

A FILTER MODULE

Field of Invention

The present invention relates generally to a filter module for use with a face mask for filtering air inhaled by a user thereof.

Background

Conventional surgical masks are worn for catching bacteria shed in liquid droplets and aerosols from the user's mouth and nose. However, the surgical masks are also worn, for reducing chances of catching virus or bacteria that has been shed by people in the immediate environment of the user. As the surgical mask has to be worn in close contact with the user's mouth and nose, they have to be changed, at least daily, for hygiene reasons. In an event of a virus outbreak, the demand for such masks increases manifold. Recent events have demonstrated that daily use and change of existing masks based on existing availability and continuous production of these surgical masks to meet immediate demands is unsustainable. Structurally light but robust face masks with replaceable filters reduces the amount of filter material required between each filter change. However, as the effective surface area of the replaceable filters are smaller than the typical surgical mask, flow of air through the replaceable filters is constricted.

One way to increase the effective surface area is to form the replaceable filter into an accordion-like structure, or also known as a corrugated structure or shape, with a zig-zag shape from thermoplastically moldable and heat-sealable material. However, a recurring problem in these filters is the difficulty of providing regular fold spacing and the tendency for the corrugated shape to be flattened during use, transport or storage, thereby unintentionally, resulting in reduced filter action. Therefore, there is an apparent need to provide a solution to address the foregoing problems.

Summary

In accordance with a first aspect of the invention, there is disclosed a filter module adapted for use with a face mask to be worn over the face of a user for filtering air being drawn through the face mask, the filter module comprising a first flange, a second flange; and a

corrugated web interposing the first flange and the second flange. The corrugated web having a corrugated shape forming alternating peaks and troughs extending substantially along a web plane defined thereby with each of the first flange and the second flange being substantially perpendicular the web plane for retaining the corrugated shape of the corrugated web. The corrugated web is formed from a body segment of a filter material and the first flange and the second flange are formed from respectively a first edge segment and a second edge segment of the filter material, the body segment interposes the first edge segment and the second edge segment of the filter material, the filter material for filtering air being drawn therethrough.

In accordance with a second aspect of the invention, there is disclosed a filter module adapted for use with a face mask to be worn over the face of a user for filtering air being drawn through the face mask, the filter module comprising a first flange, a second flange and a corrugated web interposing the first flange and the second flange. The corrugated web having a corrugated shape forming alternating peaks and troughs extending substantially along a web plane defined thereby, each of the first flange and the second flange being substantially perpendicular the web plane for retaining the corrugated shape of the corrugated web. The corrugated web is formed from a filter material for filtering air being drawn therethrough.

Brief Description of the Drawings

FIG. 1 shows a partial front perspective view of a filter module comprising in accordance with an aspect of the invention with the cover being in the secure position;

FIG. 2 shows a plan view of the filter module of FIG. 1;

FIG. 3 shows a partial front sectional view of the filter module along view Y-Y of FIG. 2;

FIG. 4 shows a partial side sectional view of the filter module along view X-X of FIG. 2;

FIG. 5 shows a plan view of a filter material use for forming the filter module of FIG. 1;

FIG. 6 shows a partial front perspective view of a stack of the filter module of FIG. 1 being aligned for being received between a base and a carrier cover of a carrier for containing the stack of the filter module;

FIG. 7 shows a partial front perspective view of the filter module of FIG. 1 further comprising a first tray and a second tray forming a cartridge assembly for sandwiching a corrugated web of the filter module;

FIG. 8 shows a partial front perspective inverted view of the filter module of FIG. 1 being located and held between the first tray and the second tray;

FIG. 9 shows a partial front view of a face mask with a lid in a closed position for retaining the filter module of FIG. 1 within a receptacle of the face mask;

FIG. 10 shows side sectional view along view A-A of the face mask of FIG. 9 with the filter module of FIG. 1 being held between the lid and the receptacle;

FIG. 11 shows a partial front sectional view of the filter module shown in FIG. 3 along view Y-Y of FIG. 2 with an upper edge of a first flange and a second flange being closer to notches along the respective one of the first flange and the second flange;

FIG. 12 shows a partial side sectional view of the filter module shown in FIG. 4 along view X-X of FIG. 2 with an upper edge of a first flange and a second flange being closer to notches along the respective one of the first flange and the second flange;

FIG. 13 shows a partial front perspective view of the filter module of FIG. 11 further comprising a first tray and a second tray forming a cartridge assembly for sandwiching a corrugated web of the filter module and being inter-coupled by a pair of tongues removably receivable by a pair of receptacles; and

FIG. 14 shows a partial front perspective view of more than one stack of the filter module of FIG. 11 being aligned for being received between a container and a lid of a carrier for containing the stack of the filter module.

