

Body and respiratory protective device

The present disclosure relates to personal protection equipment. More specifically, the present disclosure relates to a body and respiratory protective device.

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BACKGROUND

According to the World Health Organization (WHO), a personal protective equipment (PPE) consists of a device that is used to prevent or minimize exposure to hazards such as biological, chemical, radiological, electrical, mechanical hazards, etc.

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PPEs are intended to protect health care workers or any other persons against risks to health or safety such as to get infected or exposed to injuries and illnesses. The use of PPEs is crucial for a wide range of different sectors and industries, such as, for example, hospital, medical, laboratory, chemical, pharmaceutical, manufacturing, and mining environments.

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Protection is extremely important particularly in the case of healthcare, in which doctors, nurses, assistants, etc. are usually in direct contact with sick patients, who may transmit a disease through infectious agents, such as liquids, airborne, etc. to healthcare workers or other patients. Protection is also highly important in clean room environments, where a high degree of protection against contamination from airborne particles is required.

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PPE include masks, for example, surgical masks, comprising pieces of cloth or paper made of insulating material that are placed over the nose and mouth of the health worker, and secured through a rubber band or headband to prevent infectious agents from being transferred from a patient to the health worker or vice versa. As an example, filtering facepiece respirators are disposable half facepiece respirators that filter out particles such as dusts, mists, and fumes. A further example is elastomeric half facepiece respirators. They are reusable and have replaceable cartridges or filters. They cover the nose and mouth and provide protection against gases, vapors, or particles when equipped with the appropriate cartridge or filter.

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The main disadvantage of said devices is that the user or wearer is not completely isolated, and the user or wearer may get sick from contact with infectious agents through the eyes, the skin, etc. Furthermore, infectious agents from the health worker

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such as expired air, sweat, etc. may also endanger the patient's health. In the case of filtering facepiece respirators, they do not provide protection against gases and vapors.

5 Full face masks are also included within the definition of PPE. They comprise a transparent face shield or visor that cover a large part of the user's face. The visor is attached to the head by means of straps, covering the user's face and isolating it from the outside. Full face masks may include an opening formed at a lower part thereof for the entry and exit of air. A filter may be included for filtering the air that
10 passes through said opening when in use. In one example, elastomeric full facepieces are reusable respirators including replaceable canisters, cartridges, or filters. The facepiece covers the face and eyes, which offers eye protection.

The main disadvantage of full-face masks is that they are not comfortable, in
15 particular due to the provision of filters in a front portion of the mask, near the user's mouth. Full-face masks are not capable of isolating the user's entire head.

Respiratory protection devices are also considered PPEs such as, for example, protective shells which are adapted to cover at least a portion of a user's head as in
20 the respirator assembly disclosed in WO2009064555A1. It includes a protective shell, a visor, an air inlet conduit, and a top air delivery conduit. An external air supply pipe is connected to a portable air source that is carried by the user in a backpack or on a belt. The portable air source includes a fan driven by a motor powered by a battery, and a filter.

25 PPEs may comprise a garment such as a hood, and a transparent visor. The hood and the visor define a closed inner chamber that surrounds the user's head. Said devices may be fitted with a ventilation unit that includes a fan to deliver air into the garment.

30 Powered air purifying respirators (PAPRs) have a battery-powered blower that pulls air through attached filters, canisters, or cartridges. An external air supply pipe is connected to a rear portion of the garment and to an external air flow generating device for the flow of air into the hood. Such devices provide protection against
35 gases, vapors, or particles, when equipped with the appropriate cartridge, canister, or filter. Loose-fitting PAPRs do not require fit testing and can be used with facial hair.

In a further example, supplied-air respirators are connected to a separate source that supplies clean compressed air through a hose. They can be lightweight and used while working for long hours in environments not immediately dangerous to life and health (IDLH).

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Still in a further example, self-contained breathing apparatuses (SCBAs) are used for entry into or escape from environments considered to be IDLH. They contain their own breathing air supply and can be either open circuit or closed circuit.

