VENTILATING GLOVES AND METHODS

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ABSTRACT

The present invention generally relates to various gloves capable of ventilating air in and out of themselves in response to various user input forces. More particularly, the present invention relates to a glove which, has a body arranged to define at least one opening for receiving at least a portion of a hand of a user therethrough and an interior arranged to extend from the opening inwardly into the body and for retaining the received portion of the hand of the user. Such a glove also include at least one pumping module which couples with and/or disposed inside the body and is capable of supplying air to the body and/or dispensing air from the body through at least one input force applied by the user and/or at least one movement of at least a portion of the body of the glove which is effected by such an input force of the user. Accordingly, the present invention also relates to various pumping modules arranged to be incorporated into various gloves and/or various actuator modules. Coupling with such pumping modules and converting various user input forces into various driving forces which drive the pumping modules. The present invention also relates to various methods of ventilating air in and out of various gloves, incorporating such pumping modules and/or actuator modules into such gloves, and/or converting various user input forces into various driving forces. The present invention further relates to various processes for providing such ventilating gloves and for providing pumping modules and/or actuator modules for such gloves. The pumping and/or actuator modules of the present invention may be incorporated into various gloves designed for thermal insulation and for protection of users hands from mechanical, chemical, radiological, and/or electrical hazards by ventilating air into and out of the gloves, thereby controlling humidity and/or temperature inside such gloves.
VENTILATING GLOVES AND METHODS

FIELD OF THE INVENTION

[0001] The present invention generally relates to various gloves capable of ventilating air in and out of themselves in response to various user input forces. More particularly, the present invention relates to a glove which has a body arranged to define at least one opening for receiving at least a portion of a hand of an user therethrough and an interior arranged to extend from the opening inwardly into the body and for retaining the received portion of the hand of the user. Such a glove also includes at least one pumping module which couples with and/or disposed inside the body and is capable of supplying air to the body and/or dispensing air from the body through at least one input force applied by the user and/or at least one movement of at least a portion of the body of the glove which is effected by such an input force of the user. Accordingly, the present invention also relates to various pumping modules arranged to be incorporated into various gloves and/or various actuator modules coupling with such pumping modules and converting various user input forces into various driving forces which drive the pumping modules. The present invention also relates to various methods of ventilating air in and out of various gloves, incorporating such pumping modules and/or actuator modules into such gloves, and/or converting various user input forces into various driving forces which drive the pumping modules. The present invention also relates to various methods of ventilating air in and out of various gloves, incorporating such pumping modules and/or actuator modules into such gloves, and/or converting various user input forces into various driving forces which drive the pumping modules. The present invention further relates to various processes for providing such ventilating gloves and for providing pumping modules and/or actuator modules for such gloves.

SUMMARY OF THE INVENTION

[0005] The present invention generally relates to various gloves capable of ventilating air in and out of themselves in response to various user input forces. More particularly, the present invention relates to a glove which includes at least one pumping module coupling with or disposed inside a body of the glove and capable of supplying air into and/or dispensing air out of the body through at least one input force applied by the user and/or through at least one movement of at least a portion of the body of the glove effected by the input force. Accordingly, this invention also relates to various pumping modules arranged to be incorporated into various gloves and/or various actuator modules coupling with such pumping modules and converting various user input forces into various driving forces which drive the pumping modules. The present invention also relates to various methods of ventilating air in and out of various gloves, incorporating such pumping modules and/or actuator modules into such gloves, and/or converting various user input forces into various driving forces. The present invention further relates to various processes for providing such ventilating gloves and for providing pumping modules and/or actuator modules for such gloves.

[0006] In one aspect of the present invention, a ventilating glove is provided to have a body which is arranged to define at least one opening to receive at least a portion of a hand of an user therethrough and to also define an interior arranged to extend from the opening inwardly into the body and to retain the portion of the hand of the user therein. In another exemplary embodiment, a glove may include at least one pumping module coupling with the body and capable of supplying air to the interior of the body and/or dispensing air out of such an interior of the body by an input force applied by the user. In another exemplary embodiment, the glove may include at least one pumping module which is coupled to the body and capable of supplying air to the interior of the body and/or dispensing air out of such a body in response to at least one movement of at least a portion of such a body. In another exemplary embodiment, the glove may include at least one pumping module and at least one actuator module. The pumping module is arranged to couple with the body and capable of supplying air to the interior of the body and/or dispensing air out of the body by a driving force, while the actuator module is arranged to operatively couple with the pumping module and to receive an input force applied by the user and then to convert the input force into the driving force by changing an amplitude, a direction, and/or a timing of application of the input force. In another exemplary embodiment, the glove may include at least one pumping module and at least one actuator module. The pumping module is arranged to couple with the body and capable of supplying air to the interior of the body and/or dispensing air out of the body by a driving force, while the actuator module operatively couples with the pumping module and is arranged to convert at least one movement of at least a portion of the body into the driving force by changing an amplitude, a direction, and/or a timing of application of an input force which is applied by the user and arranged to cause such a movement of such a portion of the body.

