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(71) Applicant(s):
The Secretary of State for Defence
DSTL, Porton Down, Salisbury, Wiltshire, SP4 0JQ, United Kingdom

(72) Inventor(s):
Colin Skelton

(74) Agent and/or Address for Service:
DIPR Formalities Section
Poplar 2 #2214, MOD Abbey Wood (South), Bristol, BS34 8JH, United Kingdom

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DE 001200689 B **ES 002778900 A1**
FR 001098537 A **JP 2010243704 A**
KR 20190134436

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INT CL **A42B, A61D, A61F, A62B**
Other: **WPI, EPODOC, Patent Fulltext**

(54) Title of the Invention: **Personal protective equipment**
Abstract Title: **Visor with means for generating an air curtain**

(57) Personal protective equipment (PPE) 100 comprising a visor 101 with means for mounting to the head of a user (102, Fig 2). In preferred arrangements the PPE takes the form of glasses or goggles. The PPE provides a conduit 104 defining an inlet 103 and at least one outlet 105. The inlet is preferably connected or connectable to an air pump, and the at least one outlet is arranged such that in use air exiting therefrom provides an air curtain 202, 203, 204 around at least a part of the PPE to prevent or limit the contact of airborne contaminants with the eyes of the user. The conduit is preferably arranged about at least a part of the perimeter of the visor, and in some arrangements substantially all of the perimeter. The outlet(s) may be provided by a plurality of apertures in the conduit, which may be arranged equidistant about the perimeter of the visor. The PPE may also comprise an oro-nasal mask component (302, Fig 2).