Detailed Description

Reference will now be made in detail to an exemplary embodiment of the present invention, examples of which are illustrated in the accompanying drawings. While the invention will be described in conjunction with the embodiment, it will be understood that they are not intended to limit the invention to these embodiments. On the contrary, the invention is intended to cover alternatives, modifications and equivalents, which may be included within the spirit and scope of the invention as defined by the appended claims. Furthermore, in the following detailed description of embodiments of the present invention, numerous specific details are set forth in order to provide a thorough understanding of the present invention. However, it will be recognized by one of ordinary skill in the art that the present invention may be practiced without these specific details. In other instances, well-known methods, procedures, components, and circuits have not been described in detail as not to unnecessarily obscure aspects of the embodiments of the present invention

An exemplary embodiment of the invention, a filter module 20, is described with reference to FIGS 1 to 14. The filter module 20 is preferably for use with a face mask 22 to be worn over a face of a user for filtering air being drawn through the face mask 22 for inhalation by the user and to impede germs and viruses carried by bodily fluids from being exhausted from the nose and mouth of the user from reaching the people or environment therearound.

Preferably, the filter module 20 comprises a first flange 26, a second flange 28 and a corrugated web 30 interposing the first flange 26 and the second flange 28. The corrugated web 30 has a corrugated shape 32 forming alternating peaks 34a and troughs 34b substantially along a web plane 36 defined thereby. Each of the peaks and troughs 34a are aligned substantially parallel a web axis 37 which is parallel the web plane 36. Each of the first flange 26 and the second flange 28 is substantially perpendicular the web plane 36 for retaining the corrugated shape 32 of the corrugated web 30 and substantially impede the corrugated shape 32 from flattening out. Although the first flange 26 and the second flange

28 may have certain level of structural flexibility in some implementations, displacement between the peaks 34a and the troughs 34b, specifically and to a greater degree at the point where the corrugated web 30 adjoins the first flange 26 and the second flange 28, is substantially impeded along the plane and about a normal to the plane of each of the first flange 26 and the second flange 28.

The corrugated web 30 is formed from a body segment 38 of a filter material 40. The first flange 26 and the second flange 28 are formed from respectively a first edge segment 42 and a second edge segment 44 of the filter material 40. Prior to being formed into the corrugated shape, and preferably subsequent thereto, the body segment 38 interposes the first edge segment 42 and the second edge segment 44 of the filter material 40. The filter material 40 is for filtering air being drawn therethrough.

For the avoidance of doubt, "corrugated" means a surface that has the peaks 34a and the valleys 34b extending over that surface which forms the body segment 38 of the filter material 40, and "corrugated surface area" means the width of the corrugated web 30 multiplied by its length, where the length is taken along the corrugated web's "sinusoidal-type" path. The "effective surface area" is the area of the corrugated web 30 available for filtering. In the corrugated web 30, the effective surface area is equal to the corrugated surface area less the areas that are rendered fluid-impermeable when secured to a material via, for example, melt bonding, adhesive bonding or ultrasonic welding. As the corrugated web 30 is preferably formed from the same material as the first flange 26 and the second flange 28 and further preferably from the same piece of material to reduce the need for material to material bonding, the effective surface area is kept substantially close to the corrugated surface area of the corrugated web 30.

Preferably, the first edge segment 42, the second edge segment 44 and the body segment 38 are formed from a single structurally contiguous piece of the filter material 40. Alternatively, the first edge segment 42 and the second edge segment 44 are welded, adhered or coupled to the body segment 38 to form the filter material 40. Hence, the first edge segment 42 and the second edge segment 44 may be formed from the same or different material from the body segment 38. Preferably, the filter material 40 comprises a blend of synthetic and cellulose fibers and comprises at least one filter layer, for example, a single, triple or multiple ply.

Each of the first flange 26 and the second flange 28 are formable by one of thermoplastic molding and folding the respective one of the first edge segment 42 and the second edge segment 44 of the filter material 40. Forming of the first flange 26 and the second flange 28 can occur in tandem with or separately from, for example sequential to, the forming of the corrugated web 30.

