

COMPACT NBC FILTRATION SYSTEM FOR RESIDENTIAL SAFE ROOM**FIELD OF THE INVENTION**

The present invention relates to a Nuclear Biological Chemical (NBC) filtration system for residential safe rooms, more particularly to a simple, low cost, space saving and easy to operate NBC filtration system for residential safe rooms.

BACKGROUND OF THE INVENTION

National civilian defense authorities such as US DEPARTMENT OF HOMELAND SECURITY (DHS) and Israel's HOME FRONT COMMAND (HFC) instruct citizens to enter a sealed shelter in case of a nuclear, biological or chemical attack. In Israel, every living unit includes a sealed, blast protected safe room built to Israeli government standards. The regulations in Israel enforces installation of an NBC filtration system in the blast protected safe room of every new discrete living unit.

The regulations require that the NBC filtration system should be fixedly installed in position and be ready for immediate use. Typically, the NBC filtration system is mounted to an air intake fitted through an exterior wall of the building, carrying an integrated blast valve at the outer side of the wall and a standard or quick connect flange at the inner side of the wall. An air exhaust unit is mounted through a preferably opposite interior wall of the safe room, provided with an over-pressure relief valve. The regulations indicate that such NBC filtration system should include an NBC filter unit composed of a particulate filter and an adsorption filter, and an electric blower appropriate for certain amount of air exchange. In addition the NBC filtration system should have an air exchange backup pump manually operated in case of electric power failure. Typically, the manual air exchange backup pump consists of a bellows that is manually expanded and contracted to force external air into the safe room, directly during ventilation mode, or through the NBC filter unit during NBC filtration mode.

Israeli patent application 212657 to the present applicant, describes an NBC filtration system with electric blower and manual bellows, including an automatic interchange between the electric operation and the manual operation by means of two one way valves. Accordingly it is possible to actuate the bellows without any preparations and even without detaching the bellows from its original position, as long as the filtration system is installed at the arm height of an average person, typically up to 1.5 meters from floor level.

However in order to achieve optimal usage of the safe room space, it is desired and now widely accepted that the NBC filtration system and the air intake are fitted above an

average person height. Current NBC filtration systems where the air intake is installed above an average person height, are supplied with a bracket fitted on the wall below the NBC filtration system and a discrete bellows that can be attached to the bracket. The bellows is then connected by a flexible duct supplied with the system, to the air intake directly for operation at ventilation mode, or to the filter unit that is attached to the air intake for operation at NBC filtration mode.

Until recently, there was also a need upon declaration of NBC hazard, to remove air tight seals fitted to the inlet and outlet of the NBC filter unit and to assemble the NBC filter unit between the air intake and the flexible duct. However this is now eliminated according to Israeli patent application 214577 to the present applicant, describing a two-way changeover valve within an NBC air filtration system that allows changing from ventilation mode to NBC filtration mode by only switching a manual state selector handle attached thereon.

Yet, in case of electric power failure, when manual operation of the bellows is required, and the air intake is installed above an average person height, there is still a need even for systems equipped with a changeover valve, to make some preparations before the NBC filtration system is ready for manual operation. The preparations include: removing or opening (if hinged) the NBC filtration system cover, collecting the bellows and flexible duct which are stored under the cover, fitting the bellows to the on-wall bracket, connecting each side of the flexible duct to the changeover valve outlet and to the bellows inlet respectively.

The described sequence of operations may be difficult to the average user to perform under stress. It was shown by field tests, that some people have difficulty in performing the set-up task even when completely calm.

Yet another drawback of currently available NBC filtration systems is their size. The smallest NBC filtration systems currently available are in the size range of 65cm wide, 35cm high and 21cm thick. Total volume is about 50 liters which could otherwise be used for other normal living purposes.

Israeli patent application No. 250296 to the present applicant describes an NBC filter unit including an integral ventilation bypass and air flow direction means selectively operated to direct air flow internally from the inlet port of the filter unit to the outlet port, either through the bypass, constituting a ventilation mode, or through the particulate filter and gas adsorption filter constituting an NBC filtration mode.