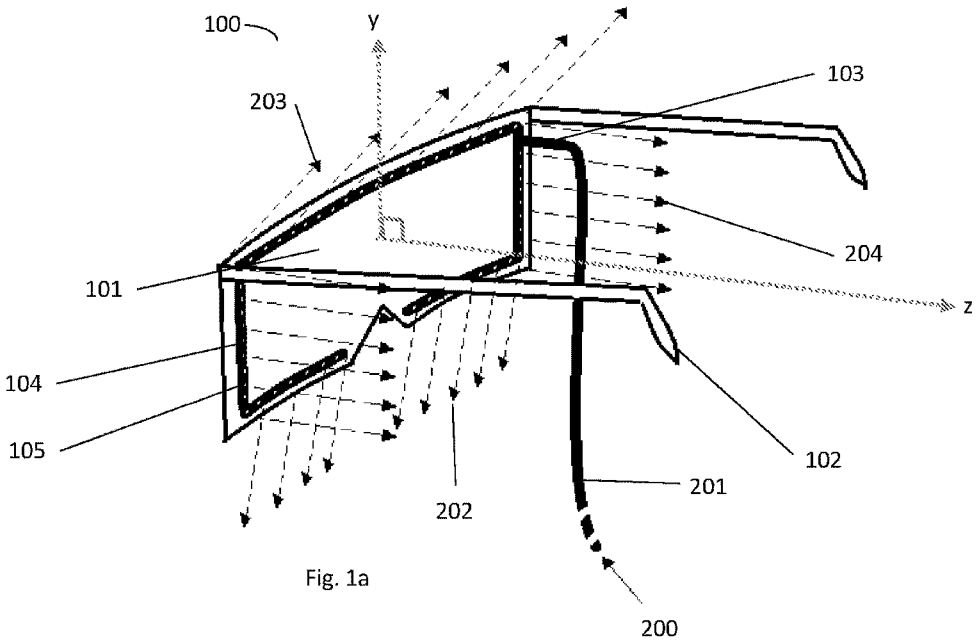

Fig. 1a

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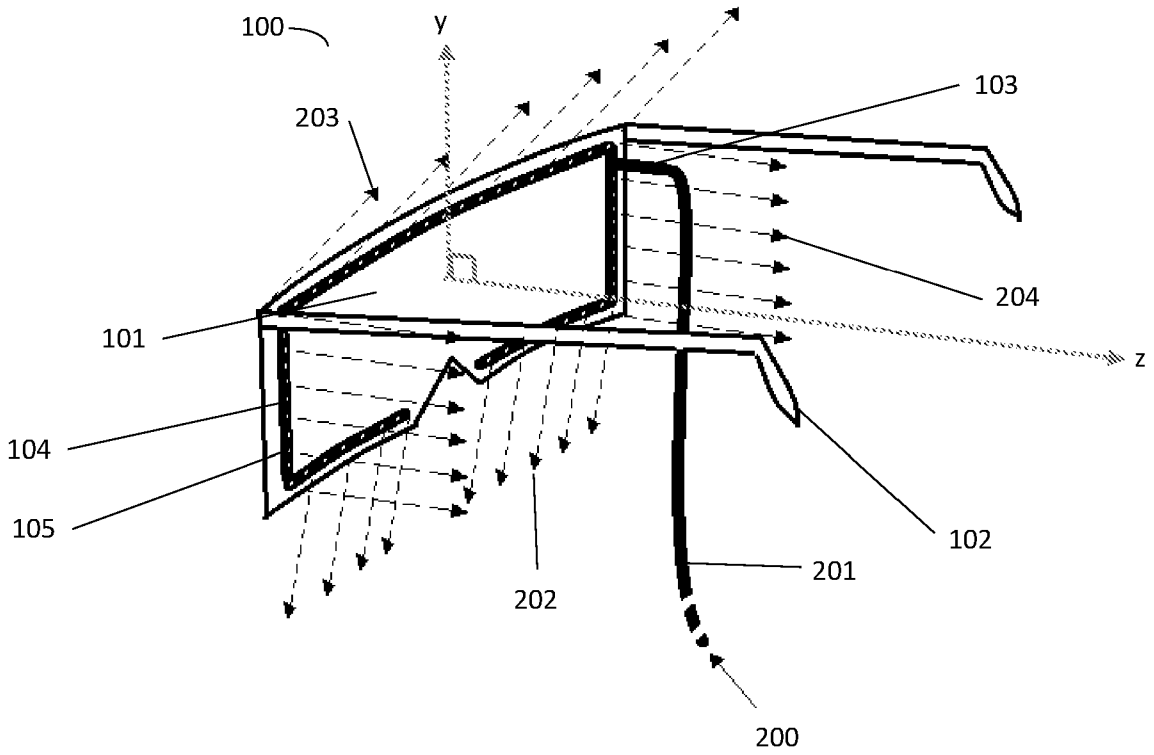
100
y
203
103
204
101
z
104
105
102
201
202
200

