

PROCESS AND SYSTEM FOR EMERGENCY
SMOKE INHALATION PROTECTION

Background of the Invention

The present invention relates to fire fighting safety methods, and more particularly to techniques for protecting fire fighters against smoke inhalation in imminent life-threatening situations.

Breathing masks are often worn by workers in hazardous environments. One type of such a mask extends only over a user's nose and mouth, and contains a charcoal filter through which the air being breathed passes. The filter removes particles and toxic gases from the air. However, use of this type of breathing apparatus is typically prohibited by most fire departments as being inadequate, unreliable or unsafe in many environments where fire and smoke are present.

Instead, fire fighters are commonly approved to use safer self-contained breathing equipment when entering burning buildings. Such equipment includes a tank of compressed air and a pressure regulator to supply air at a constant pressure that can be tolerated by the fire fighter. A hose connects the air regulator to a full-face mask that is worn over the fire fighter's face. The mask includes an outlet for air exhaled by the fire fighter and a transparent visor. When worn by the user, the mask not only provides a sealed volume of breathable air over the user's face, but also protects the fire fighter's eyes from the smoke. Self-contained breathing apparatus with a full-face mask typically is the only type of smoke inhalation prevention equipment that is authorized by a fire department.

The tank of the fire fighter's breathing equipment has a finite supply of air. Although warning mechanisms are provided to alert the fire fighter when the supply of air is running low, there always is the possibility that the fire fighter will not be able to exit the burning structure before the exhaustion of the air supply. There is also a possibility that a fire fighter may become trapped within a burning structure, due to structure collapse, for example. The fire fighter may become lost in a large smoke-filled area, such as a shopping mall. The fire fighter could also be injured or incapacitated in some way and rendered immobile. In these instances, the fire fighter can run out of breathable air and be in imminent danger of death. As a consequence, it is desirable to provide an alternative breathing apparatus that protects against smoke inhalation for use in such imminent life-threatening emergencies.

Although a charcoal filter-type mouth filter could be provided to fire fighters for emergency back-up to authorized self-contained breathing apparatus, fire department officials are often concerned that such masks will be used routinely in the normal course of fire fighting and not reserved for imminent death situations, and therefore prohibit their use outright. Accordingly, it is desirable to provide a way of issuing back-up breathing devices to fire fighters in a manner which restricts their use to true emergency imminent death situations. It is also desirable to provide a mechanism by which fire fighters can quickly identify previous use and fire department officials can detect the unauthorized use of such emergency breathing devices.

Summary of the Invention

A general object of the present invention is to provide a reliable emergency breathing system and a process to protect fire fighters from smoke inhalation in last resort, imminent death situations in a manner that inhibits use of such equipment in the ordinary course of fire fighting.

Another object is to provide a use-evidencing container for use in an emergency breathing method which provides a clear indication that the apparatus has been used.

A further object of the invention is to provide a method for storing the emergency device in a durable and moisture resistant manner for long term dormancy.

A still further object of the invention is to provide a method of emergency air filtering that can quickly be applied by an endangered fire fighter.

These objects are achieved by an emergency air filtering method for protecting a fire fighter from smoke and hazardous chemical inhalation in imminent life-threatening situations. It is recognized that all fire fighting experiences are life-threatening to varying degrees. As used throughout this specification and associated claims, the terms "imminently life-threatening" or "imminent death situations" are used to describe those instances during fire fighting in which a fire fighter realizes that circumstances have placed him in imminent and impending danger of death. These terms are intended to distinguish from the ordinary course of normal fire fighting in which a fire fighter is aware of options and opportunities to remain secure against death while performing his fire fighting tasks.

The invention provides a method of using a compact emergency air filtering device that can be attached to the mask of a conventional self-contained breathing apparatus. The air filtering device comprises a canister having at least one opening through which air can enter and a coupling for attachment to the mask to supply air to the user. A filter is contained within the canister through which air passes between the opening and the coupling.