[0007] Embodiments of this aspect of the invention may include one or more of the following features.

[0008] The pumping and/or actuator modules may be provided based on any of the following pumping and/or
actuator modules as will be described in greater detail below. Such a pumping module may be arranged to take air thereinto in response to the input force and/or movement or, in the alternative, to dispense air therefrom in response to the input force and/or movement. The foregoing movement of the movable or deformable portion of body may be any of the following movements of the body as will be described in greater detail below. In addition, the input force may be applied to any modules of the ventilating glove.

[0009] In another aspect of the present invention, a ventilating glove is provided to have a body which includes at least one mobile portion and is arranged to define at least one opening to receive at least a portion of a hand of an user therethrough, to define an interior arranged to extend inwardly from the opening into the body and to retain the portion of the hand therein. In one exemplary embodiment, the glove may also include at least one pumping module which is coupled to the body, arranged to operate between at least one on-position and at least one off-position, arranged to move from one to the other of the positions by an input force applied by the user, and capable of supplying air to the interior of the body while moving to one of the such positions and/or dispensing air out of the body while moving to the other of such positions. In another exemplary embodiment, the glove may also include at least one pumping module which couples with the body and which is arranged to operate or move between at least one on-position and at least one off-position, to move from one to the other of such positions in response to at least one movement of the mobile portion of the body, and capable of of supplying air to the interior of the body while moving to one of the positions and/or dispensing air from such a body while moving to the other of the positions. In another exemplary embodiment, the glove may include at least one pumping module and at least one actuator module. The pumping module may couple with the body and may be arranged to operate or move between at least one on-position and at least one off-position, to operate or move from one to the other of the positions by a driving force, and capable of supplying air to the interior of the body while moving to one of the above positions and or dispensing air out of the body while moving to the other of the positions. The actuator module operatively couples with the pumping module and may be arranged to receive an input force applied by the user and then to convert the input force into the driving force by changing an amplitude, a direction, and/or a timing of application of such an input force. In another exemplary embodiment, the glove may include at least one pumping module and at least one actuator module. Such a pumping module is coupled to the body and arranged to operate between at least one on-position and at least one off-position, to move from one to the other of such positions by a driving force, and capable of supplying air to the interior of the body while moving to one of such positions and/or dispensing air therefrom while moving to the other of the positions. The actuator module is operatively coupled to the pumping module and is arranged to convert at least one movement of the mobile portion of the body into the driving force by changing an amplitude, a direction, and/or a timing of application of an input force which is applied by the user and arranged to cause the movement of the mobile portion of the body.

[0010] Embodiments of this aspect of the invention may include one or more of the following features.

[0011] The pumping and/or actuator modules may be provided based on any of the following pumping and/or actuator modules as will be described in greater detail below. Such a pumping module may be arranged to take air thereinto in response to the input and/or driving force or, alternatively, to dispense air therefrom in response to the input and/or driving force. The foregoing movement of the movable or deformable portion of body may be any of the following movements of the body as will be described in greater detail below. In addition, the input and/or driving force may be applied to any modules of the ventilating glove.