Fig. 1a

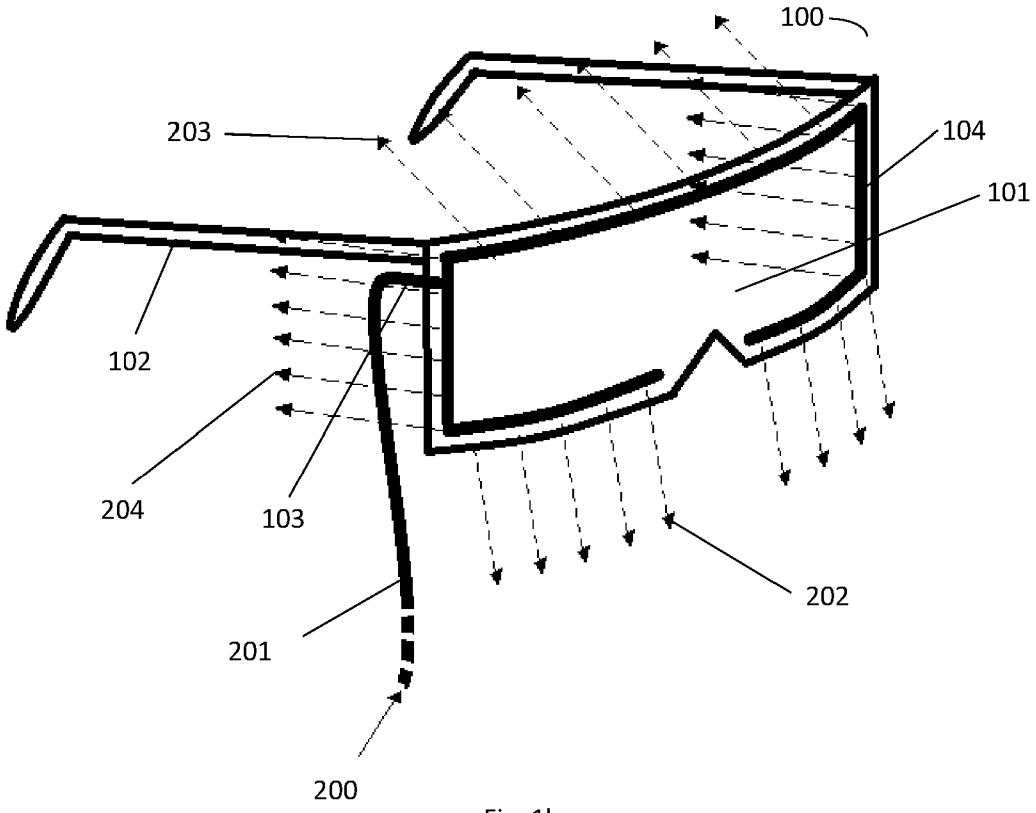
100
203
104
101
102
204
103
202
201
200

Fig. 1b

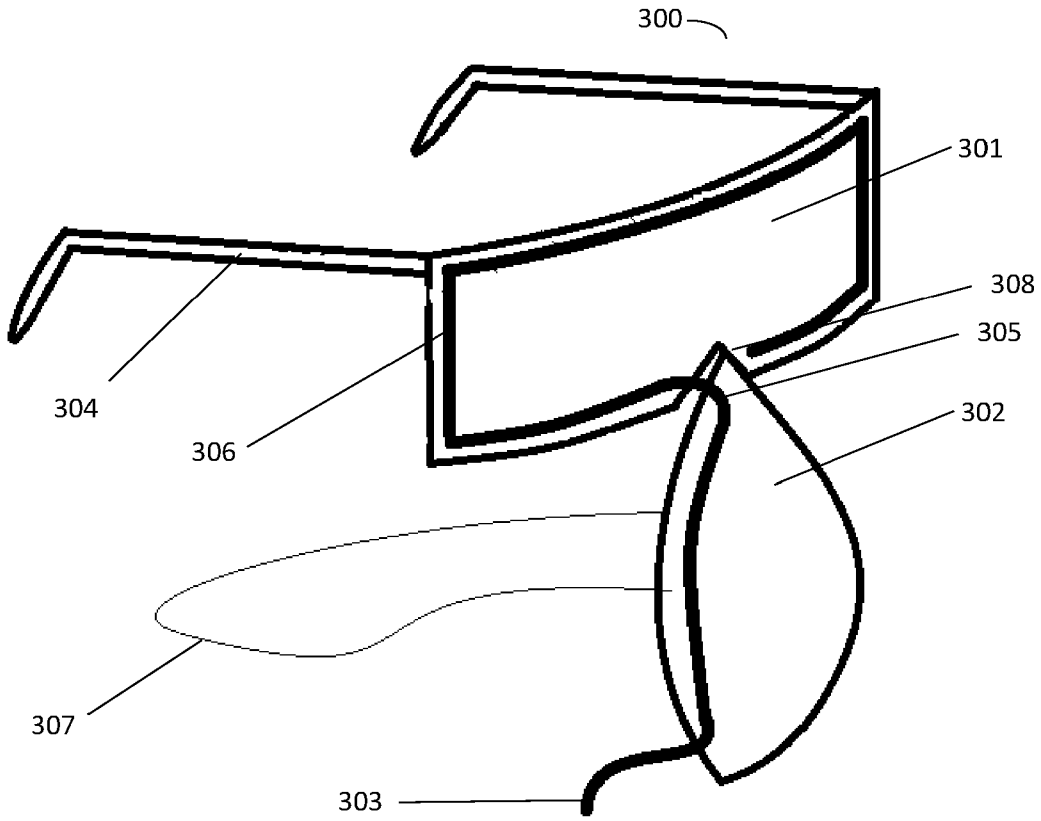
300
301
308
305
304
306
302
307
303

Fig. 2

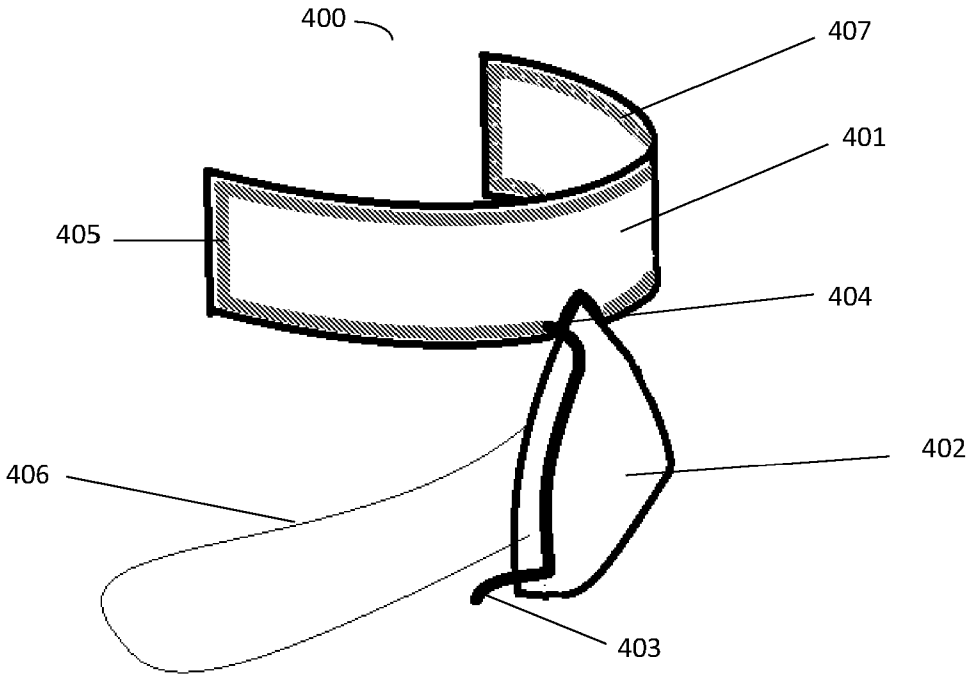
400
407
401
405
404
402
406
403

Fig. 3

Personal Protective Equipment

The present invention is concerned with personal protective equipment (PPE), and especially for healthcare workers, and more especially eye and ear protection, and PPE providing improved eye and ear protection, and especially eye protection from aerosols that may contain viruses or microorganisms.

Currently, PPE for healthcare workers is either an oro-nasal mask, with the option of a plastic visor over the whole face (often referred to as a face shield), or alternatively a Powered Air Purifying Respirator. The oro-nasal masks, with the addition of visor, often only provide for passive, rather than active, protection, whereas powered air purifying respirators are often bulky, heavy, cumbersome, expensive, difficult to decontaminate and many are full helmets making communication with the patient difficult.

There is consequently a need for improved personal protective equipment, especially improved protection over the passive protection devices, but which is less bulky and less cumbersome than the powered air purifying respirators.

The present invention aims to provided improved PPE, and in particular PPE with improved eye protection, especially from aerosolised contaminants, such as bacterial and viral contaminants, for example the SARS-CoV2 virus.

In a first aspect, the present invention provides personal protective equipment (PPE) comprising a visor and a means for mounting the visor to a head of a user, wherein the PPE comprises a conduit defining a space for air flow between an air inlet and an air outlet, the air inlet is capable of being connected to a filtered air pump, and the air outlet is arranged such that in use air exiting at the air outlet provides an air curtain around at least a part of the PPE to prevent/limit contact of airborne viral contaminants with the eyes of a user of the PPE.