Israeli patent application No. 252068 to the present applicant describes a manually actuated backup bellows for an NBC filtration system, comprising an electric blower fitted to an internal space of the backup bellows. The electric blower is mounted to either the inlet port

or outlet port of the backup bellows, such that the backup bellows and the electric blower can be operated alternately, independently of each other. The backup bellows is ready for immediate manual actuation in case of electric power failure.

Although not being a necessity, embodiments of the present invention may make use of the NBC filter unit, the backup bellows and actuation lever as described above with reference to Israeli patent applications No. 250296 and No. 252068 respectively.

Israeli patent application No. 252594 to the present applicant describes an NBC filtration system comprising in addition to the NBC filter unit and backup bellows, an actuation lever, manual propulsion of the actuation lever expands and contracts the backup bellows. A grip-able portion of the actuation lever is accessible at a height lower than the installation height of the NBC filtration system. Optionally the NBC filtration system may further comprise a transmitting mechanism, where manual propulsion of the actuation lever drives the transmitting mechanism to expand and contract the backup bellows. Accordingly, it is possible to actuate the backup bellows without any preparations and even without detaching the bellows from its original position. However there is still a need to remove or open a protective cover fitted to the NBC filtration system. The protective cover is essential for neat appearance of the NBC filtration system, and for improved storage conditions during normal times.

NBC filtration system production cost and installation cost are also a concern, there are some essential auxiliary parts included with existing NBC filtration systems, such as the flexible duct and quick connect flanges. Other parts are required for installation only, such as wall fixing screws. Installation may include concrete wall drilling and leveling of the system, those additional parts and procedures lead to increase in cost, they could be avoided with proper conceptual design as disclosed in the present invention.

SUMMARY OF THE INVENTION

Accordingly, it is a principal object of the present invention to overcome the disadvantages and limitations of prior art systems and provide a compact and low cost NBC filtration system for residential safe rooms. The provided systems will also feature easier operation and faster installation procedure.

These and other objects are achieved according to the present invention by providing an NBC filtration system for residential safe rooms, comprising: an NBC filter unit, an electric blower, a manually actuated backup bellows, and a protective cover. Manual back and forth actuation of the backup bellows is carried out with at least a portion of the protective cover being actuated as well, thus eliminating the need to first detach the protective cover

The backup bellows further comprises at least a deformable chamber. A stationary first extremity of the deformable chamber is airflow coupled, at least at times of NBC filtration, to an outlet of the NBC filter unit and a movable second extremity of the deformable chamber is attached to the protective cover.

According to another aspect of the present invention, a face of the NBC filter unit serves also as a stationary closure of the deformable chamber first extremity and a face of the at least portion of the protective cover serves also as a movable closure of the deformable chamber second extremity, such that the NBC filter unit, the at least portion of the protective cover and the backup bellows becomes an integrated unit.

Yet according to another aspect of the present invention, the at least portion of the protective cover is movably linked to the NBC filter unit with at least one scissors mechanism.

Optionally, there may be provided an NBC filtration system comprising the above, where a movable closure of the backup bellows functions as at least a part of the protective cover, thus eliminating the need to first detach the protective cover.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention and the way it may be carried out in practice, will be understood with reference to the following illustrative figures, by way of non-limiting example only, in which like reference numerals identify like elements, and in which:

Fig. 1 is a perspective view of an NBC filtration system made according to an embodiment of the present invention;

Fig. 2 is a perspective view of the NBC filtration system of fig. 1, showing the rear side;

Fig. 3 is a perspective view of the NBC filtration system of fig. 1, with the protective cover shown sectioned to expose the internal components;

Fig. 4 is a perspective view of the NBC filtration system as in Fig. 1, shown without the protective cover and bellows;

Fig. 5 is a perspective view of the NBC filtration system as in Fig. 4, shown without the protective cover and bellows and with the scissors mechanism expanded;

Fig. 6 is a perspective view of the NBC filtration system as in Fig. 1, shown fully assembled with the bellows and scissors mechanism expanded;

Fig. 7 is a perspective view of the NBC filtration system as in Fig. 1, demonstrating the NBC filter unit only; and

Fig. 8 is a perspective view demonstrating the internal side of the cover only.