In an imminent life-threatening situation, such as when the air in the tank of the standard self-contained breathing apparatus is depleted, the fire fighter uncouples the air tank from the mask. The emergency air filtering device then is attached either directly to the mask or to the remote end of the air supply hose in place of the tank. When the fire fighter inhales, air is drawn into the mask through the canister where the filter cleanses the air. The small, compact nature of the emergency air filter system allows convenient long term storage of the gear of the fire fighter and rapid application in an imminent life-threatening situation.

A use-evidencing mechanism is associated with the canister to indicate possible previous use of the air filtering device. Such mechanism is constructed or configured to visually reveal that canister has been arranged for operation and to prevent rearrangement to the previous, unused condition and appearance. This mechanism may take any one of several forms. In one embodiment, the use-evidencing mechanism can comprise a package that is closed with a non-reusable closure or which is vacuum sealed to provide

evidence, when opened, that the air filtering device stored therein has been used. The vacuum sealed package also can provide resistance against moisture that otherwise undermines the effectiveness of the filter medium.

5 In another embodiment, self-adhesive covers can be applied over the opening and the coupling of the canister. The adhesive used will not permit the covers to be reapplied over the opening and coupling once the covers have been removed. Alternatively, use-evidencing tape, that leaves a
10 message bearing residue or the like, can be used as the covers.

 The present invention allows the prior use of the breathing device to be visually detected and to be monitored by fire fighter supervising personnel, thereby discouraging
15 unauthorized use for other than imminent death situations.

Brief Description of the Drawings

FIGURE 1 is an exploded, isometric view of an emergency breathing apparatus according to the present invention;

FIGURE 2 illustrates the use of such emergency breathing apparatus by an individual.

FIGURE 3A is an isometric view of an assembled breathing apparatus with use-evidencing covers over the air inlet and outlet;

FIGURE 3B illustrates the mouthpiece of the breathing apparatus with a use-evidencing removable cover in place;

FIGURE 4 shows the emergency breathing apparatus enclosed in another use-evidencing container embodiment;

FIGURE 5 is a pictorial view of a fire fighter wearing a mask of a conventional self contained breathing apparatus;

FIGURE 6 is a pictorial view of a fire fighter wearing the mask of Figure 5 which is attached to an emergency air filtering system according to the present invention;

FIGURE 7 is a cross-sectional view through the emergency air filtering system; and

FIGURE 8 illustrates the emergency air filtering system attached to a hose of a mask for a standard breathing apparatus.

Detailed Description of the Invention

The invention is directed to a method for providing fire fighters with an emergency device for providing breathable air when a standard breathing source such as a self-contained
5 breathing apparatus is exhausted. This method is intended to provide the fire fighter a few extra minutes of breathing to escape the imminently life threatening situations. The invention also resides in the step of configuring the breathing device to be use-evidencing so as to provide an
10 accountability of the use by the fire fighter. With initial reference to Figure 1, the method can be accomplished , for example, by an emergency personal air filtering device 10 includes a housing 12, a filter cartridge 14 and a nose clip 16. The assembly of these components provides a relatively
15 small and hoodless device which can be carried easily by a fire fighter for use in imminent life-threatening situations, such as an unexpected failure of standard self--contained breathing equipment.

As discussed earlier, it is recognized that all fire
20 fighting experiences are, to varying degrees, life-threatening. As used throughout this specification and the associated claims, the terms "imminently life-threatening" or "imminent death situations" are used to describe those instances during fire fighting in which the fire fighter
25 realizes that circumstances have placed him in imminent and impending danger of death. These terms are intended to distinguish from the ordinary course of normal fire fighting in which a fire fighter is aware of options and opportunities

to remain secure against death while performing his fire fighting tasks.

The compact nature of the air filtering device 10 also makes it easy to insert into a mouth as application of a large hood or mask over the head of the user is not required. This convenient and rapid use offsets any delay created by a use-evidencing covering, discussed more fully below.

