A more protective respirator is a self-contained breathing apparatus (SCBA). SCBA units include an air tank containing compressed purified air. The tank provides positive pressure air to a respirator mask. Air enters the mask through a demand valve that opens when the user inhales. The cracking pressure of the exhalation unit check valve is greater than the cracking pressure of the demand valve to prevent continuous flow of air through the respirator. In this way, air flows into the respirator during inhalation but ceases to flow during exhalation. In addition to providing an independent source of pure air, SCBA respirators are advantageous in the continuous, positive air pressure inside the mask of a SCBA unit effectively prevents the ingress of ambient air. However, a problem commonly associated with SCBA respirators is that they can be relatively loud, and the source of air is limited to the volume of the associated bottle. Thus, the SCBA arrangement may not be optimal for all environments, especially those in which a user wishes to remain inconspicuous (e.g., for law enforcement and military use).

In view of the foregoing, it is apparent that if a user wishes to be prepared for different types of environments that may require different types of respirators, the user must carry and maintain multiple types of respirators. This can be very cumbersome and inconvenient. It would therefore be desirable to provide a respirator that can quickly and easily be converted for use in various operation modes, including APR and SCBA.

Summary

A configurable exhale system is disclosed for use in a respirator. The system may comprise a housing having a chamber and a first valve assembly disposed within the chamber and configured to prevent air from flowing through the first valve assembly when an air pressure differential between an upstream side and a downstream side of the first valve assembly is below a first opening pressure. The system may further include a second valve assembly disposed within the chamber in fluid communication with the first valve assembly, the second valve assembly configured to prevent air from flowing through the second valve assembly when an air pressure differential between an upstream side and a downstream side of the second valve assembly is below a second opening pressure, where the second opening pressure is greater than the first opening pressure. The system may also include at least one bypass opening positioned adjacent the second valve assembly, where the at least one bypass opening is configured to enable air to bypass the second valve assembly. A bypass member may be positioned adjacent the at least one bypass opening. The bypass member may be movable between first and second positions. In the first position the bypass member may block the at least one bypass opening. In the in the second position the bypass member may not block the at least one bypass opening. In one embodiment, moving the bypass member between the first and second positions comprises axial movement of the bypass member. In another embodiment, moving the bypass member between the first and second positions comprises rotational movement of the bypass member.

In some embodiments, the system comprises a removable cartridge. In other embodiments, the system comprises a built-in feature of a respirator. In some embodiments, moving the bypass member between the first and second positions is initiated manually by a user. In other embodiments, moving the bypass member between the first and second positions is initiated automatically based on a change of state or an aspect of a respirator associated with the system. In further embodiments, the change of state or an aspect of a respirator associated with the system is selected from the list consisting of: the wearer turning on the cylinder, enabling a function of a demand valve, and creating an abnormal pressure condition in an internal volume of the respirator.

A method is disclosed for providing a switchable exhale filter system for a respirator. The method may include providing a housing having a first and second valve assemblies in fluid communication with each other. The first valve assembly may be configured to prevent air from flowing through the first valve assembly when an air pressure differential between an upstream side and a downstream side of the first valve assembly is below a first pressure. The second valve assembly may be configured to prevent air from flowing through the second valve assembly when an air pressure differential between an upstream side and a downstream side of the second valve assembly is below a second pressure. The second pressure may be greater than the first pressure. The method may further include providing at least one opening adjacent the second valve assembly for allowing air to bypass the second

valve assembly; providing a bypass member adjacent the at least one opening; and moving the bypass member between first and second positions, wherein in the first position the bypass member does not block the opening and allows air to flow through the opening to bypass the second valve assembly, and wherein in the second position the bypass member blocks the opening to prevent air from bypassing the second valve assembly. In some embodiments, moving the bypass member between the first and second position comprises moving the bypass member axially. In other embodiments, moving the bypass member between the first and second position comprises rotating the bypass member.

In some embodiments, the system comprises a removable cartridge. In other embodiments, the system comprises a built-in feature of a respirator. In some embodiments, moving the bypass member between first and second positions is initiated manually by a user. In other embodiments, moving the bypass member between first and second positions is initiated automatically based on a change of state or an aspect of a respirator associated with the system. In further embodiments, the change of state or an aspect of a respirator associated with the system is selected from the list consisting of: the wearer turning on the cylinder, enabling a function of a demand valve, and creating an abnormal pressure condition in an internal volume of the respirator.

52 to define a cavity or catch. The head of the catch pin 50 of the valve seat member 38 may fit within the recess 58 to hold the two pieces together. The center of the disc member 40 may thereby be securely "clipped" to the valve seat member 38, so that the peripheral region 56 of the disc member is held in sealing engagement with the annular rim 39 of the valve seat member.