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Combination respirators can be either a supplied-air/ SCBA respirator or supplied-air/air-purifying respirator. The SCBA type has a self-contained air supply if primary airline fails and can be used in IDLH environments. The air-purifying type offers protection using both a supplied-air hose and an air-purifying component and cannot be used for entry into IDLH environments.

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A personal protection system for medical/surgical personnel comprising a hood and a ventilation unit is disclosed in EP1907071. A support structure is provided over which the hood is disposed. A transparent face shield is provided in the hood. The ventilation unit includes a fan for circulating air inside the hood. At least one outlet duct is connected to the fan. A filter is provided to filter air between the user and the outer environment.

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Further examples of powered air purifying respirators including a ventilation unit are shown in documents WO2020084482A1 and EP2814578B1 including a ventilation unit and a respirator face piece in the form of helmet having a face shield. The ventilation unit includes an air outlet connected to one end of an external air supply pipe. The other end of the external air supply pipe is connected to an air inlet of the respirator face piece. The ventilation unit is mounted on a belt to be worn on a wearer's back.

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The devices cited above suffer from the disadvantage that the provision of external air supply pipes and external units results in cumbersome awkward devices making it difficult for the user or wearer to move. In addition, since the flow of air that is driven into the hood flows out through an opening provided in a front portion of the hood, in a section close to the user's mouth, no outlet air filter is provided. Even in cases when an outlet air filter is provided in the front portion of the hood for isolating both the user and the patients from infectious agents, this results in the device being

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inconvenient for the user.

In an attempt to overcome or to at least mitigate the above disadvantages, protection devices have been also proposed including a ventilation unit mounted to a surgical helmet, as shown in the surgical assembly disclosed in WO2019079537A1 for use with a surgical helmet.

In a further example, a personal protection system disclosed in WO2014160149 includes a structural support extending around a wearer's head and configured to support a hood above the wearer's head. In this case, a ventilation unit is mounted to the structural support and includes a fan for drawing air through the hood and through at least one nozzle for discharging air within the hood. The hood has a transparent face shield and a filter for filtering air entering from the external environment.

A further example of protective devices including a ventilation unit is disclosed in WO2023161536A1 filed in the name of the applicant of the present application in which a protective air filtration device is provided comprising a structure to be fastened to the head of a user, a visor, a hood, inlet and outlet air filters and a fan.

Although increasingly effective protection devices have been proposed so far, a need still remains for a personal protection device that is cost effective to produce, provides integral, bidirectional/dual protection, that is, safe protection to the user of the protection device and also safe protection to professional users, patients, and other persons in the surroundings which, at the same time, is compact, comfortable, and easy to wear.

SUMMARY

The above objects of the invention and other advantages are achieved by the body and respiratory protective device disclosed herein according to the claims. References to user and wearer are used herein interchangeably.

The present body and respiratory protective device comprises a head support for supporting the device on a wearer's head. The head support may comprise, for example, a supporting band arranged to surround the user's head. One or more transverse bands may be optionally provided if required. However, in other examples of the protective device, the head support may be configured as a helmet,

substantially surrounding the wearer's head. In any case, the head support may be provided with fastening and adjustment means for adapting to the user's head. Foam may be included in different interior areas of the supporting band to be in contact with the user's head to provide comfort when in use.

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An airtight synthetic garment is provided. Within the meaning of the present disclosure, synthetic refers herein to any garment made from chemically produced fibers such as polyester. The garment is preferably made of a technical fabric or suitable material that is of at least one of waterproof and anti-bacterial nature. As used herein, anti-bacterial refers to the property of the garment material to resist the passage of bacteria, hazardous and cytotoxic micro-organisms, or other infectious particles and harmful materials therethrough thus acting as a protective barrier. If required, the garment may advantageously have anti-static properties.