DETAILED DESCRIPTION OF EMBODIMENTS

With reference to the figures, according to one embodiment of the present invention, there is shown in Fig. 1, a compact, low cost and simple in operation, NBC filtration system generally referenced 10, for residential safe rooms. Fig. 2 depicts the rear side of the NBC filtration system 10, showing the air inlet 16 and mounting flange 18. With reference to Fig. 3, the NBC filtration system comprises an NBC filter unit 20, an electric blower 22, a manually actuated backup bellows generally referenced 24, and a protective cover 26 shown sectioned in Fig. 3.

Yet with reference to Fig. 3, the manually actuated backup bellows 24 is intended for forcing fresh air into the safe room during electric power failure when the electric blower 22 is not effective. The backup bellows 24 as known in the art has a deformable chamber 28 typically configured as a cylindrical expandable duct. A stationary first extremity 30 of the deformable chamber 28 is airflow coupled, at least at times of NBC filtration, to an outlet 34

(Fig. 4) of the NBC filter unit 20. In an event of a power failure manual back and forth actuation of a movable second extremity 36 of the deformable chamber 28, expands and contracts the deformable chamber 28 in particular or the backup bellows 24 in general.

As will be hereinafter explained, the actuation of the backup bellows 24 in combination with two or more one way valves, draws fresh air into the safe room either directly or through the particulate filter and gas adsorption filter enclosed in the NBC filter unit 20. According to the present invention, manual back and forth actuation of the backup bellows 24 is carried out with the protective cover 26, or part of it, being actuated as well, thus eliminating the need to first detach the protective cover 26 or reposition any of the components of the NBC filtration system, as needed in prior art filtration systems. Optionally, with reference to Fig. 1, the protective cover 26 may be split into a fixed portion 44 and a movable portion 46, separated for instance along the dashed line marked 48 in Fig. 1. In cases where the protective cover 26 is split, manual back and forth actuation of the backup bellows 24 is carried out with the movable portion 46 of protective cover 26 being actuated as well. Both options, the one piece protective cover 26 as described above, and the split protective cover 44, 46, eliminates the need to first detach the protective cover 26, a portion 46 of it or to reposition any of the components, as needed in prior art filtration systems.

According to an embodiment of the present invention, a front face 40 (Fig. 4) of the NBC filter unit 20, serves also as a stationary closure of the first extremity 30 of the deformable chamber 28. An internal face 41 (fig. 8) of the protective cover 26, or at least a portion 46 (Fig. 1) of the protective cover 26, serves also as a movable closure of the second extremity 36 of the deformable chamber 28. According to the above, the NBC filter unit 20, the protective cover 26, or at least portion 46 of the protective cover 26 and the deformable chamber 28 becomes an integrated unit. The described combination, uses the NBC filter unit front face 40 and the protective cover 26 as closures for the backup bellows deformable chamber 28 first and second extremities 30, 36 respectively. The deformable chamber 28 is typically configured as an expandable duct open at both ends. Using the NBC filter unit front face 40 and the protective cover 26 as closures on both ends of the duct saves manufacturing and material cost. As will be understood, upon assembly of the NBC filtration system, actuation of the protective cover 26 or at least a portion 46 of it, expands and contracts the backup bellows generally referenced 24.

According to the above explanation, it will be understood that the term protective cover includes any surface of the NBC filtration system that is visible to the safe room occupants during normal times, even if related to over component of the NBC filtration system. For example, a movable closure of the backup bellows which is visible at normal times and therefore functions as at least a part of the protective cover, eliminating the need to first detach the protective cover as a preparation step of manual operation, will also fall under the scope of the present invention.