The disc member 40 may be configured so that when a first pressure is applied to one side of the disc member (e.g., the pressure of a user's exhaled breath), the disc member deflects away from the annular rim 39, enabling air to pass around the disc member. When the first pressure is removed, the disc member 40 returns to its original position, sealed against the annular rim 39, thereby preventing air from returning in a reverse direction through the APR valve assembly 14. In one non-limiting exemplary embodiment, the first pressure may be about 0.1 mbar to about 3 mbar.

In the illustrated embodiment, an O-ring 60 or other resilient sealing member may be provided on or adjacent to the valve seat member 38 to provide a secure, airtight seal with a respirator mask (not shown) in which the system 10 is disposed.

The SCBA valve assembly 16 of the system 10 may include a bypass member 62, a SCBA valve disc 64, a valve spring plate 66, and a valve spring 68. Also provided are a retaining member 70, a retaining spring 72, and an actuator 74, all of which fit

an opening pressure of the SCBA valve assembly 16 which is greater than a cracking pressure of a demand valve for a compressed air supply (not shown) when the respirator operates in a mode utilizing a compressed air supply, as will be described in greater detail below. The opening pressure of the SCBA valve assembly 16 may be greater than the opening pressure of the APR valve assembly 14. In one non-limiting exemplary embodiment, this opening pressure of the SCBA valve assembly 16 may be from about 3.5 mbar to about 6.5 mbar.

The actuator member 74, which is best viewed in **FIG. 1**, comprises a circular body 105 having a central opening 106 for receiving a mounting shaft (not within view) that extends rearwardly from the cover 18. An actuation lever 108 may extend radially outward from the circular body 105 through an opening in the cover to allow a user to rotate the actuator 74. A plurality of cam followers 110 may extend rearwardly from the circular body 105 and comprise curved cam follower surfaces that are configured to engage the cams 78 of the bypass member 62 so that as the actuator member 74 is rotated in a first direction the bypass member 62 is moved axially toward the partition 24 of the main housing 12, and as the actuator member 74 is rotated in a second direction the bypass member 62 is moved axially away from the partition.

Thus, in a first position (shown in **FIG. 2**), the bypass member 62 is positioned away from the partition 24 such that the rear extent of the bypass member 62 does not block the peripheral openings 29 in the partition 24. As such, exhaled air is allowed to

CLAIMS:

1. A configurable exhale system for a respirator, the system comprising:

a housing having a chamber;

a first valve assembly disposed within the chamber and configured to prevent air from flowing through the first valve assembly when an air pressure differential between an upstream side and a downstream side of the first valve assembly is below a first opening pressure;

a second valve assembly disposed within the chamber in fluid communication with the first valve assembly, the second valve assembly configured to prevent air from flowing through the second valve assembly when an air pressure differential between an upstream side and a downstream side of the second valve assembly is below a second opening pressure, where the second opening pressure is greater than the first opening pressure;

at least one bypass opening positioned adjacent the second valve assembly, the at least one bypass opening configured to enable air to bypass the second valve assembly; and

a bypass member positioned adjacent the at least one bypass opening, the bypass member movable between first and second positions, wherein in the first position the bypass member blocks the at least one bypass opening, and wherein in the in the second position the bypass member does not block the at least one bypass opening.

2. The configurable exhale system of claim 1, wherein moving the bypass member between the first and second positions comprises axial movement of the bypass member.

3. The configurable exhale system of claim 1, wherein moving the bypass member between the first and second positions comprises rotational movement of the bypass member.

4. The configurable exhale system of claim 1, wherein the system comprises a removable cartridge.

5. The configurable exhale system of claim 1, wherein the system comprises a built-in feature of a respirator.

6. The configurable exhale system of claim 1, wherein moving the bypass member between the first and second positions is initiated manually by a user.

7. The configurable exhale system of claim 1, wherein moving the bypass member between the first and second positions is initiated automatically based on a change of state or an aspect of a respirator associated with the system.

8. The configurable exhale system of claim 7, wherein the change of state or an aspect of a respirator associated with the system is selected from the list consisting of: the wearer turning on the cylinder, enabling a function of a demand valve, and creating an abnormal pressure condition in an internal volume of the respirator.