[0012] In another aspect of the present invention, a ventilation system is arranged to transport air into and out of a glove including a body which defines at least one opening to receive at least a portion of a hand of an user therethrough and also defines an interior extending inwardly from the opening to the body and capable of retaining such a portion of the hand of the user. In general, such a ventilation system has at least one inlet module and at least one outlet module. The inlet module is arranged to be directly or indirectly coupled to the body, to have at least one inlet air pathway, and to define at least one inlet opening which is disposed in one end of the inlet air pathway and which is capable of being in fluid communication with one of the interior of the body and an exterior of the body. Similarly, the outlet module is arranged to directly or indirectly couple with the body, to include at least one outlet air pathway, and to also define at least one outlet opening disposed in one end of the outlet air pathway and capable of being in fluid communication with the other of the interior and exterior of the body. In one exemplary embodiment, the ventilating system further includes at least one pumping module which is arranged to directly or indirectly couple with the body, capable of being in fluid communication with the other end of the inlet air pathway and with the other end of the outlet air pathway, and capable of supplying air from the exterior into the interior of the body and/or dispensing air from the body through an input force applied by the user. In another exemplary embodiment, the ventilating system may further include at least one pumping module which is arranged to be directly or indirectly coupled to the body, is capable of being in fluid communication with the other end of the inlet air pathway and with the other end of the outlet air pathway, and is capable of supplying air from the interior into the body and/or dispensing air from the exterior into the body in response to at least one movement or deformation) of at least one movable (or deformable) portion of the body. In another exemplary embodiment, the ventilating system also includes at least one pumping module which is arranged to be directly or indirectly coupled to the body, to operate between at least one on-position and at least one off-position, and to move from one to the other of the positions by an input force applied by the user, and capable of supplying air from the exterior into the interior of such a body while moving to one of such positions and/or dispensing the air out of the interior to the exterior of such a body while moving to the other of such positions. In another exemplary embodiment, such a ventilating system may include at least one pumping module which is arranged to directly or indirectly couple with the body, to operate between at least one on-position and at least one off-position, and to move from one to the other of the positions in response to at least one movement of at least a
portion of the body of the glove, and capable of supplying air to the interior of the body while moving to one of such positions and/or dispensing air out of the interior to the exterior of the body while moving to the other of the positions. In any of such embodiments, the ventilating system may further include at least one valve disposed in or around at least one of the foregoing modules and arranged to direct air in a preset direction therethrough.

[0013] Embodiments of this aspect of the invention may include one or more of the following features.

[0014] The pumping and/or actuator modules may be provided based on any of the following pumping and/or actuator modules as will be described in greater detail below. Such a pumping module may be arranged to take air thereto in response to the input force and/or movements of such a portion of the body or, alternatively, to dispense air therethrough in response to such an input force and/or movements. The foregoing movements of the movable (or deformable) portion of body may be any of the following movements of the body as will be described in greater detail below. In addition, such an input force may be applied to any modules of the ventilating glove.

[0015] In another aspect of the present invention, a ventilation system is provided to transport air into and out of a glove in response to at least one input force which is applied thereto by a user, where such a ventilation system includes a body which defines at least one opening for receiving at least a portion of a hand of an user therethrough and further defines an interior extending inwardly from the opening into the body and capable of retaining such a portion of the hand of the user. In general, the ventilation system includes at least one inlet module and at least one outlet module. The inlet module is arranged to be directly or indirectly coupled to the body, to have at least one inlet air pathway, and to define at least one inlet opening disposed in one end of the inlet air pathway and capable of being in fluid communication with one of the interior of the body and an exterior of the body. The outlet module is arranged to directly or indirectly couple with the body, to include at least one outlet air pathway, and to also define at least one outlet opening disposed in one end of the outlet air pathway and capable of being in fluid communication with the other of the interior and exterior of the body. In one exemplary embodiment, such a ventilating system may also includes at least one pumping module and at least one actuator module. Such a pumping module is arranged to be directly or indirectly coupled to the body, capable of being in fluid communication with the outer end of the inlet air pathway and with the other end of the outlet air pathway, and capable of supplying air from the exterior to the interior of the body and/or dispensing air from the interior to the exterior of the body by at least one driving force. Such an actuator module is operatively coupled to the pumping module and is arranged to receive the input force and to convert the input force into the driving force by changing an amplitude, a direction, and/or a timing of application of the input force. In another exemplary embodiment, the ventilating system may have at least one pumping module and at least one actuator module. The pumping module is arranged to be directly or indirectly coupled to the body, capable of being in fluid communication with the outer end of the inlet air pathway and with the other end of the outlet air pathway, and capable of supplying air from the exterior to the interior of the body and/or dispensing air from the interior to the exterior of the body by at least one driving force. The actuator module is arranged to operatively couple with the pumping module, to convert at least one movement of at least a portion of such a body into the driving force by changing an amplitude, a direction, and/or a timing of application of the input force and/or movements of the body and/or dispensing air from the interior to the exterior of the body by at least one driving force. The actuator module is arranged to operatively couple with the pumping module, to convert at least one movement of at least a portion of such a body into the driving force by changing an amplitude, a direction, and/or a timing of application of the input force effecting such a movement of the portion of the body. In another exemplary embodiment, the ventilating system includes at least one pumping module and at least one actuator module. The pumping module may be arranged to be directly or indirectly coupled to the body, to operate between at least one on-position and at least one off-position, and to move from one to the other of the positions by at least one driving force, capable of being in fluid communication with the other end of the inlet air pathway and with the other end of the outlet air pathway, and capable of supplying air from the exterior to the interior of the body while moving to one of such positions and/or dispensing air from the interior to the exterior of the body while moving to the other of such positions. The actuator module is operatively coupled to the pumping module and arranged to receive the input force and then to convert such an input force into the driving force by changing an amplitude, a direction, and/or a timing of application of the input force. In another exemplary embodiment, the ventilating system includes at least one pumping module and at least one actuator module. The pumping module is arranged to directly or indirectly couple with the body, to operate between at least one on-position and at least one off-position, to move from one to the other of the positions by at least one driving force, capable of being in fluid communication with the other end of the inlet air pathway and with the other end of the outlet air pathway, and capable of supplying air from the exterior to the interior of the body while moving to one of the above positions and/or dispensing air from the interior to the exterior of the body while moving to the other of such positions. The actuator module is operatively coupled to the pumping module and is arranged to convert at least one movement of at least a portion of such a body effected by the input force into the driving force by modulating an amplitude, a direction, and/or a timing of application of the input force. In any of the foregoing embodiments, the ventilating system may include at least one valve disposed in at least one of the foregoing modules and arranged to direct the air in a preset direction therealong.