Optionally, as mentioned above with reference to Fig. 1, the protective cover 26 may be split into a fixed portion 44 and a movable portion 46, separated for instance along the dashed line marked 48 in Fig. 1. The surface area of the movable portion 46 being larger than the cross section of the deformable chamber 28, such that the movable portion 46 of the protective cover 26 may serve as a closure for the second extremity 36 of the backup bellows deformable chamber 28. The movable portion 46 of the protective cover 26 being actuated with the second extremity 36 of the backup bellows deformable chamber 28.

According to an optional embodiment of the present invention, a lever 50 linked to the protective cover 26 is further provided. Manual actuation of the lever 50 expands and contracts the deformable chamber 28 in particular and the backup bellows 24 in general. A grip-able portion 52 of the lever 50 is accessible at a height lower than the installation height of the NBC filtration system 10.

The NBC filter unit 20 typically includes a particulate filter and a gas adsorption filter as known in the art. Preferably but not necessarily, the NBC filter unit 20 of the present invention further includes an integrated ventilation bypass and airflow direction means as disclosed in Israeli patent application No. 250296 to the present applicant. The ventilation bypass and airflow direction means located within the NBC filter unit 20, enable simple state changing of the NBC filtration system between ventilation mode effective during normal times or conventional hazard and NBC filtration mode effective during NBC hazard. The airflow direction means is switched between the two operating modes by a state selector handle 56 preferably located at the bottom of the NBC filtration system 10 to be clearly visible and conveniently operated.

Due to the high integration and low cost of the peripheral components, the NBC filter unit 20 or the entire NBC filtration system 10 may be disposable and replaceable as a

complete unit in case of chemical contamination of the filter unit 20 or when the NBC filter unit reaches end of life period.

Optionally, with reference to Figs. 3 and 4, the protective cover 26 or the movable portion 46 of the protective cover, which is attached to the movable second extremity 36 of deformable chamber 28, may be movably linked to the NBC filter unit 20 on one, or both sides, as shown in the figures, by a scissors mechanism 60. The scissors mechanism 60, keeps parallelism of the protective cover 26 in relation to the NBC filter unit 20 while permitting free linear movement of the protective cover. Consequently, the user does not have to carry the weight of the protective cover or keep the required parallelism in order to prevent collapsing of the deformable chamber 28.

In cases where the NBC filtration system is installed above an average person height, the back and forth actuation may be performed with the aid of a fixed or detachable lever 50. A grip-able portion 52 of the lever 50 is accessible at a height lower than the installation height of said NBC filtration system 10, such that the lever 50 may be operated at the arm height of an average person. The lever 50 may be linked to one stage of the scissors mechanism 60, for instance to the first stage 62 (Fig. 4), by means of an adapter 64, thus actuating the other stages gathering the scissors mechanism.

The scissors mechanism 60 effectively multiplies, the manual propulsion of the actuation lever by the number of stages gathering the scissors mechanism 60. Accordingly, the stroke of the backup bellows may be configured by changing the number of stages gathering the scissors mechanism 60. As a result, moderate actuation of the lever 50 may be transmitted to a large linear stroke of the protective cover 26 along with the movable second extremity 36 of deformable chamber 28, or in general the linear stroke of the backup bellows 24. The scissors mechanism 60 is shown in the expanded state without the protective cover in Fig. 5, and with the protective cover in Fig. 6, demonstrating the high linear stroke that can be achieved as a result of moderate actuation of the lever 50.

With reference to Fig. 8, there is shown a rear view of the protective cover 26, exposing the scissors mechanism rail 68 including a static link hole 70 and a sliding link slot 72. Also shown a circular rim 74 ready for attachment of the second extremity 36 of the deformable chamber 28, preferably externally tightened with a plastic or metal tie band. With reference also to Figs. 4 and 5, when assembled the static link hole 70 accepts the static pin

76 fitted to the last stage 78 of the scissors mechanism 60, and the sliding link slot 72 accepts the sliding pin 80 of the last stage 78 of the scissors mechanism 60.