In one embodiment the visor of the PPE comprises the conduit, and in another embodiment the air outlet of the conduit is arranged such that in use air exiting at the air outlet provides an air curtain around at least part of the visor.

The PPE of the first aspect further preferably provides for an air curtain to be generated across and around at least part of the head of the user, which could extend up towards the forehead, around past the ears, and down past the mouth and chin, thus potentially limiting or preventing contaminants from coming into contact with any orifice (eyes, ears, mouth, nose).

The term an 'air curtain around' either the PPE or the visor means an air barrier is created about the perimeter, rim or edge of the PPE or visor, which is preferably generated around the outside of the PPE or visor, rather than on the inside of the PPE or visor, with the effect of pushing away airborne contaminants from the PPE or visor, thereby limiting or preventing particles from contacting the eyes of a user.

The Applicant has conceived of personal protective equipment which overcomes some of the problems of devices in the art, and in particular provides for improved eye and ear protection. The Applicant has found that through generation of an air curtain around at least part of the PPE, and especially generation around at least a part of the visor of the PPE, that contaminants can be prevented from contacting at least the eyes of a user/wearer of the equipment.

An air curtain is a known physical effect that can be generated to prevent air, gas, aerosols or contaminants from escaping/moving from one area to another. The typical air curtain design, often used in doorways/entrances to buildings, such as to shops, is a fan mounted above the entrance/doorway and pointing downward.