The housing 12 is formed of moldable plastic or rubber and has a mouthpiece 18 that includes an oval-shaped tube 20 with a radial flange 22 extending around one end of the tube. A pair of teeth grips 24 project from the side of the flange 22 that is remote from tube 20. In use, the mouthpiece 18 is inserted into the fire fighter's mouth so that the flange 22 is between the lips and the teeth with lips tightly sealed around the tube 20.

An air duct 26 extends from the tube 20 of the mouthpiece 18 and has accordion walls allowing the air duct to assume the form of an easily flexible 90° elbow. An end of the air duct 26, that is remote from the mouthpiece 18, is connected to an opening at the top of a plenum 28 of the housing 12. The plenum 28 has a hollow cylindrical shape defining an interior plenum chamber 30 with an open front end 32 and a closed rear end 34. The air duct 26 and tube 20 provide an air passage between the plenum chamber 30 and the outlet of mouthpiece 18 through which the user is able to breathe.

The plenum chamber 30 has a circular cross section adapted to receive a cylindrically-shaped filter cartridge 14. When the filter cartridge 14 is placed into the plenum chamber 30, the outer circumferential surface 36 tightly engages a

pair of ribs 38 within the plenum chamber. The resiliency of the plenum 28 and specifically the ribs 38 provide an air tight seal around the exterior of the filter cartridge 14. Securing the filter cartridge in the plenum chamber 30 effectively closes the open end 32 of the plenum.

The filter cartridge 14 is of a conventional design having an inlet 40 in a front surface 42 and an outlet (not shown) in a rear surface 44. A charcoal filter element 46 is contained within the filter cartridge 14 through which air flows between the inlet and the outlet. The charcoal filter element 46 removes particles, such as smoke, and hazardous vapors from the air passing through the filter cartridge. The filter element can also includes hopkolite to convert noxious carbon monoxide to a harmless gas. The filter can be any of a variety of type, but it is preferred that the filter be designed to filter and render breathable air filled with large quantities of carbon monoxide.

The mouthpiece 18, air duct 26 and plenum chamber 30 when closed by the filter cartridge 14 form an enclosure through which air being breathed by a user flows. When the user inhales, air is drawn through filter cartridge 14 and into a chamber at the rear of the plenum 28 between the filter cartridge and rear end 34. The air then travels upward into the air duct 26 and the mouthpiece tube 20. Finally, the air exits the air filtering device 10 and into the user's mouth through the opening 76 in the remote end of the mouthpiece tube 20 that is surrounded by flange 22 as illustrated in Figure 3B. When the user exhales, air flows through the air filtering device 10 in the reverse direction.

By wearing the nose clip 16 shown in Figure 1 and 2, ambient air is prevented from flowing through the user's nostrils when using the air filtering device 10. The nose clip 16 has a spring clip 50 with a pair of legs 52 and 53 connected by a cross member 54 that includes a torsion spring 56. The ends of the legs 52 and 53 which are remote from the cross member 54 are attached to separate mushroom-shaped nose depressors 58 and 59. The force provided by torsion spring 56 on legs 52 and 53 causes the nose depressors 58 and 59 to abut one another when the device is not in use. Each nose depressors 58 and 59 has a stem 60 and 61, respectively, which can be grasped by the user for installation and removal of the nose clip 16. A leash 55 has a loop at one end that passes through the torsion spring 56 and a loop at another end which passes through a bracket 48 at the exterior top of the plenum 28. The leash 55 attaches the nose clip 16 to the housing 12.

The nose clip 16 and leash 55 also serve to maintain connection between the filter and the user. If the mouthpiece is inadvertently dropped from the mouth, the nose clip 16 can retain the filter in proximity of the face for prompt reinsertion. This feature can be lifesaving as the user may not be able to relocate a filter dropped to the ground in a smoke-filled area.