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A most preferred spinning material for the garment may comprise 90-99% polyester microfibers and 1-10% carbon fiber filaments, with a preferred density of 125 g/m². A very comfortable, lightweight, highly breathable material is provided which offers a pleasant texture to the wearer. This results in a sustainable device that may be advantageously considered a sanitary product.

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Other materials for the garment of the present device are however not ruled out such as 100% polyester. The material of the garment may include fluorocarbon finishing. A microporous inner/outer membrane/layer of PVC, ePTFE, or polyurethane may be applied.

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Although the garment is preferably made of a reusable and durable material such as the above mentioned polyester microfibers with carbon fiber filaments, having an extremely high durability of the order of, for example, 15-50 uses, the garment could however be made of a single-use, disposable material if required.

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The garment extends covering most of a wearer's body. Within the meaning of the present disclosure, covering most of a wearer's body is to be understood herein as extending from the wearer's head up to at least the wearer's knees. In some examples, the garment may extend covering the whole body, from the head up to the feet. Within the meaning of the above definition, the garment may be for example a coverall, a gown, and the like, that may be made of various sizes depending on requirements and user size. The garment may be made either of a single piece or it

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may be made of several pieces. In any case, the above configuration results in the present body and respiratory protective device capable of providing full protection to the user's head, neck, chest, arms, legs, feet, hands, etc.

- 5 The garment may be fixedly attached to the head support, or it may be removed therefrom. A zipper may be provided, for example, on a waist area, for quickly and easily putting the garment on and taking it off. A zipper may be also provided for joining pieces of the garment in the case it is formed of several pieces.
- 10 The present body and respiratory protective device further comprises a transparent face shield arranged in the garment. The face shield may be preferably made of silicone or derivatives thereof. In one example, the face shield is 0.250 - 3.5 mm thick and the material thereof may have a tensile strength of 7.0 - 7,5 MPa, and an elongation of 300- 350%. Other values are also envisaged. The face shield may
- 15 preferably have anti-fog properties.

The face shield may be integrally formed with the garment, or it may be a separate part that may be removably attached thereto. Still in other examples, the face shield may include a frame. The frame, when included, may be adapted to provide for a

- 20 proper tensioning of the surface of the face shield. As a result, a wide field of view is provided for proper visibility, making the device suitable for use in different environments such as operating rooms, clean rooms, or in any contaminated environment.

- 25 In preferred examples, attaching means may be provided for removably attaching the face shield to the head support. Said attaching means may comprise press fitting elements configured as male portions formed in the frame capable of being press received into complementary female portions formed in a front portion of the head support. It is to be noted that the male portions could be formed in a front portion of
- 30 the head support for being press received into complementary female portions formed in the frame.

- A ventilation assembly is provided. The ventilation assembly comprises a fan suitable for causing air to flow within the garment from an air inlet to an air outlet. The air inlet
- 35 is preferably provided in the head support. The air outlet may be advantageously arranged in at least one lateral portion of the device, for example in at least one lateral portion of the garment.

A suitable fan is capable of providing positive pressure to the interior of the garment with a minimum air flow rate of 120-300 l/min. In one optimal example, the fan is arranged at the top of the head support and more preferably at a rear portion of the head support.

The air flow rate may be suitably controlled by adjusting the fan speed according to readouts from at least one temperature sensor under specific control electronics. Thus, the air flow rate can be suitably adapted within the garment based on temperature in the air outlet. Other sensors may be included in the device for continuous real time monitoring of different parameters such as CO₂ level, air speed, etc.

In use, the garment envelops the wearer's head and most of her/his body allowing a positive pressure to be generated, preventing air leakage. The garment is preferably provided with watertight and airtight seams and joints for preventing air from passing there through.

Two-way air filter means are included in the ventilation assembly of the present protective device. Within the meaning of the present disclosure, two-way air filter means involves using one or more filters to purify the air being breathed in, to protect the wearer, and also using one or more filters to purify the air being breathed out, to protect the patient or other persons in the surrounding area.