[0016] Embodiments of this aspect of the invention may include one or more of the following features.

[0017] The inlet and/or outlet air pathway may be shaped as a tubular or planar conduit which defines an air path therein and may be made of a rigid, elastic or deformable material and/or arranged to have an elastic configuration. The pumping and/or actuator modules may be provided based on any of the following pumping and/or actuator modules as will be described in greater detail below. The pumping module may be arranged to take air thereto in response to the input force and/or movements of such a portion of the body or, alternatively, to dispense air therefrom in response to the input force and/or movements. The foregoing movements of the movable (or deformable) portion of body may be any of the following movements of the body as will be described in greater detail below. In addition, such an input and/or driving force may be applied to any modules of the ventilating glove.
In another aspect of the present invention, a pumping module may be provided for a ventilation system for ventilating air in and out of a glove in response to at least one input force applied to at least a portion thereof by an user and/or at least one movement of at least one portion of the glove, where the glove includes a body which forms at least one outer surface and at least one inner surface, defines at least one opening arranged to receive at least a portion of a hand of the user therethrough and also defining an interior which is arranged to extend inwardly into the body from the opening to retain such a portion of the hand therein. The pumping module may include a chamber which defines at least one inlet which is arranged to receive air therethrough as well as at least one outlet which is arranged to dispense air therethrough.

In one exemplary embodiment, such a chamber is arranged to be disposed between the outer and inner surfaces of the body, to indirectly receive the input force through at least one of the outer and inner surfaces, and to change its internal volume in response to the input force. The chamber is also capable of receiving air through the inlet and/or dispensing air through the outlet as a result of a change in the internal volume. In another exemplary embodiment, at least a portion of such a chamber is arranged to be disposed between the outer and inner surfaces of the body, while another portion of the chamber is arranged to be exposed through the outer surface. The chamber is also arranged to directly or indirectly receive the input force by the another portion and to change its internal volume in response thereto. Thus, the chamber is capable of receiving air through the inlet and/or dispensing the air through the outlet as a result of a change in the internal volume of such a chamber. In another exemplary embodiment, the body may also define at least one gap space between at least portions of the outer and inner surfaces. At least a portion of the body is arranged to undergo the movement and to alter at least one configuration of the gap space in response to such a movement, whereas at least a portion of the chamber is arranged to be disposed inside the gap space and is capable of receiving air through the inlet and/or dispensing air through the outlet in response to a change in the configuration of such a gap space.