Referring to Figure 2, the fire fighter 66 inserts the mouthpiece 18 in his mouth so that the flange 22 is located between the lips and the teeth with the teeth grips 24 between the teeth of upper and lower jaws. The fire fighter closes the teeth on the grips 24 to hold the mouthpiece in place and the thickness of the grips provide a gap between the teeth

through which air being breathed passes. The nose depressors 58 and 59 are pulled apart by grasping the stems 60 and 61 and placed over the nose. The fire fighter 66 then gently releases the nose depressors 58 and 59. The force provided by the torsion spring 56 presses the depressors 58 and 59 against the sides of the nose closing the nostrils.

To reserve the smoke filter to imminent life-threatening situations, the apparatus of the invention includes a use--evidencing mechanism operatively connected to the filter. The use-evidencing mechanism is constructed or configured to visually reveal that the mouthpiece and filter have been arranged for operation and to prevent rearrangement to the previous, unused condition and appearance.

In Figure 3A, the air filtering device 10 is assembled for use with the filter cartridge 14 inserted into the plenum chamber of housing 12. The use-evidencing mechanism can include a first foil cover 70 with adhesive applied to one surface that can be adhered to the front of the filter cartridge 4 over the inlet opening 40, thereby sealing the opening. The cover 70 has a large tab 72 which can be grasped by the fire fighter to pull the cover 70 off of the filter cartridge in order to use the air filtering device 10. As shown in Figure 3B, the mouthpiece 18 has a similar second cover 74 extending over the opening 76 in the flange 22 that couples with the tube 20. The second cover 42 is a foil material with a self-adhesive backing that adheres the cover to the surface of the flange 22 providing an air tight seal over the opening 76. The second cover 74 also has a large tab 78 that can be grasped by the fire fighter to pull the second

cover 74 from the mouthpiece. The covers 70 and 74 seal the openings of the air filtering device 10 prior to use, thereby preventing moisture from entering the filter cartridge 14 and degrading the charcoal filter element 46 therein. The covers
5 70 and 74 can be removed easily in an emergency situation by a fire fighter wearing gloves.

The adhesive used to apply the two covers to the air filtering device should be of a type which loses its adhesion characteristic upon removal. In other words, the adhesive
10 does not permit the covers 70 and 74 to be reattached to the mouthpiece, thus providing an indication that the mouthpiece has been used. Alternatively, the covers 70 and 74 can be made of use-evidencing tape to show that the container has been opened.

15 As previously mentioned, hoodless, smoke filtering apparatus is generally prohibited by most fire departments. To restrict use of this apparatus to only imminent life-threatening situations, the air filtration device 10 can be enclosed in a use--evidencing package 80 illustrated in Figure
20 4.

A fire fighter can quickly assess whether a filter has previously been used and possibly depleted or diminished. This rapid inspection can avoid the damage of using a possibly ineffective filter in a noxious atmosphere.

25 Also, periodically, fire department supervisory officials can inspect the packages of filtering devices which have been issued to the fire fighters to determine whether the devices have been used. If such use is detected, the respective fire fighter can be questioned as to the circumstances of such use

to insure that the device had been used only in an emergency situation, such as after the depletion or the failure of authorized self--contained breathing equipment. The fire department may impose sanctions against fire fighters who use
5 the subject breathing device 10 in other than authorized situations.

The package 80 can include an inner foil pack 42 in which the air filtering device 10 is placed. The foil pack 82 then is evacuated and sealed along a closure 84. A pair of tabs 86
10 extend from each side of the closure 84 providing mechanisms by which fire fighter can easily pull apart the closure and gain access to the air filtering device contained in foil pack 82. Because the foil pack 82 is vacuum sealed, it conforms to the external contours of the air filtering device 10. Upon
15 opening the foil pack 82, the vacuum seal is lost and the pack no longer tightly conforms to the contours of the air filtering device. This provides a further mechanism in addition to the non-resealable closure 84 by which a user and a fire department supervisor can detect that the package 80
20 was opened.