The two-way air filter means of the present protective device comprise at least one air inlet filter and at least one air outlet filter. The air filters may be capable of filtering particle sizes down to 0.02 µm.

Said at least one air inlet filter is arranged at the above mentioned air inlet for filtering the air before it reaches the fan. As a result, the ventilation assembly provides optimum air renewal ensuring suitable breathability to the user or wearer. The at least one air inlet filter may be fixed to the head support, or it may be removable therefrom. The at least one air inlet filter is preferably arranged on a top rear portion of the head support. In this way, the fan draws air into the equipment through said at least one air inlet filter and is propelled and conducted towards a front area of the inside of the garment.

The air inlet filter preferably provides a 99.8% particulate filtration performance. In terms of inwards leakage, the air inlet filter preferably provides a level of performance of up to 0.2 %, that is, less than 0.2% of the fumes or particles bypass filtration. This configuration meets the highest standard possible, in particular a TH3 level of performance (inward leakage) according to standard EN 12941.

It is advantageous to provide the air inlet filter removably attached to the head support so that the air inlet filter is interchangeable. As a result, the device is capable to adapt to particular filtering or protection requirements. Examples of the air inlet filter removably attached to the head support are with the air inlet filter screwed thereto, for example, as a screw cap or the like, and with the air inlet filter press-fitted to the head support for quick removal. Other ways for attaching the air inlet filter to the head support are not ruled out.

It is also envisaged that the air inlet filter may be received, in use, within an at least substantially transparent housing. This would allow the condition of the air inlet filter to be easily checked from the outside of the device.

On the other hand, the at least one air outlet filter is arranged at the air outlet.

Preferably, said at least one air outlet filter has a surface of at least 100 cm². The air outlet filter may be fixed to the garment, or it may be removable therefrom. When the air outlet filter is fixed to the garment, this may be carried out for example by at least one of sewing, gluing, heat-sealing, and laser welding.

When the air outlet filter is formed at least at one lateral portion of the device, as stated above, one air outlet filter may be thus also arranged in at least one side of the device. For example, one air outlet filter may be arranged in each side of the garment.

A power source is provided for supplying electric power to the fan and other electric devices. The power source may include a battery arrangement, preferably with a minimum battery life of one working day. The battery arrangement advantageously weighs less than 400 grams. This prevents weight of the device from causing discomfort to the user during use. The battery arrangement may be rechargeable and may be carried on a belt suitable to be worn by the user. The belt is preferably arranged within the garment.

The device may include at least one RFID tag so that traceability can be obtained. An IoT device may be included connected via Bluetooth, WiFi or the like for transmitting data taken by device's sensors with relevant parameters such as usage time, battery status, etc. to a cloud platform or a specific station.

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Blockchain and tokenization technology may be included so that a number of protective devices can be given identity and attributes relating, for example, to the wearer, user, or owner, battery status, usage time, last use, last disinfection, filter condition, etc. Data may be updated as the device's lifetime expires. The present protective device may thus have associated a unique digital identifier that may be recorded on a blockchain to be used to certify ownership and authenticity so that it cannot be copied, substituted, or subdivided. The present protective device may be in this way a Non-Fungible Token (NFTs) to be created in a blockchain and managed through a Smart Contract.

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The body and respiratory protective device that has been described above provides significant advantages over devices known so far for the same purpose in addition to providing the highest level of protection and comfort to the user.

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The present body and respiratory protective device is efficient to protect health persons against risks to health or safety preventing exposure to hazards of biological, chemical, radiological nature, contaminants etc. The present protective device has been found to be particularly efficient as a barrier to prevent such substances and materials from entering a person's body by inhalation, that is, via the respiratory tracts, and also orally, that is, via the mouth, or even dermally, that is, through the skin.

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The protective device described above is an integral, compact unit with all components integrated therein, that is, an airtight synthetic garment extending covering most of a wearer's body with a transparent face shield, and a ventilation assembly, everything being integrated into a compact unit. It is important to note that in the present protective device there is no need to provide external parts such as tubes for conducting air.