Each of the first edge segment 42 and the second edge segment 44 are crimped and heat sealed into the respective one of the first flange 26 and the second flange 28. Further, each of the first flange 26 and the second flange 28 can comprise a plurality of overlapping folds along the length thereof.

Preferably, the first flange 26 is substantially parallel the second flange 28. The first flange 26 is substantially symmetric the second flange 28 about a central plane 46 defined substantially perpendicular and transverse the alternating peaks 34a and trough 34b. The central plane 46 is further perpendicular the web plane 36.

Each of the first flange 26 and the second flange 28 has two ends 48 forming extremities thereof. At least one of the two ends 48 of the first flange 26 is coupled to a corresponding at least one of the two ends 48 of the second flange 28. Each of the first flange 26 and the second flange 28 may be formed as a single straight segment, multiple straight segments forming one or more kinks, a curved segment or a combination of curved and straight segments. Preferably, the two ends 48 of the first flange 26 do not touch any of the two ends 48 of the second flange 28. However, it is not precluded that one or both of the two ends of the first flange 26 may be coupled to, or abut with, one or both of the two ends 48 of the second flange 28.

Each of the first flange 26 and the second flange 28 being angularly slanted away from the normal of the web plane 36, akin to forming a draft angle 50, to enable nesting of one filter module 20 with another filter module 20 and to facilitate separation of inter-nested filter modules 20. The ability to be nested also enables a stack of the filter modules 20 to be easily carried around in a carrier 52 comprising a base 54 whereon the stack of the nested filter

modules 20 sit, and a carrier cover 56 which fits over the stack of the filter modules 20 and the base 54. In addition or alternative to the draft angle 50, the first flange 26 and the second flange 28 may be further shaped and dimensioned, or inter-configured, to enable the inter-nesting thereof. Alternatively, the carrier 52 can comprise a container 57a for receiving one or more stacks of the nested filter modules 20, and a lid 57b. The lid 57b is one or rigid, flexible and a peel-off layer, either re-attachable or not re-attachable to the container 57a, for enclosing the nested filter module 20 therein. When implemented as a peel-off layer, the lid 57b is for one time use for keeping one or more stacks of the nested filtered modules 20 in a substantially sterile condition in the container 57a prior to removal of the lid 57b from the container 57a.

The filter module 20 further comprises a first tray 60 defining at least one first aperture 62 and a second tray 64 defining at least one second aperture 66. The first tray 60 together with the second tray 64 forms a cartridge assembly 68. The first tray 60 is couplable with the second tray 64 for locating the corrugated web 30 therebetween. The at least one first aperture 62 and the at least one second aperture 66 are for exposing at least one portion of the corrugated web 30 for the passage of air therethrough. The draft angle 50 of each of the first flange 26 and the second flange 28 is also for facilitate removal thereof from the cartridge assembly 69.

The first tray 60 comprises a first frame 70 defining a periphery thereof and the second tray 64 comprises a second frame 72 defining a periphery thereof. The first frame 70 has at least one serrated segment 74a for shape matching and accommodating one side of the corrugated web 30 and the second frame 72 has at least one serrated segment 74b for shape matching and accommodating the other side of the corrugated web 30 when the corrugated web is disposed and located between the first tray 60 and the second tray 64. Each of the at least one serrated segment 74a of the first frame 70 and the at least one serrated segment 74b of the second frame 72 can comprise two similar rows of teeth shape-matching a corresponding one of a top side and a bottom side of the corrugated web 30 to allow the peaks 34a and troughs 34b to abut and nestle between the rows of teeth of the first frame 70 and the second frame 72 when the corrugated web 30 is held between the first tray 60 and the second tray 64. The rows of teeth of the first frame 70 and the second frame 72 are further for enable the

corrugated shape 32 of the corrugated web 30 to be substantially retained, or re-formed if it has been slightly ruffled or flattened during transport thereof, when in use. The second tray 64 can comprise a pair of tongues 76a formed on the second frame 72 while the first tray 60 can comprise a pair of receptacle 76b formed on the first frame 70. Each of the pair of receptacles is shaped and dimensioned for removably receiving the corresponding one of the pair of tongues 76a for removable coupling of the first tray 60 with the second tray 64.

Preferably, each of the first flange 26 and the second flange 28 is elongated and has an upper edge 78a and a lower edge 78b. Preferably, the upper edge 78a of each of the first flange 26 and the second flange 28 is formed with a plurality of notches 78c what shape matches the cross-section of the corrugated web 30 along the central plane 46 to enable the upper edge 78a to define the interface between each of the first flange 26 and the second flange 28 with the corrugated web 30. As such, the lower edge 78b of each of the first flange 26 and the second flange 28 becomes a free edge. Alternative or additionally, the plurality of notches 78c may be formed along the lower edge 78b of each of the first flange 26 and the second flange 28.