Because the foil pack 82 is subject to accidental puncture if left exposed, the pack can be enclosed in a heavier gauge, puncture resistant transparent plastic bag 88. This bag may include mechanisms (not shown) for fastening the
25 package 80 to fire fighting gear, such as a belt 87, conventional self-contained breathing equipment or a turn-out coat. In other cases, the pack 80 may simply be placed within a pocket 89 of the turn-out coat. An opening of bag 88 is

thermally sealed along seam 90 in a manner which leaves an open section 92 which can be grasped by the fire fighter to pull apart the sealed seam 90, thereby gaining access at the foil pack 82. The closures of foil pack and bag 5 88 are designed to release easily so that access to the breathing device will not be significantly impeded in imminent life-threatening situations.

Other forms of use-evidencing containers can be used to store the air filtering device. Another version of the air 10 filtering device for use in the method to save fire fighters in imminent life-threatening situations can be used with conventional fire fighter breathing equipment, such as the one shown in Figure 5. This embodiment is preferred because it enables the fire fighter to leave his eye and face protecting 15 mask on and quickly apply a filter in place of the hose and regulator for a self-contained breathing tank.

Fire fighters commonly wear self-contained breathing apparatus comprising a tank of compressed air (not shown) that is worn on the person's back. A hose 100 extends from the 20 tank to a regulator (not shown) on the mask 102 worn over the face 105 of the fire fighter 104. The mask 102 has a ring 106 of resilient material such as rubber that conforms to contours of the user's head to provide a relatively air-tight seal when held in place by a set of elastic straps 110 that go around 25 the head. A clear plastic window 108 projects like a bubble from the ring 106 in front of the face 105 of the fire fighter 104. The hose 100 (and regulator) connects to a fitting 112 or similar interface at the bottom of the mask 102, thereby

supplying air to the envelope formed by the mask and the fire fighter's face 105.

It should be understood that the description of the face mask and air supply assembly is intended to be illustrative of a typical configuration. The method of the invention can be applied to a wide variety of fire fighter's self-contained breathing systems to allow a fire fighter to obtain extra life-saving minutes of breathing.

With reference to Figure 6, in the event that the fire fighter is unable to exit a burning structure before the exhaustion of the air supply in the tank, the hose 100 and regulator can be disconnected from the mask 102 and an emergency air filtering device 120 attached to the interface of the mask 102. The emergency air filtering device 120 normally is stored on the fire fighter by fastening to fire fighting gear, such as the standard breathing equipment or a turn-out coat from which the device can be readily accessed in an emergency. Also, the filter can be stored in a pocket of a turn-out coat.

As shown in Figure 7 the emergency air filtering device 120 can comprise a canister 122 having a cylindrical container 126 and a lid 125 sealed to an open end of the container. The other end of container 126 can be closed by a contiguous bottom wall 124 which has a plurality of apertures 128 therethrough. Use-evidencing tape 130 can be adhered to the exterior surface of the bottom wall 124 closing the apertures 128. The tape 130 prevents air from entering the canister 122 when not in use, thereby preserving a filter element 134 contained therein. The tape 130 has a tab 132 which is

grasped by a fire fighter to remove the tape in order to use the air filtering device 120. The releasable adhesive used to attach the tape 130 to the canister is of the type that can not be reused once the tape has been removed, thus providing evidence that the canister has been opened. Alternatively, the canister 122 can be enclosed in a use-evidencing container as discussed above in connection with the mouthpiece embodiment.

The filter element 134 within the canister 122 can have a separate fabric filter 136 and 138 against the bottom wall 124 and the lid 125 respectively. Between the two fabric filters 136 and 138 is an activated charcoal filter 140.

Alternatively, a multiple stage filter can be placed between the fabric filters. For example, in addition to an activated charcoal filter, a desiccant can be provided to remove moisture and a material that converts carbon monoxide into carbon dioxide by catalyzation may be included. While the filter can be constructed in a variety of ways, it is preferred that the filter be equipped to clean air filled with high levels of carbon monoxide, for example, through the use of hopkolite and silica gel. The filter cartridge could also be constructed in a more compact, puck-like container.

