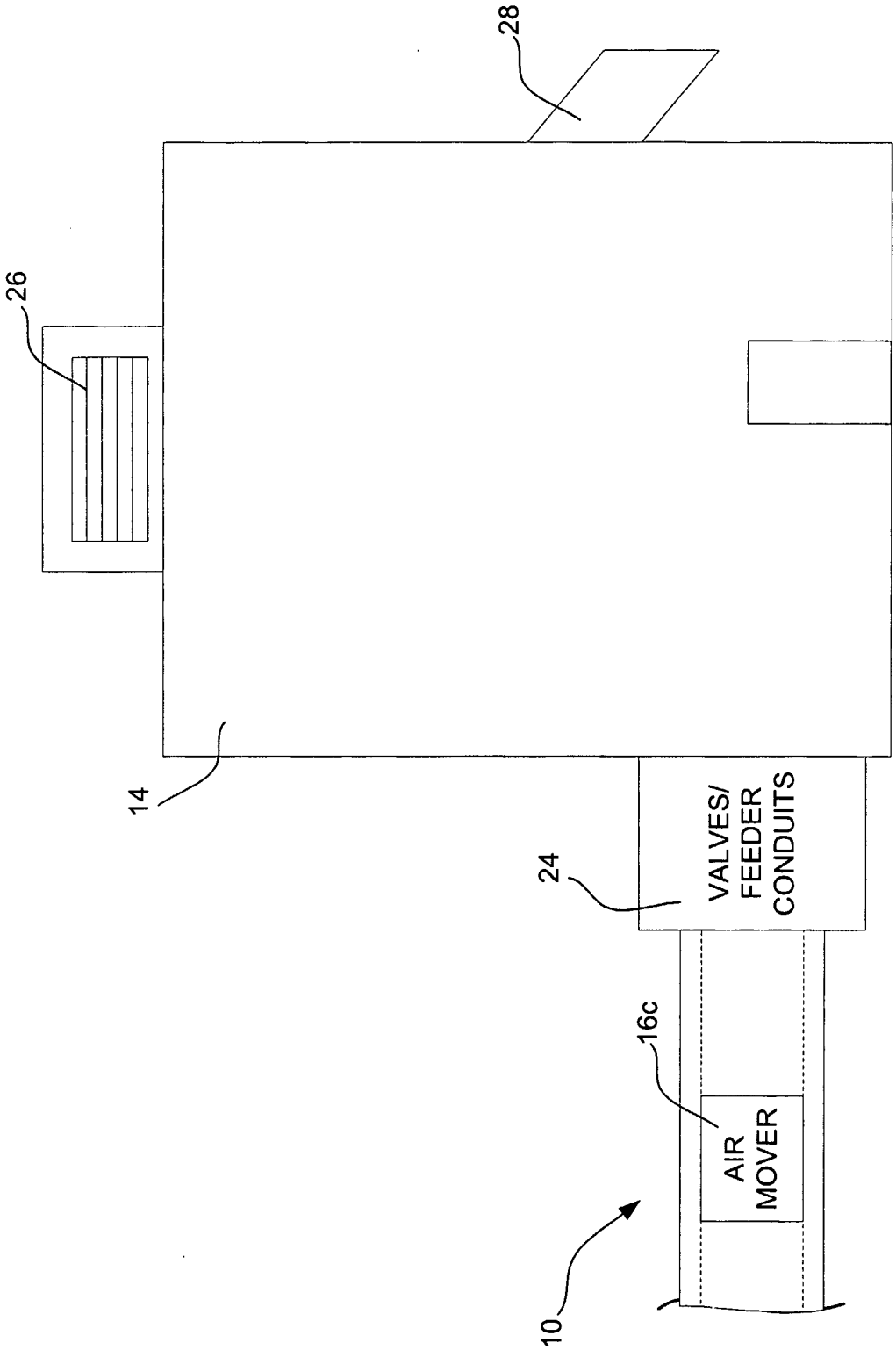


FIG. 1B