An air curtain is, in its simplest application, an air barrier of a continuous stream of air, such as a continuous broad stream of air that circulates across a doorway, which could be to an air-conditioned space. This reduces penetration of insects and unconditioned air into a conditioned space through a forced air stream over the entire entrance.

An air curtain can however also be used to prevent air, gas, aerosols and contaminants from entering any undesired space. The Applicant has now conceived of PPE that can generate an air curtain to prevent or limit at least contact of aerosols and environmental contaminants with the eyes of a user of the PPE, but also potentially the ears, mouth and nose.

PPE may for example include features providing for eye protection, nose protection, or mouth protection, and especially for protection from environmental contamination, which contamination could in particular be particulates or aerosols, and could be bacterial or viral contaminants. The PPE of the first aspect is in particular directed to improved eye protection, and improved ear protection.

The visor of the first aspect of the invention may be a face shield, thus designed to cover the whole face, however in a preferred embodiment the visor is designed to only protect the eyes, and indeed most likely to only cover from the base of the nose to the eyebrows or forehead of a user. Indeed the visor may take the form of spectacles or goggles. In a preferred embodiment, the visor is not a face shield, as a face shield (i.e. over the whole face) is bulky and difficult to manipulate. The visor of the present invention preferably consists of an eye shield (for example goggles, or at least a visor which protects a similar area on the face as googles or safety spectacles), which is lighter, and less bulky and cumbersome than a face shield, but is able to provide at least similar eye protection as a face shield as a result of the air curtain generated across the face.

The conduit may be arranged at least in part about at least a part of the perimeter of the visor, and may be arranged about at least 50% of the perimeter of the visor, or around essentially the whole perimeter of the visor, or at least between 90% and 100% of the perimeter of the visor. In one embodiment, the air outlet is multiple holes or apertures in the conduit.

When referring to the arrangement of the conduit about the perimeter of a visor, the skilled person would understand that in such an arrangement the conduit is in fact arranged in at least the region of the edge of the visor, rather than in or near the centre of the visor. For example, for a visor having a frame, the conduit could be arranged on the frame of the visor.

The Applicant has found that a conduit about the perimeter of the visor, especially one with multiple holes or apertures in the conduit, is able to generate an air curtain around at least part of the visor, preferably the majority of the visor, when air is flowed through the conduit, for example from an air pump. Such a generated air curtain has been successfully shown by the Applicants to limit or prevent ingress of contaminants behind the visor, and thus to limit contact of environmental contaminants with the eyes of a user/wearer of the equipment. The placement of the conduit about the periphery/perimeter of the visor also ensures line of sight through the visor is not impeded.

The protection achieved is particularly effective where the multiple holes or apertures are arranged equidistant along the conduit, or about the perimeter of the visor. The conduit for example could be a tube with holes or apertures arranged equidistant along the length of the tube. The multiple holes or apertures are preferably arranged such that in use air is directed over and around the face/head of a user of the PPE, with the effect of generating an air curtain around the surface of the head and thereby pushing contaminants away from the face of a user. The effect is particularly pronounced where the holes or apertures are arranged to direct airflow towards the periphery of the face of a user, such as towards the ears, the top of the head, and down towards the chin, with the generated air curtain ensuring that contaminants remain as far away from the eyes as possible, and preferably also directed away from the nose, mouth, and ears of the user.

In one embodiment of the first aspect the PPE further comprises an air pump, which may be an air filtered pump, wherein the air pump is connected to, or is capable of being connected to, the air inlet of the conduit. Thus the equipment is provided with its own air source, for providing the air flow for generating the air curtain.

An air pump is a device for pumping or flowing air in to or towards something. Thus for the present invention, an air pump is a device for providing an air flow to and through the conduit of the PPE. It may provide a pressurised air flow. The air pressure may be between 200kNm^{-2} to 800kNm^{-2} (2 to 8 bars), or 600kNm^{-2} (6 bars). The air flow rate may be 1.25x10^{-3}m^{3}s^{-1} (>75 l min^{-1}), or 8.75x10^{-3}m^{3}s^{-1}

(525 l min^{-1}). The air flow velocity may be >5ms^{-1}, or 35ms^{-1}. The combination of air pressure, flow rate, velocity should be selected accordingly to reduce the ingress of contaminants through an air curtain.

The PPE may also further comprise an oro-nasal mask, thereby protecting not only the eyes, and other aspects of the face with an air curtain, but also potentially additional protection to the mouth and nose regions of the face from environmental contaminants. The visor and oro-nasal mask may be connected to each other, and thus may be a single unit.