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The present device is also lightweight, comfortable to use with no facial pressure and with no elements in contact with the user's face. It is quick and easy to wear, with safe adjustment and handling. It is ergonomic and fits different user physiognomies,

with a long service life, simple, reliable, cost-effective, and involving reduced waste.

BRIEF DESCRIPTION OF THE DRAWINGS

5 One non-limiting example of the present body and respiratory protective device will be described in the following, with reference to the appended drawings. In the drawings:

10 Figure 1 is a general perspective view of one example of the present body and respiratory protective device;

Figure 2 is a front view of the body and respiratory protective device shown in figure 1;

15 Figure 3 is a rear view of the body and respiratory protective device shown in figure 1;

Figure 4 is a rear perspective view of the body and respiratory protective device showing a further example of the inlet air filter;

20 Figure 5 is a top plan view of the body and respiratory protective device shown in figure 1;

25 Figure 6 is a top perspective view of the head support of the body and respiratory protective device in figure 1 with the inlet air filter removed from the head support;

Figure 5 is a perspective view of one example of the inlet air filter of the protective device shown in figure 1; and

30 Figure 8 is a detail perspective enlarged view of a portion of the protective device with the garment removed and showing the airflow when in use.

DETAILED DESCRIPTION OF EXAMPLES

35 In the non-limiting examples that will be described in detail below by referring to the figures, the present body and respiratory protective device has been denoted as a whole by reference numeral 100. The user's or wearer's body has been depicted in

the figures through dashed lines. References to user and wearer are used herein interchangeably.

The present body and respiratory protective device 100 is a personal protective equipment (PPE) intended to fully provide the highest level of protection to the user or wearer with two-way air filter means for bidirectional protection, that is, safe protection to the user or wearer of the device and also safe protection to other persons in the surroundings through an integral yet compact device including all necessary components into a compact and comfortable unit that is easy to wear.

The body and respiratory protective device 100 shown in the non-limiting examples of the figures comprises a head support 120 for supporting the protective device 100 on a wearer's head. In the non-limiting example shown in the figures of the drawings, the head support 120 is formed of a supporting structure comprising a supporting band 122 configured for surrounding the user's head as shown in figure 3 of the drawings.

The head support 120 further includes fastening and adjustment means 125 for suitably fitting on the user's head. Said fastening and adjustment means 125 comprise a knob 126 that is arranged at the rear of the head support 120. Said knob 126 can be rotated for tightening or loosening the supporting band 122 to fit the user's head circumference as shown in figure 3 of the drawings. The inner surface of the supporting band 122 is preferably provided with foam elements, not shown, to be in contact with the user's head to provide comfort.

Attached to the head support 120 is an airtight, waterproof, synthetic garment 130 one example of which in the form of a coverall 130 is shown in figures 1-6 of the drawings. The coverall 130 may be made of various sizes for adapting to different users.

In the non-limiting example shown in the drawings and disclosed herein, the coverall 130 is made of 99% polyester microfibers and 1 % carbon fiber filaments, with a density of 125 g/m². Anti-static properties may be applied to the coverall 130 if required. As a result, a protective device 100 having an extremely high durability of the order of, for example, 75-125 uses, is required. As a result, a coverall 130 suitable for acting as a protective barrier against bacteria is obtained.

However, other materials and variations are however envisaged as required, such as

for example, disposable materials so that the garment 130 is a single-use coverall. The coverall 130 is made in this example of a single piece and extends covering most of the wearer's body, from the head up to the legs. The coverall 130 has watertight seams and joints for preventing air from passing through the inside. A waist zipper, not shown, may be also provided for quickly and easily putting the coverall 130 on and taking it off.