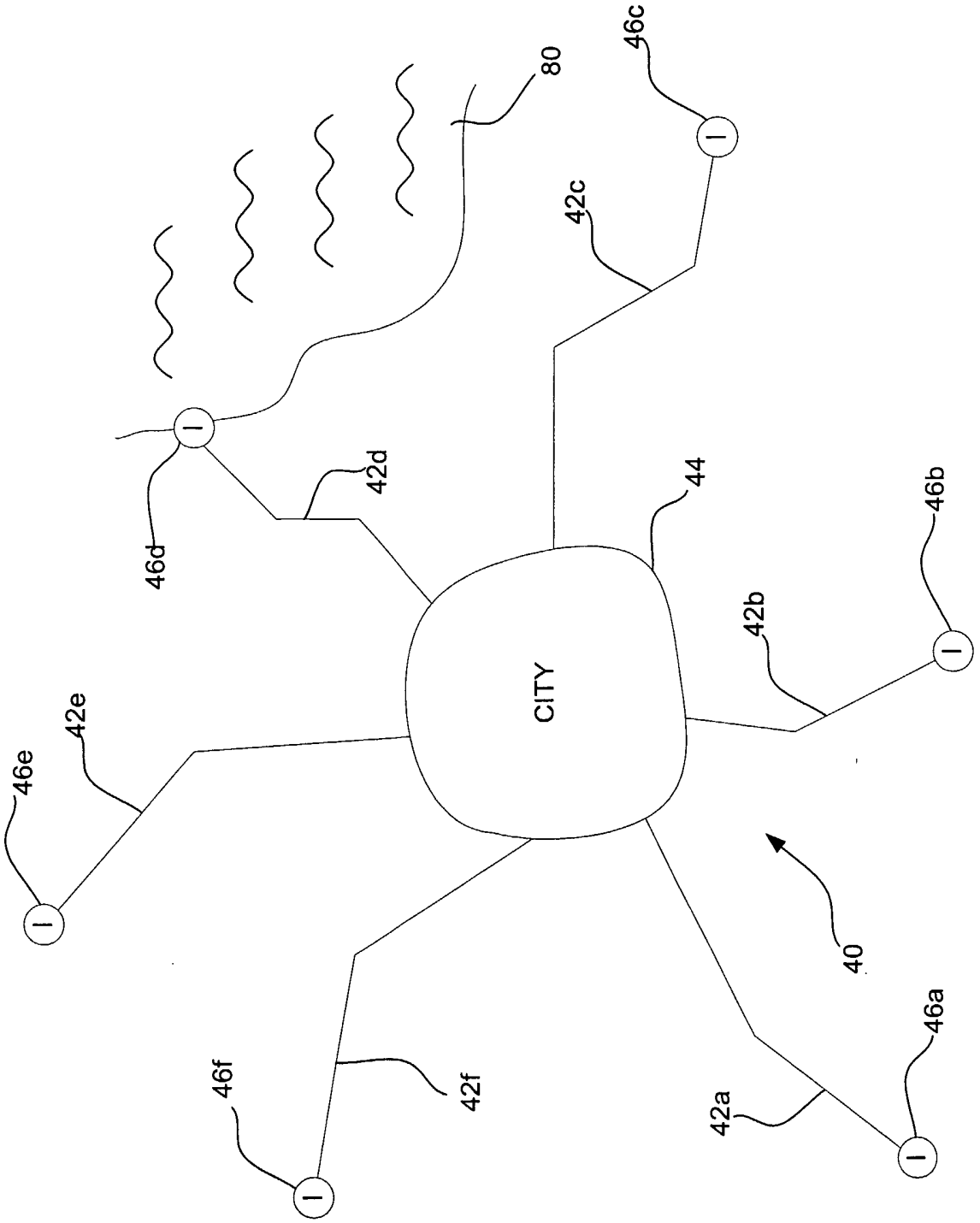
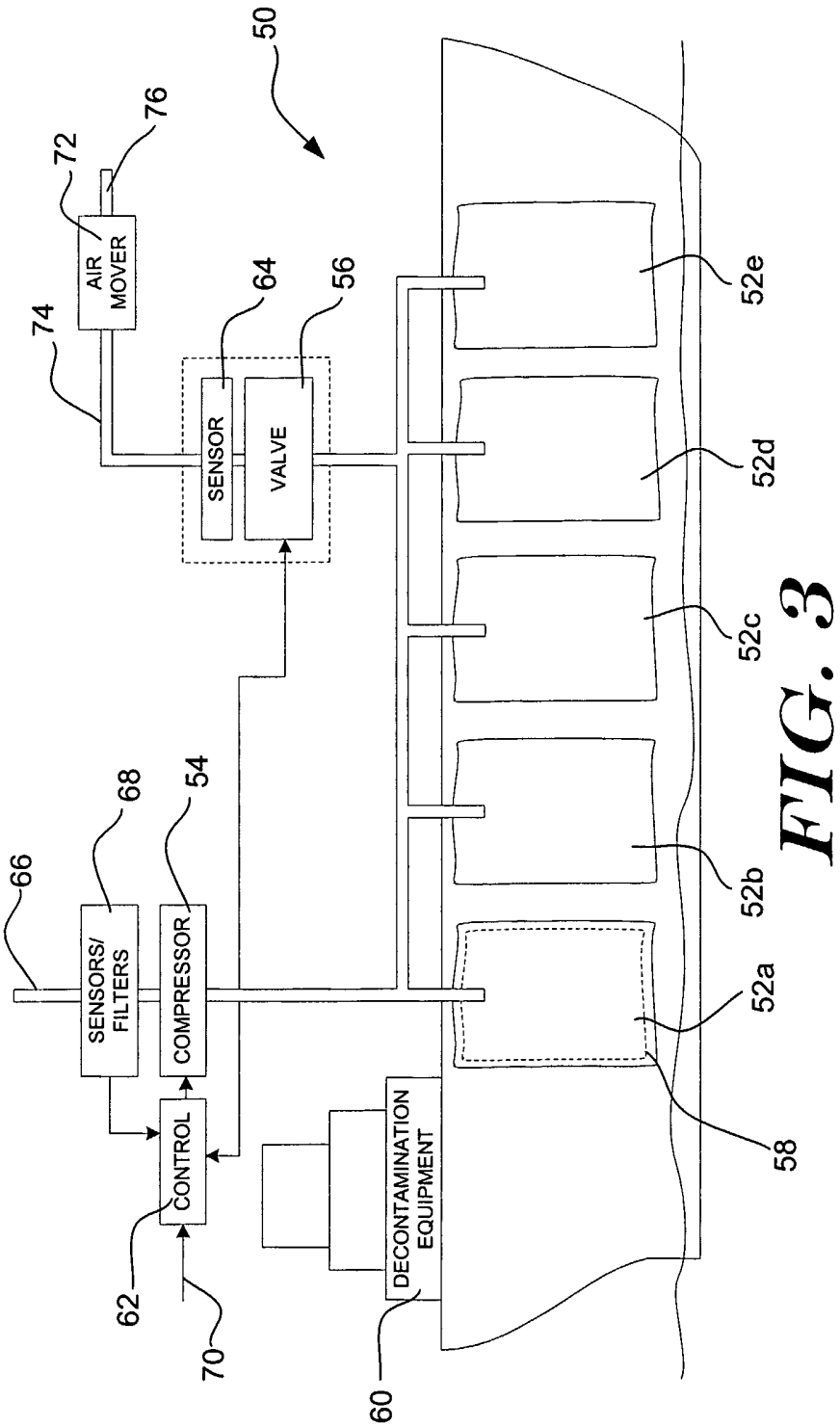