Preferably, each of the first tray 60 and the second tray 64 is further shaped and dimensioned for disposing the first flange 26 and the second flange 28 adjacent both the first frame 70 and the second frame 72 when the corrugated web 30 is located between the first tray 60 and the second tray 64 to thereby dispose at least one of the first tray 60 and the second tray 64 between the first flange 26 and the second flange 28. When the corrugated web 30 is received between the first tray 60 and the second tray 64, the cartridge assembly 68 prevents deviation in the distance between the first flange 26 and the second flange 28 to prevent unintended or accidental crumpling of the corrugated web 30.

The first tray 60 is hingably coupled to the second tray 64 for positioning, specifically the cartridge assembly 68, between an open position and a closed position. The first tray 60 and the second tray 64 are adapted for positioning over a port 80 defined by the face mask 22 when in the closed position. The face mask adapted to fit over and receive within an inside space 82 a nose and mouth of the user. The at least one first aperture 62 and the at least one second aperture 66 are alignable with the port for fluid communicating the inside space 82

with a mask exterior 84 and for forming a substantially air tight seal with the corrugated web 30 when in the closed position such that when the face mask 22 is fitted over the nose and the mouth of the user, exchange of air between the inside space 82 and mask exterior 84 thereof passages substantially through the corrugated web 30 for filtering thereby.

In one implementation, the second tray 64 is one of formed with and coupled to the face mask 22 adjacent the port 80. Alternatively, in another implementation, the face mask 22 defines a receptacle 86 for receiving the first tray 60 and the second tray 64, specifically the cartridge assembly 68, when in the closed position and is adapted for aligning the at least one first aperture 62 and the at least one second aperture 66 with the port 80. The face mask 22 further comprises a lid 88 movably coupled to the receptacle 86 for removably securing the first tray 60 and the second tray 64 to the receptacle 86. Further preferably, the filter material 40 comprises at least one of textile, cellulosic material, a sponge, multi-ply surgical mask material and a filter composite, while the first tray 60 and the second tray 64 may be coated with biocidal iodinated resin.

The lid 88 is displaceable between a closed position and an open position. The lid 88 and the receptacle 86 sandwich and form a substantially air tight seal with the cartridge assembly 68 when in the closed position such that when the mask body 22 is fitted over the nose and the mouth of the user, exchange of air between the inside space 82 and mask exterior 84 thereof passages substantially through the filter module 20 for filtering thereby.

Preferably, the receptacle 86 comprises a first compressible seal for abutting the cartridge assembly 68 for forming a substantially air-tight seal therewith and the lid 88 comprises a second compressible seal for abutting the cartridge assembly 68 for forming a substantially air-tight seal therewith. The cartridge assembly 68 is disposed substantially between the first compressible seal and the second compressible seal when the lid 88 is in the closed position to thereby further compress the corrugated web 30 of the filter module 20 between the first tray 60 and the second tray 64. The lid 88 comprises one of a hinge for rotatably coupling and longitudinal guides, for example a guide rail or guide rod assembly, for slidably coupling the lid 88 with the face mask 22 to enable reciprocation between the open position and the closed position. Further, one of the mask body 22 and the lid 88 comprising at least one of a

clasp, a latch, screw threadings, a bolt, a pin and a yieldably snap-fittable structure for securing the lid 88 to the mask body 22 when in the closed position.

The face mask 22 further comprises at least one anchor formed for coupling of securing means thereto. The at least one anchor can be at least one loop or hook or at least one hole or notch formed in the face mask 22. The securing means is rigged for being worn around at least a portion of the head of the user for positioning and substantially securing the face mask 22 around the nose and mouth of the user. Preferably, the securing means is one of strings straps, elastic bands and a harness for being worn over at least one of the scalp, nape, neck and ear of the user.

In a forgoing manner, a filter module is described according to an exemplary embodiment of the invention. Although only one embodiment of the invention is disclosed in this document, it will be apparent to one skilled in the art in view of this disclosure that numerous changes and/or modifications can be made to the disclosed embodiment without departing from the scope and spirit of the invention.