The coverall 130 includes a transparent face shield 140 with a wide field of view for proper visibility in any condition in different environments. In this example, the face shield 140 is made of silicone or derivatives thereof with anti-fog properties. In this example, the transparent face shield 140 is 0.250 - 3.5 mm thick with a tensile strength of 7.0 - 7,5 MPa, and an elongation of 300- 350%.

Referring now to figures 1-6 of the drawings, the coverall 130 is provided with a drawstring closure 136 for suitably fitting to the user. In the non-limiting example shown in said figures 1-6, the drawstring closure 136 is arranged outside the coverall 130. In this case, the coverall 130 is provided with a double-layer portion 135 for suitably protecting the drawstring closure 136. Said double-layer portion 135 is provided in a region of the user's neck of the coverall 130 and in the surroundings thereof, as shown, or even in other regions where required. In this way, safe handling of the protective device 100 is ensured. The drawstring could be provided inside the coverall 130, in which case the double-layer portion 135 may not be required.

The face shield 140 includes, in the example shown, a frame 145 extending around the perimeter of the face shield 140 to provide proper tensioning of the surface of the face shield 140. The face shield 140 is attached to and removed from the head support 120 through attaching means 150. In the example shown, said attaching means 150 comprise press fitting elements in particular female portions 146 formed in the frame 145 capable of being press received into complementary male portions 121 formed in a front portion of the head support 120.

The body and respiratory protective device 100 further comprises a ventilation assembly 200. The ventilation assembly 200 includes a fan 230. As shown in figure 8 where the airflow path of the protective device 100 has been depicted, when the protective device 100 is in use, the fan 230 is capable of causing air to flow within the coverall 130 from an air inlet 215 to an air outlet 220 provided at each side of the coverall 130 and through an air duct 210 towards the front area inside the coverall

130.

The fan 230 is arranged at a top rear portion of the head support 120 to draw air into the coverall 130 when in use, providing positive air pressure with a minimum air flow rate of 120 l/min. At least one temperature sensor is provided for adjusting fan speed to control air flow rate through a control unit, not shown.

An air inlet filter 300 capable of filtering particle sizes down to 0.02 μm arranged at the air inlet 215. In the example shown in figures 1-3, the air inlet filter 300 is press-fitted to the head support 120 at a top rear portion thereof for quick removal. In a different example shown in figure 4, the air inlet 215 is configured for receiving the air inlet filter 300 screwed thereto at a top rear portion of the head support 120 also allowing quick removal. In this case, the air inlet filter 300 is configured as a screw cap or the like.

In use, the air inlet filter 300 filters the air before reaching the fan 230 so that optimum air renewal is provided for suitable breathability to the wearer. In the example shown, the air inlet filter 300 is removably attached to the head support 120 so that the inlet air filter 300 is interchangeable. The device can be thus easily adapted to particular filtering or protection requirements. In use, the air inlet filter 300 is received within an at least substantially transparent housing 310. The condition of the air inlet filter 300 can be thus checked from the outside of the device 100.

The air inlet filter 300 provides a 99.8% particulate filtration performance. In terms of inwards leakage, the air inlet filter 300 provides a level of performance of up to 0.2 %, that is, less than 0.2% of the fumes or particles bypass filtration. This meets the highest standard possible, in particular a TH3 level of performance (inward leakage) according to standard EN 12941.

Referring to figure 8 of the drawings, one air outlet filter 350 is provided in each lateral portion of the coverall 130 corresponding to each lateral air outlet 220. In said example, the air outlet filter 350 has a surface of at least 100 cm^2 such as, for example, 155 cm^2 . A total outlet filtering surface of 310 cm^2 is thus provided in this example resulting in the fan 230 providing a maximum operating noise below 55 dB for blowing air through both air outlet filters 350.

Both air outlet filters 350 can be removed from the lateral portions of the coverall 130,

although they could be fixed thereto by being formed integrally with it or being fixedly attached thereto by at least one of sewing, gluing, heat-sealing, and laser welding.