FIG. 2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76
72
AIR MOVER
74
64
56
SENSOR
VALVE
52e
52d
52c
52b
52a
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54
66
SENSORS/ FILTERS
COMPRESSOR
CONTROL
62
70
DECONTAMINATION EQUIPMENT
60

FIG. 3

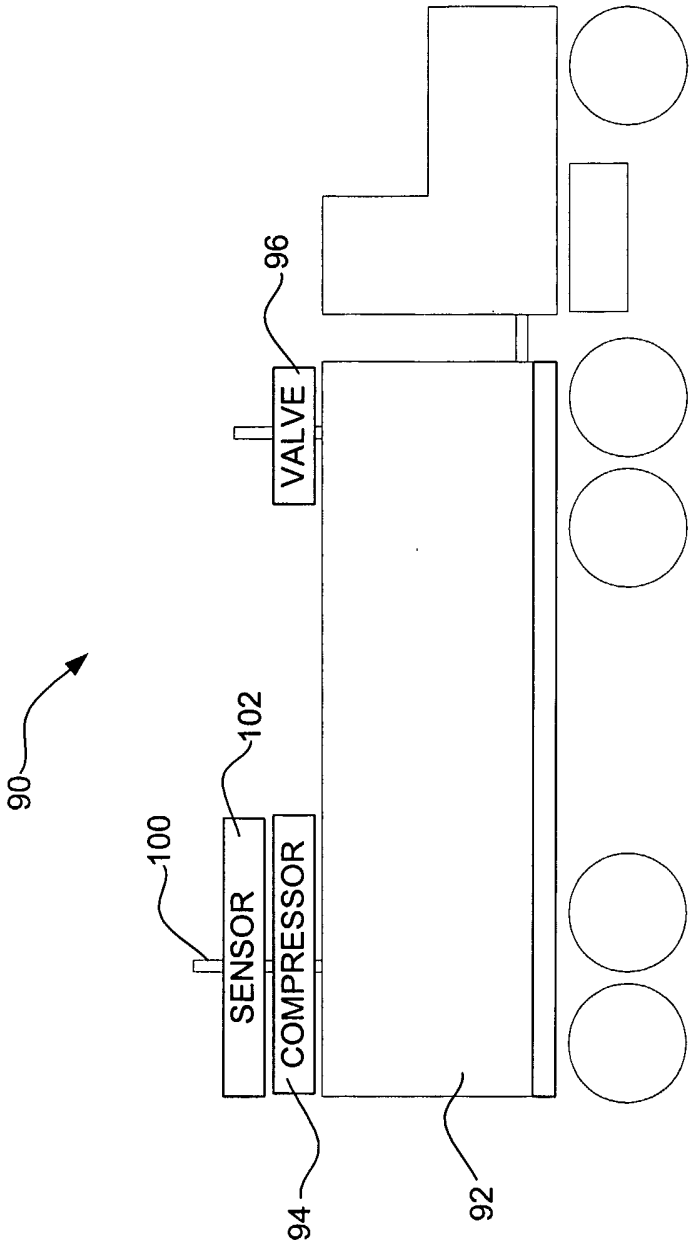

FIG. 4