The air pump may be connected to both the oro-nasal mask and to the visor via the conduit, or via tubing, or other suitable means. The oro-nasal mask may for example comprise an air inlet, and indeed the PPE could be arranged such that air is provided from the air pump through the oro-nasal mask, and then on to the visor. In such an arrangement only one air supply would be needed. The PPE could further include filtration means to ensure the air being provided to the oro-nasal mask, the conduit, the visor, or combinations thereof is filtered during use.

The conduit, which may be a tube, may have an internal diameter of between approximately 1 mm and 10 mm, which are suitable dimensions for delivering the air flow for generating an air curtain around the PPE and/or visor (and over the face), and indeed for being fixed to a visor. The internal diameter may be approximately 2 mm.

The holes or apertures may be between approximately 0.5 mm and 5 mm in diameter, which is particularly applicable for conduits of an internal diameter of up to 10 mm. The dimensions of the holes are suitable for potentially providing generation of a uniform air curtain, especially where the holes/apertures are around essentially the whole perimeter of the visor, or at least between 90% and 100% of the perimeter of the visor. The diameter of the holes or aperture also determine the thickness of the air curtain. The air curtain thickness may be less than 8mm thick, or may be 1mm thick.

In one embodiment, the internal diameter of the conduit is approximately 2 mm, and the holes/apertures are approximately 1mm in diameter. The holes or apertures may be approximately between 1 mm and 1.5 mm apart, to aid generation of a uniform air curtain.

In some embodiments, the air outlets are angled such that an air curtain is directed around the surface of the head of a user. The angle may be different across the length of the conduit to minimise any gaps between an air curtain and the surface of the head of a user. The angle is relative to an axis that is parallel to the visor (see for example Figure 1). In some embodiments, the angle of the air outlet is between 20-45 degrees, more preferably between 25-35 degrees, most preferably 30 degrees to direct an air curtain over the top of a user's head. In some embodiments, the angle of the air outlet is between 2-6 degrees to direct an air curtain over the temples and/or cheeks of a user.

The visor may be a wrap-around visor, or wraparound safety spectacles or goggles, thus one that extends around the head/face, most likely between at least the temples of a user. A wrap-around visor in PPE of the first aspect, with the ability of providing an air curtain, that extends towards the temples of a user can be particularly effective for protecting the ears of a user. The visor may comprise or be manufactured from polycarbonate. The PPE is preferably designed, and the visor arranged, such that the majority of the visor is offset from the face of the user, which offset may be approximately 1 cm. Having such an offset can reduce turbulence that may be created as a result of the air flow interacting with the head or face of the user.

In a second aspect the present invention provides for use of an air curtain in personal protective equipment to enable protection of the eyes of a user from airborne contaminants (eye protection). Also provided is such use of an air curtain in PPE for providing ear protection, and potentially mouth and nose protection.

In a third aspect the present invention provides personal protective equipment (PPE) comprising a visor and an air pump, wherein the visor and air pump are arranged and connected to each other to

provide an air curtain around at least a part of the visor to prevent/limit contact of airborne contaminants with the eyes of a user of the PPE.

The personal protective equipment according to the third aspect may further comprise an oro-nasal mask.

Embodiments of the invention will now be described by way of example only and with reference to the accompanying drawings, in which:

Figure 1a illustrates in perspective view the interior of a pair of eye protection glasses with a tube producing an air curtain around the rim of the visor.

Figure 1b illustrates in perspective view the exterior of the eye protection glasses of Figure 1.

Figure 2 illustrates in perspective view the exterior of a pair of eye protection glasses connected to an oro-nasal mask.

Figure 3 illustrates in perspective view the exterior of an eye protection visor connected to an oro-nasal mask.

Figure 1a illustrates an embodiment of eye protection glasses 100 as viewed from the interior. The eye protection glasses 100 comprise a visor 101 which can be mounted onto the head of a user and held into position by temple tips 102. A conduit tube 104 is affixed around the rim of the visor 101. An air inlet port 103 is positioned at the top of the right side of the visor 101 (from the perspective of the user). The air inlet port 103 contains an air filter and is connected to the conduit tube 104. The conduit tube 104 has a circular cross section and the inner diameter of the conduit tube 104 is 2mm. The conduit tube 104 has multiple holes 105 spread equi-distant along its length. Each hole 105 has a diameter of 1mm and is separated from adjacent holes 105 by a separation distance of 1.5mm. The visor 101, temple tips 102 and conduit tube 104 all comprise a polycarbonate material.