9. A method for providing a switchable exhale filter system for a respirator, the method comprising:

providing a housing having a first and second valve assemblies in fluid communication with each other; the first valve assembly configured to prevent air from flowing through the first valve assembly when an air pressure differential between an upstream side and a downstream side of the first valve assembly is below a first pressure; the second valve assembly configured to prevent air from flowing through the second valve assembly when an air pressure differential between an upstream side and a downstream side of the second valve assembly is below a second pressure; the second pressure being greater than the first pressure;

providing at least one opening adjacent the second valve assembly for allowing air to bypass the second valve assembly; and

providing a bypass member adjacent the at least one opening; and

moving the bypass member between first and second positions, wherein in the first position the bypass member does not block the opening and allows air to flow through the opening to bypass the second valve assembly, and wherein in

the second position the bypass member blocks the opening to prevent air from bypassing the second valve assembly.

10. The method of claim 9, wherein moving the bypass member between the first and second position comprises moving the bypass member axially.

11. The method of claim 10, wherein moving the bypass member between the first and second position comprises rotating the bypass member.

12. The method of claim 9, wherein the system comprises a removable cartridge.

13. The method of claim 9, wherein the system comprises a built-in feature of a respirator.

14. The method of claim 9, wherein moving the bypass member between first and second positions is initiated manually by a user.

15. The method of claim 9, wherein moving the bypass member between first and second positions is initiated automatically based on a change of state or an aspect of a respirator associated with the system.

16. The method of claim 15, wherein the change of state or an aspect of a respirator associated with the system is selected from the list consisting of: the wearer turning on the cylinder, enabling a function of a demand valve, and creating an abnormal pressure condition in an internal volume of the respirator.

A more protective respirator is a self-contained breathing apparatus (SCBA). SCBA units include an air tank containing compressed purified air. The tank provides positive pressure air to a respirator mask. Air enters the mask through a demand valve that opens when the user inhales. The cracking pressure of the exhalation unit check valve is greater than the cracking pressure of the demand valve to prevent continuous flow of air through the respirator. In this way, air flows into the respirator during inhalation but ceases to flow during exhalation. In addition to providing an independent source of pure air, SCBA respirators are advantageous in the continuous, positive air pressure inside the mask of a SCBA unit effectively prevents the ingress of ambient air. However, a problem commonly associated with SCBA respirators is that they can be relatively loud, and the source of air is limited to the volume of the associated bottle. Thus, the SCBA arrangement may not be optimal for all environments, especially those in which a user wishes to remain inconspicuous (e.g., for law enforcement and military use).

In view of the foregoing, it is apparent that if a user wishes to be prepared for different types of environments that may require different types of respirators, the user must carry and maintain multiple types of respirators. This can be very cumbersome and inconvenient. It would therefore be desirable to provide a respirator that can quickly and easily be converted for use in various operation modes, including APR and SCBA.

US 2008/257352, upon which the pre-characterising portion of claim 1 is based, discloses a configurable exhale system for a respirator, the system comprising a housing having a chamber; a negative pressure valve and a selectively actuatable positive pressure valve assembly (130) disposed within the chamber. An actuating pin is associated with the positive pressure valve assembly which may be used, by rotation of a cover plate, to manually move the valve closure member of the positive pressure valve assembly from a closed position into an open position. As a result, when the cover is rotated to lift the pin and thereby open the positive pressure valve assembly, air is allowed to freely pass through the positive pressure valve and only the negative pressure valve causes any obstruction in the flow. When the pin is lowered to the positon, the valve closure member of the positive pressure valve is biased by a closure spring against the valve seat and the positive pressure valve only then opens when sufficient pressure differential exists across the valve, thereby enabling a second mode of operation of the unit in which air must actuate both the positive and negative valves

Other prior art valves are disclosed in US 2985169, US 2406888, WO 2010/131031 and US 2010/236554.

According to the present invention, there is provided a configurable exhale system as defined in claim 1.