For space saving purpose, the electric blower 22 may be fitted to the internal space of the backup bellows 24. It may be fitted directly to a first outlet 82 (Fig. 7) of the NBC filter unit 20 as shown in the figures, or to the internal side 41 (Fig. 8) of the protective cover 26. As explained above, the protective cover 26 additionally serves as a closure of the movable second extremity 36 of the deformable chamber 28.

A second outlet 34 of the NBC filter unit is provided with a first one way valve 86, the backup bellows is provided with a second one way valve 88 (Fig. 1), fitted to the air outlet 84 of the NBC filtration system located on the protective cover 26, and the electric blower is provided with a third one way valve 90 (Fig. 4) fitted to an outlet of the electric blower 22. The first 86, second 88 and third 90 one way valves may accept different shapes and materials, they may be constructed for instance as flaps hinged about a thin resilient material connecting the flaps to the NBC filter unit 20 and cover 26, as shown in the figures. Springs may be provided to keep the flaps in the initial closed position when not in use. The first 86, second 88 and third 90 one way valves automatically redirects air flow through the electric blower or the manual backup bellows as needed. Specifically, when the electric blower 22 is operative the third one way valve 90 will be open and the first one way valve 86 will be closed and vice versa in case of an electric power failure when the backup bellows is operated. The second one way valve 88 will be constantly open during operation of the electric blower 22. At times of manual operation, the second one way valve 88 will be intermittently opened and closed according to contraction and expansion of the backup bellows 24 respectively.

The inlet of the NBC filter unit 16 (Fig. 2) may be provided with a mounting flange 18 of the standard or fast connect type. The mounting flange is suitable for direct attachment on a mating standard or fast connect flange provided to an air intake pipe which is fitted through an exterior wall of the safe room (not shown). The air intake pipe may be further provided with an internally integrated blast valve and carry the above mentioned mating flange at the inner side of the exterior wall.

Installation of the system is performed on any standard 4" or 8" intake pipe by slackening the provided nuts and removing the temporary cover fitted on the standard air intake mating flange, the entire NBC filtration system is brought to place on the mating

flange and the nuts re tightened. According to the present invention there is no need to drill the concrete wall, level the NBC filtration system or to make any in-site preparations for installation.

In operation of the NBC filtration system 10, typically the first step would be operation at ventilation mode when conventional hazard is declared and the safe room is occupied. Ventilation mode is selected by switching on an electric switch that powers the electric blower. The second step, would be operation at NBC filtration mode when NBC hazard is declared. NBC filtration mode is selected by switching on the electric blower as indicated above and switching the state selector handle 56 towards an NBC filtration state sign marked on the system. The third step would be operation in case of electric power failure, either in ventilation mode or in NBC filtration mode, which is performed by manually actuating back and forth the backup bellows 24 along with the protective cover 26, functionally replacing the electric blower 22. If the NBC filtration system is installed above an average person height, there is an additional step of fitting the detachable lever 50, as described above with reference to the scissors mechanism 60, and manually actuating back and forth the lower grip-able portion 52 of the detachable lever. Manual operation is effective for either the ventilation mode or the NBC filtration mode.

Optionally, the state selector handle 56 may be a three position handle, linked also to the electric switch, thus capable of switching between an off mode where the NBC filtration system is not in use, the above mentioned ventilation mode and the above mentioned NBC filtration mode.

It will be appreciated that the specific embodiments of the present invention described above and illustrated in the accompanying drawings are set forth merely for purposes of example. Other variations, modifications, and applications of the present invention will readily occur to those skilled in the art. It is therefore clarified that all such variations are considered within the scope and spirit of the invention. Accordingly, the protection sought herein is as set forth in the claims below.