The holes 105 positioned across the top of the visor 101 are angled 30° from an axis y parallel to the surface of the visor 101; such that when worn, the holes 105 are pointing just over the head of a

user. The holes 105 positioned across the bottom of the visor 101 are angled 184° from axis y i.e. just pointing away from the face of a user. The holes 105 on the left of the visor 101 are angled 356° from an axis z which is perpendicular to axis y i.e. pointing just over the left ear of a user. The holes 105 on the right of the visor 101 are angled 4° axis z i.e. pointing just over the right ear of a user. Note Figure 1a is for illustration purposes only and the angles of the holes are not accurately represented.

Figure 1b illustrates the eye protection glasses 100 of Figure 1a as viewed from the exterior.

In use, the eye protection glasses 100 of Figures 1a and 1b are worn on the head of a user. An air supply (not shown) is connected to the air inlet port 103 via a pipe 201. Pressurised air 200 of approximately 6 bar is then pumped into the pipe 201. The pressurised air 200 travels along the conduit tube 104 and is forced out of the holes 105 forming a uniform air curtain over the head of the user 203, over the ears of the user 204 and over the face of the user 202. Whilst in use, the eye protection glasses 100 provide a protective enclosure around the eyes and ears of the user and part of the users face. The visor 101 providing a physical barrier and air curtains 203, 202 and 204 provide an air barrier which collectively block airborne contaminants from entering the protective enclosure.

Turning to Figure 2, there is provided a face protection mask 300. The face protection mask 300 comprises a visor 301 and oro-nasal mask 302 which are secured together above the nose of the user by an adhesive 308. The visor 301 comprises a polycarbonate and the oro-nasal mask 302 comprises a rubber. The face protection mask 300 is mounted to the head of the user using temple tips 304 and an elastic strap 307. A tube 306 comprising a polycarbonate is affixed around the rim of the visor 301. The tube 306 has holes (not shown) along its length pointing around (but not towards) the face of the user. A rubber pipe 303 is connected to an air inlet port 305. Inside the air inlet port 305 is an air filter. The rubber pipe 303 runs from the air inlet port 305 around one side of the oro-nasal mask 302 and out of the bottom oro-nasal mask 302. In use, the end of rubber pipe 303 is

connected to an external air supply (not shown) which pumps pressurised air of 6 bar into the tube 306 and out of the holes to produce an air curtain around the face of the user.

Turning to Figure 3, there is provided a face protection mask 400. The face protection mask 400 comprises a wrap-around visor 401 and oro-nasal mask 402. The wrap around visor 401 and oro-nasal mask 402 are moulded from a polycarbonate into a single unit. The wrap-around visor 401 is curved and long such that it extends around the face of the user covering the user's temples. The face protection mask 400 is mounted to the head of the solely from an elastic strap 406 attached to the sides of the oro-nasal mask 402. A conduit tube 405 comprising a polycarbonate is affixed around the rim of the wrap-around visor 401. The conduit tube 405 has an internal diameter of 2mm. The conduit tube 405 has holes 407 along its length pointing around (but not towards) the face of the user. Each hole 407 has a diameter of 1mm and is separated from adjacent holes by a separation distance of 1.5mm. A rubber pipe 403 is connected to an air inlet port 404 which positioned on one end of the conduit tube 405 near the top of the nose of the user. The rubber pipe 403 runs from the air inlet port 404 around one side of the oro-nasal mask 402 and out of the bottom oro-nasal mask 402. There is an air filter positioned inside the rubber pipe 403 at the bottom of the oro-nasal mask 402 and an additional air filter inside the conduit tube 405 near the air inlet port 404. In use, the end of rubber pipe 403 is connected to an external air supply (not shown) which pumps pressurised air of 6 bar into the tube 405. The pressurised air travels along the conduit tube 405 and is forced out of each of the holes 407 to produce a uniform air curtain around the face of the user.

Claims

1. Personal protective equipment (PPE) comprising a visor and means for mounting the visor to a head of a user, wherein the PPE comprises a conduit defining a space for air flow between an air inlet and an air outlet, the air inlet is capable of being connected to an air pump, and the air outlet is arranged such that in use air exiting at the air outlet provides an air curtain around at least a part of the PPE to prevent/limit contact of airborne contaminants with the eyes of a user of the PPE.