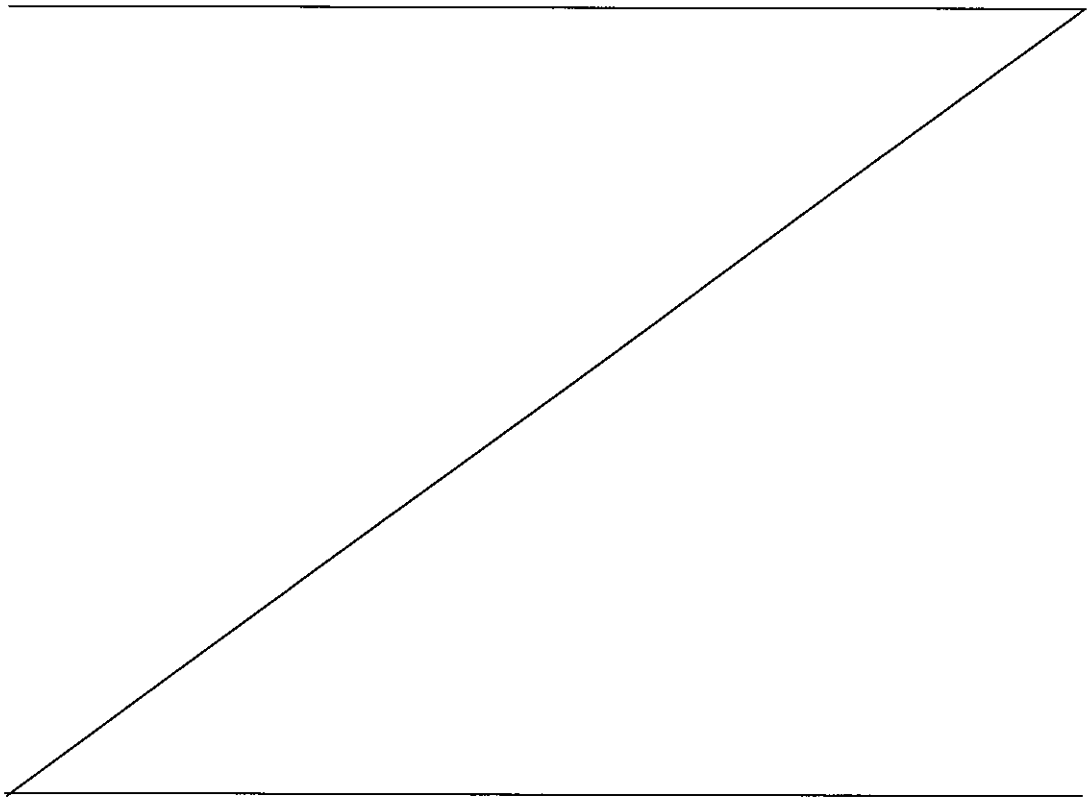
The present invention further provides a method for providing a switchable exhale filter system for a respirator according to claim 7.

In one embodiment, moving the bypass member between the first and second positions comprises axial movement of the bypass member. In another embodiment, moving the bypass member between the first and second positions comprises rotational movement of the bypass member.

In some embodiments, the system comprises a removable cartridge. In other embodiments, the system comprises a built-in feature of a respirator. In some embodiments, moving the bypass member between the first and second positions is initiated manually by a user. In other embodiments, moving the bypass member between the first and second positions is initiated automatically based on a change of state or an aspect of a respirator associated with the system. In further embodiments, the change of state or an aspect of a respirator associated with the system is selected from the list consisting of: the wearer turning on the cylinder, enabling a function of a demand valve, and creating an abnormal pressure condition in an internal volume of the respirator.

In some embodiments, moving the bypass member between the first and second position comprises moving the bypass member axially. In other embodiments, moving the bypass member between the first and second position comprises rotating the bypass member.

In some embodiments, the system comprises a removable cartridge. In other embodiments, the system comprises a built-in feature of a respirator. In some embodiments, moving the bypass member between first and second positions is initiated manually by a user. In other embodiments, moving the bypass member between first and second positions is initiated automatically based on a change of state or an aspect of a respirator associated with the system. In further embodiments, the change of state or an aspect of a respirator associated with the system is selected from the list consisting of: the wearer turning on the cylinder, enabling a function of a demand valve, and creating an abnormal pressure condition in an internal volume of the respirator.



52 to define a cavity or catch. The head of the catch pin 50 of the valve seat member 38 may fit within the recess 58 to hold the two pieces together. The center of the disc member 40 may thereby be securely "clipped" to the valve seat member 38, so that the peripheral region 56 of the disc member is held in sealing engagement with the annular rim 39 of the valve seat member.

The disc member 40 may be configured so that when a first pressure is applied to one side of the disc member (e.g., the pressure of a user's exhaled breath), the disc member deflects away from the annular rim 39, enabling air to pass around the disc member. When the first pressure is removed, the disc member 40 returns to its original position, sealed against the annular rim 39, thereby preventing air from returning in a reverse direction through the APR valve assembly 14. In one non-limiting exemplary embodiment, the first pressure may be about 0.1 mbar to about 3 mbar.

In the illustrated embodiment, an O-ring 60 or other resilient sealing member may be provided on or adjacent to the valve seat member 38 to provide a secure, airtight seal with a respirator mask (not shown) in which the system 10 is disposed.