CLAIMS:

1. A compact, low cost and simple in operation, NBC filtration system comprising: an NBC filter unit; an electric blower; a manually actuated backup bellows configured to functionally replace said electric blower in an event of power failure, said backup bellows is airflow coupled, at least at times of NBC filtration, to an outlet of said NBC filter unit; and a protective cover, wherein manual back and forth actuation of said backup bellows is carried out with at least a portion of said protective cover being actuated as well, thus eliminating the need to first detach said protective cover.
2. An NBC filtration system as claimed in claim 1, wherein said backup bellows further comprises a deformable chamber, a stationary first extremity of said deformable chamber is airflow coupled, at least at times of NBC filtration, to an outlet of said NBC filter unit, and a movable second extremity of said deformable chamber is attached to said protective cover.
3. An NBC filtration system as claimed in claim 2, wherein a face of said NBC filter unit serves also as a stationary closure of said deformable chamber first extremity and a face of said at least portion of said protective cover serves also as a movable closure of said deformable chamber second extremity, such that said NBC filter unit, said at least portion of said protective cover and said deformable chamber becomes an integrated unit.
4. An NBC filtration system as claimed in claim 1, further comprising a lever, manual actuation of said lever expands and contracts said backup bellows.
5. An NBC filtration system as claimed in claim 4, wherein a grip-able portion of said lever is accessible at a height lower than the installation height of said NBC filtration system.
6. An NBC filtration system as claimed in claim 1, wherein said NBC filter unit further comprises a particulate filter, a gas adsorption filter, an integrated ventilation bypass and air flow direction means.
7. An NBC filtration system as claimed in claim 2, wherein said protective cover is split into a fixed portion and a movable portion, a surface area of said movable portion being larger than a cross section of said deformable chamber, said movable portion of said protective cover is attached to and is actuated with said deformable chamber second extremity.

8. An NBC filtration system as claimed in claim 3, wherein said at least portion of said protective cover is movably linked to said NBC filter unit with at least one scissors mechanism.
9. An NBC filtration system as claimed in claim 8, wherein a lever is attached to one stage of said scissors mechanism thus enabling actuation of said scissors mechanism, said scissors mechanism effectively multiplies, the manual propulsion of the actuation lever by the number of stages gathering said scissors mechanism.
10. An NBC filtration system as claimed in claim 1, wherein said electric blower is fitted to an internal space of said backup bellows.
11. An NBC filtration system as claimed in claim 1, further comprising an electric switch, wherein switching on said electric switch powers said electric blower and starts operation of said NBC filtration system in a ventilation mode.
12. An NBC filtration system as claimed in claim 11, further comprising a state selector handle, wherein switching on said electric switch and switching said state selector handle to NBC filtration state, starts operation of said NBC filtration system in an NBC filtration mode.
13. An NBC filtration system as claimed in claim 12, wherein in an event of electric power failure, either in ventilation mode or in NBC filtration mode, manual back and forth actuation of said backup bellows, functionally replaces said electric blower.
14. An NBC filtration system as claimed in claim 13, wherein said state selector handle is a three position handle, linked also to said electric switch, thus capable of switching between an off mode in which said NBC filtration system is not in use, said ventilation mode and said NBC filtration mode.
15. An NBC filtration system as claimed in claim 4, wherein operation in case of power failure is performed by fitting said lever and manually actuating back and forth said grip-able portion of said lever.
16. An NBC filtration system as claimed in claim 1, wherein installation of said NBC filtration system to a safe room is performed by fitting a mounting flange of said NBC filtration system to a mating flange of an intake pipe of said safe room, thus eliminating the need to drill the concrete wall and level the NBC filtration system.
17. A compact, low cost and simple in operation, NBC filtration system comprising: an NBC filter unit; an electric blower; a manually actuated backup bellows airflow coupled, at least at times of NBC filtration, to an outlet of said NBC filter unit, manual back and forth

actuation of said backup bellows, functionally replaces said electric blower; and a protective cover, wherein a movable closure of said backup bellows functions as at least a part of said protective cover, thus eliminating the need to first detach said protective cover.