5 The fan 230 and other suitable electronics are powered by a battery arrangement 400 that is shown in figures 3 and 4, electrically connected to said parts of the protective device 100 through suitable connection wiring 420. The battery arrangement 400 includes at least one battery, preferably of the rechargeable type, with a minimum battery life of one working day. The battery arrangement has a weight of 366 grams in the particular example shown and, in general, less than 400 grams. The battery
10 arrangement 400 is removably attached to a belt 410 to be worn by the user. The belt 410 with the battery arrangement 400 attached thereto is arranged within the coverall 130. Furthermore, due to the light weight of the battery arrangement 400, it may be envisaged to place it attached to the head support 120 thus avoiding external connection wiring 420.

15 An integral, compact protective device 100 is obtained capable of providing the highest level of protection to the user, with all necessary components, namely the head support 120, the coverall 130, the face shield 140, the air duct 210, the air inlet and outlet 215, 220, the fan 230, the filters 300, 350, all efficiently integrated therein
20 into a compact unit, with no need for external parts.

Although examples have been disclosed herein, other alternatives, modifications, uses and/or equivalents thereof are possible. Furthermore, all possible combinations of the described examples are also covered. Thus, the scope of the present
25 disclosure should not be limited by particular examples but should be determined only by a fair reading of the claims that follow. Reference signs related to drawings placed in parentheses in a claim are solely for attempting to increase the intelligibility and shall not be construed as limiting the scope of the claim.

CLAIMS

1. Body and respiratory protective device (100) comprising:
 - 5 - a head support (120) for supporting the device (100) on a wearer's head;
 - an airtight synthetic garment (130) extending covering most of a wearer's body;
 - a transparent face shield (140) provided in the garment (130); and
 - a ventilation assembly (200) comprising:
 - 10 - a fan (230) for causing air to flow within the garment (130) from an air inlet (210) to an air outlet (220); and
 - two-way air filter means comprising at least one air inlet filter (300) arranged at the air inlet (210) and at least one air outlet filter (350) arranged at the air outlet (220).
- 15 2. The protective device (100) of claim 1, wherein the air outlet filter (350) is removable from the garment (130).
3. The protective device (100) of claim 1 or 2, wherein the air outlet filter (350) is formed at least at one lateral portion of the garment (130).
- 20 4. The protective device (100) of any of the preceding claims, wherein the air outlet filter (350) has a surface of at least 100 cm².
5. The protective device (100) of any preceding claim, wherein the air inlet filter (300) is removable from the head support (120).
- 25 6. The protective device (100) of any preceding claim, wherein, in use, the air inlet filter (300) is received within an at least substantially transparent housing (310) allowing the condition of the air inlet filter (300) to be checked from the outside of the device (100).
- 30 7. The protective device (100) of any preceding claim, wherein the air inlet filter (300) is screwed in or press-fitted to the head support (120).
- 35 8. The protective device (100) of any preceding claim, wherein the face shield (140) is made of silicone or derivatives thereof.

9. The protective device (100) of any preceding claim, wherein the face shield (140) is integrally formed with the garment (130).
- 5 10. The protective device (100) of any claims 1-8, wherein the face shield (140) includes a frame (145).
11. The protective device (100) of any preceding claim, wherein the garment (130) is made of a material that is of at least one of waterproof and anti-bacterial nature.
- 10 12. The protective device (100) of any preceding claim, wherein the garment (130) is made of a material comprising 90-99% polyester microfibers and 1-10% carbon fiber filaments.
- 15 13. The protective device (100) of any preceding claim, wherein it further includes at least one temperature sensor for adjusting the rotation speed of the fan (230) so as to adapt an air flow rate within the garment (130) based on temperature in the air outlet (220).
- 20 14. The protective device (100) of any preceding claim, wherein the fan (230) is arranged at a rear portion of the head support (120).
- 25 15. The protective device (100) of any preceding claim, wherein it further includes attaching means (150) for removably attaching the face shield (140) to the head support (120).