In a related aspect of this invention, the pumping module may include a chamber which defines at least one inlet which is arranged to receive air therethrough, at least one outlet which is arranged to dispense air therethrough, and multiple foldable pleats by which the chamber is arranged to deform. In one exemplary embodiment, the chamber is arranged to be disposed between the outer and inner surfaces of the body, to indirectly receive the input force through the outer and/or inner surfaces, and to change its internal volume as a result of deformation of the chamber involving at least one of such pleats effected by the input force. Therefore, the chamber is capable of receiving air through the inlet and/or dispensing air through the outlet due to a change in the internal volume of such a chamber. In another exemplary embodiment, a portion of such a chamber is arranged to be disposed between the outer and inner surfaces of the body, while another portion of the chamber is arranged to be exposed through the outer surface. The chamber is arranged to directly or indirectly receive the input force by the another portion and to change its internal volume as a result of deformation of thereof including at least one of the pleats effected by the input force. Therefore, such a chamber is capable of receiving and/or dispensing air through the inlet and outlet, respectively, as a result of a change in the internal volume. In another exemplary embodiment, the body defines at least one gap space between at least portions of the outer and inner surfaces, and at least a portion of the chamber with at least one pleat is arranged to undergo the movement and to change at least one configuration of the gap space as a result of the movement. By disposing at least a portion of the chamber having at least one pleat in the gap space, such a chamber is capable of receiving air through the inlet and/or dispensing air through the outlet as a result of a change in the configuration of the gap space.

In another related aspect of this invention, the pumping module may include at least one piston and at least one cylinder, where the piston defines at least one inlet for receiving air therethrough, at least one outlet for dispensing air therethrough, and a cavity therein, whereas the piston is arranged to move inside the cavity between at least one intake position and at least one discharge position and capable of taking air into the cavity between at least one intake position and/or dispensing air out of the cavity while moving to the discharge position. In one exemplary embodiment, the cylinder and piston are arranged to be disposed between the outer and inner surfaces of the body, where the piston is arranged to indirectly receive the input force through the outer and/or inner surfaces, to reciprocate along the cavity between the positions in response thereto, and to change a change of air contained inside the cavity to a maximum value in the intake position while to a minimum value in the discharge position. The cylinder is arranged to receive air through the inlet in the intake position and to dispense air through the outlet in the discharge position resulting from a change in its volume. In another exemplary embodiment, at least a substantial portion of the cylinder may be arranged to be disposed between the outer and inner surfaces of the body. At least a portion of the piston may be arranged to be exposed through the outer surface and to directly receive the input force thereby, to reciprocate along the cavity between the positions in response thereto, and to change a volume of the cavity to a maximum value in the intake position and then to a minimum value in the discharge position. The cylinder, therefore, arranged to receive air through the inlet in the intake position and then to dispense air through the outlet in the discharge position due to a change in the internal volume. In yet another exemplary embodiment, the body defines at least one gap space between at least portions of the outer and inner surfaces. At least a portion of the body is arranged to undergo the movement and to change at least one configuration of the gap space as a result of the movement. At least a portion of the piston and/or cylinder is arranged to be disposed in the gap space and capable of receiving air through the inlet and/or dispensing air through the outlet as a result of a change in the configuration of the gap space.

Embodiments of this aspect of the invention may include one or more of the following features. For example, a single opening may serve as both of the inlet and outlet openings and multiple inlet or outlet openings may also be used. The chamber may be arranged to have a recoil property or, in the alternative, may include at least one recoil unit capable of providing such a recoil property. In addition, the pumping module may be arranged to supply fresh air to the
chamber in response to various input forces and/or movements of the glove. Contrary to such an active ventilation mechanism, a passive ventilation mechanism may be used such that the pumping module dispenses air from the interior of the glove in response to the input force and/or movements of the glove by sucking the moist air from the interior of the glove and then allowing the fresh air to replace the moist air.

[0023] In another aspect of the present invention, an actuator module is provided for an air ventilating system to ventilate air in and out of a glove in response to at least one movement of at least a portion of the glove effected by at least one input force applied to at least a portion of the glove by an user. Such a ventilation system includes at least one pumping module arranged to be coupled to the body of the glove and to pump air thereinto and therefrom. In one exemplary embodiment, the actuator module includes at least one actuator arranged to be operatively coupled to the pumping module, to deform or move in response to the movement of such a portion of such a glove, and to convert the input force into a driving force which has an amplitude, a direction, and/or a timing of application different from that of the input force and which is delivered to the pumping module so as to pump air thereinto and/or pump air therefrom. In another exemplary embodiment, the actuator module has at least one actuator arranged to be operatively coupled to the pumping module, to deform and/or move between at least one on-position and at least one off-position in response to the movement of the portion of the glove, and to convert the input force into a driving force while moving from the off-position to the on-position, where the driving force has an amplitude, a direction, and/or a timing of application different from that of the input force and to be delivered to the pumping module at least one of pump air thereinto and pump air therefrom.