The SCBA valve assembly 16 of the system 10 includes a bypass member 62, and may include a SCBA valve disc 64, a valve spring plate 66, and a valve spring 68. Also provided are a retaining member 70, a retaining spring 72, and an actuator 74, all of which fit

an opening pressure of the SCBA valve assembly 16 which is greater than a cracking pressure of a demand valve for a compressed air supply (not shown) when the respirator operates in a mode utilizing a compressed air supply, as will be described in greater detail below. The opening pressure of the SCBA valve assembly 16 is greater than the opening pressure of the APR valve assembly 14. In one non-limiting exemplary embodiment, this opening pressure of the SCBA valve assembly 16 may be from about 3.5 mbar to about 6.5 mbar.

The actuator member 74, which is best viewed in **FIG. 1**, comprises a circular body 105 having a central opening 106 for receiving a mounting shaft (not within view) that extends rearwardly from the cover 18. An actuation lever 108 may extend radially outward from the circular body 105 through an opening in the cover to allow a user to rotate the actuator 74. A plurality of cam followers 110 may extend rearwardly from the circular body 105 and comprise curved cam follower surfaces that are configured to engage the cams 78 of the bypass member 62 so that as the actuator member 74 is rotated in a first direction the bypass member 62 is moved axially toward the partition 24 of the main housing 12, and as the actuator member 74 is rotated in a second direction the bypass member 62 is moved axially away from the partition.

Thus, in a first position (shown in **FIG. 2**), the bypass member 62 is positioned away from the partition 24 such that the rear extent of the bypass member 62 does not block the peripheral openings 29 in the partition 24. As such, exhaled air is allowed to

CLAIMS:

1. A configurable exhale system (10) for a respirator, the system comprising:

a housing (12) having a chamber (20);

a first valve assembly (14) disposed within the chamber (20) and configured to prevent air from flowing through the first valve assembly (14) when an air pressure differential between an upstream side and a downstream side of the first valve assembly (14) is below a first opening pressure; and

a second valve assembly (16) disposed within the chamber (20) in fluid communication with the first valve assembly (14) , the second valve assembly (16) configured to prevent air from flowing through the second valve assembly (16) when an air pressure differential between an upstream side and a downstream side of the second valve assembly (16) is below a second opening pressure, where the second opening pressure is greater than the first opening pressure; characterized by:

at least one bypass opening (29) positioned adjacent the second valve assembly (16), the at least one bypass opening (29) configured to enable air to bypass the second valve assembly (16); and

a bypass member (62) positioned adjacent the at least one bypass opening (29), the bypass member (62) movable between first and second positions, wherein in the first position the bypass member (62) blocks the at least one bypass

opening (29), and wherein in the in the second position the bypass member (62) does not block the at least one bypass opening (29).

2. A configurable exhale system of claim 1, wherein moving the bypass member (62) between the first and second positions comprises axial movement of the bypass member (62).

3. A configurable exhale system of claim 1, wherein moving the bypass member (62) between the first and second positions comprises rotational movement of the bypass member (62).

4. A configurable exhale system of claim 1, wherein the system comprises a removable cartridge.

5. A configurable exhale system of claim 1, wherein the system comprises a built-in feature of a respirator.

6. A configurable exhale system of claim 1, wherein moving the bypass member (62) between the first and second positions is initiated manually by a user.

7. A method for providing a switchable exhale filter system for a respirator, the method comprising:

providing a housing (10) having a first (14) and second (16) valve assemblies in fluid communication with each other; the first valve assembly (14) configured to prevent air from flowing through the first valve assembly (14) when an air pressure differential between an upstream side and a downstream side of the first valve assembly (14) is below a first pressure; the second valve assembly (16) configured to prevent air from flowing through the second valve assembly (16) when an air pressure differential between an upstream side and a downstream side of the second valve assembly (16) is below a second pressure; the second pressure being greater than the first pressure; characterized by:

providing at least one opening (29) adjacent the second valve assembly (16) for allowing air to bypass the second valve assembly (16);

providing a bypass member (62) adjacent the at least one opening (29); and

moving the bypass member (62) between first and second positions, wherein in the first position the bypass member (62) does not block the opening (29) and allows air to flow through the opening (29) to bypass the second valve assembly (16), and wherein in the second position the bypass member (62) blocks the opening (29) to prevent air from bypassing the second valve assembly (16).

8. A method of claim 7, wherein moving the bypass member (62) between the first and second position comprises one of moving the bypass member axially and rotating the bypass member.

9. A method of claim 7, wherein the system comprises a removable cartridge.

10. A method of claim 7, wherein the system comprises a built-in feature of a respirator.

11. A method of claim 7, wherein moving the bypass member (62) between first and second positions is initiated manually by a user.