Claims

1. A filter module adapted for use with a face mask to be worn over the face of a user for filtering air being drawn through the face mask, the filter module comprising:
 - a first flange;
 - a second flange; and
 - a corrugated web interposing the first flange and the second flange, the corrugated web having a corrugated shape forming alternating peaks and troughs extending substantially along a web plane defined thereby, each of the first flange and the second flange being substantially perpendicular the web plane for retaining the corrugated shape of the corrugated web,

wherein the corrugated web is formed from a body segment of a filter material and the first flange and the second flange are formed from respectively a first edge segment and a second edge segment of the filter material, the body segment interposes the first edge segment and the second edge segment of the filter material, the filter material for filtering air being drawn therethrough.
2. The filter module as in claim 1, the first edge segment, the second edge segment and the body segment being formed from a single structurally contiguous piece of the filter material.
3. The filter module as in claim 1, each of the first flange and the second flange being formed by one of thermoplastic molding and folding the respective one of the first edge segment and the second edge segment of the filter material.
4. The filter module as in claim 1, each of the first edge segment and the second edge segment being crimped and heat sealed into the respective one of the first flange and the second flange.
5. The filter module as in claim 4, each of the first flange and the second flange comprising a plurality of overlapping folds along the length thereof.

6. The filter module as in claim 1, the filter material comprising a blend of synthetic and cellulose fibers and comprising at least one filter layer.
7. The filter module as in claim 1, the first flange being substantially parallel the second flange.
8. The filter module as in claim 1, the first flange being substantially symmetric the second flange about a central plane defined substantially perpendicular the alternating peaks and trough.
9. The filter module as in claim 1, each of the first flange and the second flange having two ends forming extremities thereof, at least one of the two ends of the first flange being coupled to a corresponding at least one of the two ends of the second flange.
10. The filter module as in claim 1, each of the first flange and the second flange being slanted away from the normal of the web plane to enable nesting of one filter module with another filter module.
11. The filter module as in claim 1, further comprising:
 - a first tray defining at least one first aperture; and
 - a second tray defining at least one second aperture, the first tray being couplable with the second tray for locating the corrugated web therebetween, the at least one first aperture and the at least one second aperture for exposing at least one portion of the corrugated web for the passage of air therethrough.
12. The filter module as in claim 11, the first tray comprising a first frame defining a periphery thereof and the second tray comprising a second frame defining a periphery thereof, the first frame having at least one serrated segment for shape matching and accommodating one side of the corrugated web and the second frame having at least one serrated segment for shape matching and accommodating the other side of the corrugated web when the corrugated web is located between the first tray and the second tray.

13. The filter module as in claim 12, each of the first tray and the second tray being further shaped and dimensioned for disposing the first flange and the second flange adjacent both the first frame and the second frame when the corrugated web is located between the first tray and the second tray to thereby dispose at least one of the first tray and the second tray between the first flange and the second flange.
14. The filter module as in claim 13, the first tray being hingably coupled to the second tray for positioning between an open position and a closed position, the first tray and the second tray being adapted for positioning over a port defined by the face mask when in the closed position, the face mask adapted to fit over and receive within an inside space a nose and mouth of the user, the at least one first aperture and the at least one second aperture being alignable with the port for fluid communicating the inside space with a mask exterior and for forming a substantially air tight seal with the corrugated web when in the closed position such that when the face mask is fitted over the nose and the mouth of the user, exchange of air between the inside space and mask exterior thereof passages substantially through the corrugated web for filtering thereby.
15. The filter module as in claim 14, the second tray being one of formed with and coupled to the face mask adjacent the port.
16. The filter module as in claim 14, the face mask having a receptacle for receiving the first tray and the second tray when in the closed position and adapted for aligning the at least one first aperture and the at least one second aperture with the port, the face mask further comprising a securing structure movably coupled to the receptacle for removably securing the first tray and the second tray to the receptacle.
17. The filter module as in claim 14, the filter material comprising at least one of textile, cellulosic material, a sponge, multi-ply surgical mask material and filter composite, and the first tray and the second tray being coated with biocidal iodinated resin.

18. A filter module adapted for use with a face mask to be worn over the face of a user for filtering air being drawn through the face mask, the filter module comprising:
- a first flange;
 - a second flange; and
 - a corrugated web interposing the first flange and the second flange, the corrugated web having a corrugated shape forming alternating peaks and troughs extending substantially along a web plane defined thereby, each of the first flange and the second flange being substantially perpendicular the web plane for retaining the corrugated shape of the corrugated web,
- wherein the corrugated web is formed from a filter material for filtering air being drawn therethrough.