[0024] In yet another aspect of the present invention, an actuator module is provided for a ventilation system to ventilate air in and out of a glove in response to at least one movement of at least a portion of the glove effected by at least one input force applied to at least a portion of the glove by a user. Such a glove includes a body which forms at least one finger portion arranged to receive at least one finger of a hand of the user, at least one backhand portion, and at least one palm portion, whereas the ventilation system includes at least one pumping module arranged to couple with the body of the glove and to pump air into and out of itself. In one exemplary embodiment, the actuator module includes at least one actuator arranged to be operatively coupled to the pumping module, to deform and/or move in response to lifting and/or unstretching movements of at least one of the finger portion, and to convert the input force into a driving force which has an amplitude, a direction, and/or a timing of application different from that of the input force and which is delivered to the pumping module in order to pump air thereinto and pump air therefrom. In another exemplary embodiment, the actuator module includes at least one actuator arranged to be operatively coupled to the pumping module, to deform and/or move in response to stretching and/or unstretching movements of at least one of the finger portion, and to convert such an input force into a driving force which has an amplitude, a direction, and/or a timing of application different from that of the input force and which is delivered to the pumping module in order to pump air thereinto or therefrom. In another exemplary embodiment, the actuator module includes at least one actuator arranged to be operatively coupled to the pumping module, to deform and/or move in response to bending and/or unbending movements of at least one of the above finger portion, and to convert the input force into a driving force which may have an amplitude, a direction, and a timing of application different from that of the input force and may be delivered to the pumping module so as to pump air thereinto and/or therefrom. In another exemplary embodiment, the actuator module has at least one actuator arranged to be operatively coupled to the pumping module, to deform and/or move in response to squeezing and/or relaxing movements between the palm portion and at least one of the finger portion, and to convert the input force into a driving force which has an amplitude, a direction, and a timing of application different from that of the input force and which is delivered to the pumping module in order to pump air thereinto and/or therefrom. In another exemplary embodiment, the actuator module also includes at least one actuator arranged to operatively couple with the pumping module, to deform and/or move in response to squeezing and/or relaxing movements of or between more than one finger portion, and to convert the input force into a driving force having an amplitude, a direction, and a timing of application different from that of the input force and delivered to the pumping module in order to pump air thereinto and/or therefrom.

[0025] In another aspect of the present invention, a method is provided for ventilating air into and out of a glove defining an interior. In one exemplary embodiment, such a method may include the steps of supplying fresh air from atmosphere into the interior of the glove and then dispensing moist air inside the interior of the glove out of the interior thereof. In another exemplary embodiment, such a method may include the steps of providing a pumping module capable of pumping air thereinto and therefrom, supplying a fresh atmospheric air into the interior of the glove by the pumping module, and replacing a moist air inside the interior of the glove from the fresh air. In another exemplary embodiment, the method may include the steps of providing a pumping module capable of pumping air thereinto and therefrom, dispensing moist air in the interior of the glove therefrom by such a pumping module, and allowing fresh air to flow into the interior of the glove.

[0026] In another aspect of the present invention, another method may be provided for ventilating air into and out of a glove defining an interior. In one exemplary embodiment of an active ventilation, the method includes the steps of providing at least one pumping module capable of pumping air thereinto and therefrom and manipulating such a pumping module so as to pump fresh air from atmosphere into the interior of the glove while pushing out moist air inside the interior of the glove therefrom by fresh air. In another exemplary embodiment of a passive ventilation, the method may include the steps of providing a pumping module capable of pumping air thereinto and therefrom and manipulating such a pumping module to pump out moist air inside the interior of the glove to atmosphere, thereby allowing fresh air to move into the interior of the glove.