2. PPE according to Claim 1, wherein the visor comprises the conduit.

3. PPE according to Claim 1 or Claim 2, wherein the air outlet is arranged such that in use air exiting at the air outlet provides an air curtain around at least part of the visor.

4. PPE according to Claims 2 to 3, wherein the conduit is arranged at least in part about at least a part of the perimeter of the visor.

5. PPE according to Claim 4, wherein the conduit is arranged about at least 50% of the perimeter of the visor.

6. PPE according to Claim 4 or Claim 5, wherein the conduit is arranged between 90% and 100% of the perimeter of the visor.

7. PPE according to Claims 1 to 6, wherein the air outlet is multiple holes or apertures in the conduit.

8. PPE according to Claim 7, wherein the multiple holes or apertures are arranged equidistant about the perimeter of the visor.

9. PPE according to Claim 7, wherein the multiple holes or apertures are arranged such that in use air is directed over and around the head of a user of the PPE, with the effect of generating an air curtain across the surface of the head, and thereby pushing contaminants away from the face of a user.

10. PPE according to Claims 1 to 8 further comprising an air pump, wherein the air pump is connected to, or is capable of being connected to, the air inlet of the conduit.

11. PPE according to Claims 1 to 9 further comprising an oro-nasal mask.

12. PPE according to Claims 1 to 11, wherein the conduit has an internal diameter of between approximately 1 mm and 10 mm.

13. PPE according to Claim 12, wherein the internal diameter is approximately 2 mm.

14. PPE according to Claims 7 to 13, wherein the holes or apertures are between approximately 0.5 mm and 5 mm in diameter.

15. PPE according to Claims 12 to 14, wherein the internal diameter of the conduit is approximately 2 mm, and the holes/apertures are approximately 1mm in diameter.

16. PPE according to Claim 15, wherein the holes or apertures are approximately between 1 mm and 1.5 mm apart.

17. PPE according to Claims 1 to16, wherein the visor is a wrap-around visor.

18. PPE according to Claims 9 to 17, wherein the holes or apertures are arranged to direct air flow towards the periphery of the face of a user.

19. Use of an air curtain in personal protective equipment to enable protection of the eyes of a user from airborne contaminants.

20. Personal protective equipment (PPE) comprising a visor and an air pump, wherein the visor and air pump are arranged and connected to each other to provide an air curtain around at least a part of the visor to prevent/limit contact of airborne contaminants with the eyes of a user of the PPE.

21. Personal protective equipment according to Claim 20 further comprising an oro-nasal mask.

Intellectual Property Office

Application No:	GB2105074.5	**Examiner:**	Mr Geraint Davies
Claims searched:	1-21	**Date of search:**	7 September 2021

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1-21	GB 2249405 A (DUTHIE) See entire document
X	1-5, 7-16, 18-21	GB 1341395 A (MARSHAL) See entire document
X	1-5, 7-16, 18-21	JP 2010243704 A (NOK CORP) See entire document, noting particularly the Figures, and WPI abstract, AN 2010-N47379
X	1-5, 7-16, 18-21	KR 20190134436 A (KANG) See entire document, noting particularly the Figures, and WPI abstract, AN 2019-A2421M
X	1-21	DE 1200689 B (GLOCK) Note particularly the Figures, specifically 'visor' 1 with 'air curtain creating tubes' 4, 6
X	1-4, 7-21	ES 2778900 A1 (GONZALEZ) Note particularly Figures 1-2, specifically 'visor' 4 with 'air curtain creating tube' 1
X	1-4, 7-21	FR 1098537 A (CHAVEAU) Note particularly the Figures, specifically 'visor' 1 with 'air curtain creating tube' 10

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{X} :

Worldwide search of patent documents classified in the following areas of the IPC

A42B; A61D; A61F; A62B

The following online and other databases have been used in the preparation of this search report

Intellectual Property Office

WPI, EPODOC, Patent Fulltext

International Classification:

Subclass	Subgroup	Valid From
A62B	0018/00	01/01/2006
A41D	0013/11	01/01/2006
A42B	0003/22	01/01/2006
A61F	0009/04	01/01/2006
A62B	0007/10	01/01/2006
A62B	0023/02	01/01/2006
G02C	0011/08	01/01/2006