The lid 125 is tightly attached to the container 126 by crimping or adhesive so that air can not leak therebetween.

An aperture extends centrally through the lid 125 and a tubular coupling 142 is sealed to the lid in communication with the aperture. The coupling 142 has an external lip 144 at the remote end. A cap 146, of soft plastic for example, is placed over the remote end of the coupling 142 to seal that

end of the canister 122 when not in use. A tab 148 allows the cap 146 to be peeled away in order to use the air filtering device 120. The cap 146 is destroyed by the removal process thereby preventing use of the cap to reseal the coupling.

5 Thus, cap 146 can also serve as a mechanism which provides evidence of the use of the filtering device 120. The single use covers formed by tape 130 and cap 146 not only prevent a contaminated air filtering device 120 from being inadvertently reused, but also provides a mechanism by which fire department
10 officials can detect the unauthorized use of the emergency air filtering device.

When the emergency air filtering device 120 is to be used, the fire fighter removes the tape 130 and the cap 146 from the ends of the canister 122. The coupling 142 then is
15 attached to the fitting 112 on the mask 102 in place of the hose 100 and regulator as shown in Figure 6. The coupling is preferably constructed to engage the fitting in sealed manner to prevent smoke from entering the interior of the face mask. The fire fighter then is able to breathe filtered air through
20 the canister of the device 120. Alternatively, the filter cap 146 can be formed of a breakable tape that is permanently punctured upon engagement of the coupling 142 onto the interface 112.

Alternatively, the hose 100 could remain attached to the
25 mask 102 and the emergency air filtering device 120 could be connected by coupling 142 to the remote end of the hose as shown in Figure 8. However, this method is not preferred because of the difficulty that may be encountered in

attempting to disconnect the remote end of the hose from the tank.

The emergency air filtering device 120 also can be enclosed in a use-evidencing package, such as package 80
5 illustrated in Figure 4 and described previously. The use of that type of package may be in addition to or in place of the canister closures provided by tape 130 and cap 146.

While specific embodiments of the invention have been set forth with a relatively high degree of particularity, it is
10 intended that the scope of the invention not be so limited. Instead, the proper scope of the invention may include alternatives which are now within the purview of one skilled in the art. Thus, the scope should be ascertained by a reading of the claims that follow.

CLAIMS

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We claim:

1. A method for storing and preparing a personal air filtering device for smoke inhalation protection for fire fighters in imminently life-threatening situations and for encouraging its limited use to the imminently life-threatening situations, said method comprising the steps of:

configuring a smoke filter in a use-evidencing manner so that use of the smoke filter for breathing is permanently indicated;

interfacing the smoke filter with a fire fighter's face mask to filter air breathed by the fire fighter.

2. A method as recited in Claim 1, further comprising the step: before the interfacing step, storing the smoke filter in the fire fighter's coat.

3. A method as recited in Claim 1, further comprising the step: before the interfacing step, storing the smoke filter on a fire fighter's belt.

4. A method as recited in Claim 1, further comprising the step: before the interfacing step, removing a regulator and hose from the fire fighter's face mask, wherein the smoke filter sealingly interfaces the face mask during said interfacing step to prevent smoke from entering the interior of the face mask.

5. A method for storing and preparing a personal air filtering device for smoke inhalation protection for fire fighters in imminently life-threatening situations and for encouraging its limited use to the imminently life-threatening situations, said method comprising the steps of:



configuring a smoke filter and integral mouthpiece in a use-evidencing manner so that use of the smoke filter for breathing is permanently indicated;

at least partially removing a fire fighter's face mask to access the fire fighter's mouth;

interfacing the mouthpiece with the fire fighter's mouth to filter air breathed by the fire fighter.

6. A method as recited in Claim 5, further comprising the step: before the removing and interfacing steps, storing the smoke filter in the fire fighter's coat.

7. A method as recited in Claim 5, further comprising the step: before the removing and interfacing steps, storing the smoke filter on a fire fighter's belt.



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