[0027] In another aspect of the present invention, another method is provided for controlling humidity of air in an interior of a glove. In one exemplary embodiment, such a method may include the steps of providing a pumping module capable of pumping air thereinto and therefrom and manipulating such a pumping module in order to pump dry
air from atmosphere into the interior of the glove while pushing out moist air in the interior of the glove therefrom by the dry atmospheric air, thereby controlling such a humidity approximately at a level of the atmosphere. In another exemplary embodiment, such a method may include the steps of providing a pumping module capable of pumping air thereinto and therefrom, manipulating the pumping module so as to pump out moist air in the interior of the glove to atmosphere, and allowing dry atmospheric air to move into the interior of the glove, thereby controlling the humidity approximately at a level of the atmosphere.

In another aspect of the present invention, yet another method may be provided for controlling temperature of air ventilated into an interior of a glove. In one exemplary embodiment, the method may include the steps of providing multiple air pathways for flowing air therethrough and having different lengths, disposing the air pathways adjacent to the interior of the glove, allowing air to absorb thermal energy from the interior while flowing through multiple air pathways for different temporal durations due to the different lengths thereof, and selecting one of the air pathways, thereby controlling such a temperature of air flowing through the one of the air pathways. In another exemplary embodiment, the method may include the steps of providing at least one first air pathway for flowing fresh air into the interior of the glove, providing at least one second air pathway for flowing moist air out of the interior thereof, and disposing the first and second air pathways adjacent to each other, thereby allowing a heat exchange between the fresh air and the moist air.

In another aspect of the present invention, various processes may be provided to provide the above ventilation systems and/or their modules by various methods. Details of such processes may be apparent and/or deducible from the following description and appended claims.

As used herein, terms “on-position” and “off-position” generally correspond to different states or positions of different modules of a ventilating system of this invention. For example, the on-position of a pumping module generally correspond to a deformed, stressed or moved position thereof, while the off-position of the pumping module generally corresponds to their opposite positions such as, e.g., a normal, original, unstressed or unmoved position thereof. In contrary, the on-position of an actuator module generally corresponds to an actuated position thereof resulting from an input and/or movement of at least a portion of a ventilating glove of this invention, while the off-position typically corresponds to an unactuated position which results from a cessation of application or absence of the input force and/or movement thereof.

Other features and advantages of the present invention will be apparent from the following detailed description, and from the claims.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1A is a schematic diagram of an exemplary ventilation system for a glove according to the present invention;

FIG. 1B is a schematic diagram of an exemplary insulating, protection, and/or waterproof glove which incorporates the exemplary ventilation system of FIG. 1A according to the present invention;

FIGS. 2A and 2B are schematic diagrams of an exemplary pumping module which is arranged to deform in a vertical direction and respectively in its unstressed and stressed positions according to the present invention;

FIG. 2C is a schematic diagram of the exemplary pumping module of FIGS. 2A and 2B having a cover thereon according to the present invention;

FIGS. 2D and 2E show schematic diagrams of another exemplary pumping module arranged to deform in a horizontal direction and respectively in its unstressed and stressed positions according to the present invention;

FIG. 2F is a schematic diagram of another exemplary deformation-type pumping module having inlet and outlet modules which are axially misaligned according to the present invention;

FIGS. 3A and 3B are schematic diagrams of another exemplary pumping module which defines multiple pleats and deforms in a vertical direction, disposed in its unstressed and stressed positions, respectively, according to the present invention;

FIG. 3C is a schematic diagram of the exemplary pumping module of FIGS. 3A and 3B having a cover thereon according to the present invention;

FIGS. 3D and 3E show schematic diagrams of another exemplary pumping module which also defines multiple pleats, deform in a horizontal direction, and disposed in its unstressed and stressed positions, respectively, according to the present invention;

FIG. 3F is a schematic diagram of the exemplary pumping module of FIGS. 3D and 3E including inlet and outlet modules which are axially misaligned according to the present invention;

FIG. 3G is a schematic diagram of another exemplary pumping module having pleats defined in both of horizontal and vertical directions and capable of deforming in both directions according to the present invention;

FIGS. 4A and 4B are schematic diagrams of another exemplary pumping module having at least one cylinder and at least one matching piston which translates through the cylinder respectively in its unstressed (or intake) and stressed (or discharge) positions according to the present invention;

FIGS. 4C and 4D are schematic diagrams of the pumping module of FIGS. 4A and 4B including an inlet module coupled to the cylinder and translating therewith according to the present invention;

FIGS. 4E and 4F are schematic diagrams of the pumping module of FIGS. 4A and 4B including an inlet module which is disposed inside the cylinder and over which the piston translates according to the present invention;

FIGS. 4G and 4H are schematic diagrams of the pumping module of FIGS. 4E and 4F including a piston having multiple portions coupled to each other according to the present invention;

FIGS. 4I and 4J are schematic diagrams of the pumping module of FIGS. 4A and 4B including an opening in fluid communication with both an inlet module and an outlet module according to the present invention;
FIGS. 4K and 4L are schematic diagrams of another exemplary pumping module similar to that of FIGS. 4A and 4B and disposed in an upright arrangement according to the present invention;

FIG. 5A is a cross-sectional view of an exemplary ventilating glove which is disposed straight, which includes an inlet module, a pumping module, and an outlet module, and which also incorporates an actuator module arranged to convert a movement of a finger of an user into a driving force to drive the pumping module according to the present invention;

FIG. 5B is a cross-sectional view of the exemplary ventilating glove of FIG. 5A bent at about 90 degrees according to the present invention;

FIGS. 6A and 6B are schematic diagrams of an exemplary actuator module operatively coupling with a deformation-type pumping module, where the actuator module is arranged to transmit an axial input force in the same direction and where the pumping module is disposed in its unstressed position and stressed, position, respectively, according to the present invention;

FIG. 6C is a schematic diagram of another exemplary actuator module operatively coupling with a deformation-type pumping module, where the actuator module is arranged to transmit an axial input force in parallel but off-axis directions according to the present invention;

FIGS. 6D and 6E show schematic diagrams of another exemplary actuator module operatively coupling with a deformation-type pumping module, where the actuator module is arranged to transmit an axial input force transaxially driving force normal or transverse to the input force and where the pumping module is in its unstressed position and stressed position, respectively, according to the present invention;

FIG. 6F is a schematic diagram of another exemplary actuator module operatively coupled to a deformation-type pumping module and converting an off-axis input force to a transaxial driving force normal or transverse to the input force according to the present invention;

FIG. 7A is a schematic diagram of an exemplary actuator module which is operatively coupled to a bellows-type pumping module and transmits an axial input force in the same direction according to the present invention;

FIG. 7B is a schematic diagram of another exemplary actuator module operatively coupled to a bellows-type pumping module and converting an axial input force into a transaxial driving force normal or transverse to the input force according to the present invention;

FIG. 7C is a schematic diagram of another exemplary actuator module operatively coupled to a bellows-type pumping module and converting an axial input force into another transaxial driving force according to the present invention;

FIG. 7D is a schematic diagram of another exemplary actuator module similar to that of FIG. 7C and including additional actuators according to the present invention;

FIG. 7E is a schematic diagram of another exemplary actuator module operatively coupled to a bellows-type pumping module and arranged to transmit an axial input force along a parallel but off-axis direction according to the present invention;

FIG. 7F is a schematic diagram of another exemplary actuator module operatively coupled to a bellows-type pumping module and converting an off-axis input force to a transaxial driving force normal or transverse to the input force according to the present invention;

FIG. 8A is a schematic diagram of an exemplary electric pumping module arranged to pump air in a direction transverse to a shaft thereof according to the present invention;

FIG. 8B is a schematic diagram of another exemplary electric pumping module for pumping air in a direction parallel with a shaft thereof according to the present invention;

FIG. 9A is a schematic diagram of an exemplary inlet and/or outlet module having a temperature control unit according to the present invention; and

FIG. 9B is a schematic diagram of another exemplary inlet and/or outlet module having another temperature control unit according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention generally relates to various gloves capable of ventilating air in and out of themselves in response to various user input forces. More particularly, the present invention relates to a glove which includes at least one pumping module coupling with or disposed inside a body of the glove and capable of supplying air into and/or dispensing air out of such a glove by at least one input force applied by the user and/or by at least one movement of at least a portion of the body of such a glove effected by the input force. Accordingly, this invention also relates to various pumping modules arranged to be incorporated into various gloves and/or various actuator modules coupling with such pumping modules and converting various user input forces into various driving forces which drive the pumping modules. The present invention also relates to various methods of ventilating air in and out of various gloves, incorporating such pumping modules and/or actuator-modules into such gloves, and/or converting various user input forces into various driving forces. The present invention further relates to various processes for providing such ventilating gloves and for providing pumping modules and/or actuator modules for such gloves. The pumping and/or actuator modules of the present invention may be incorporated into various gloves which may be designed for thermal insulation of user’s hands, for protecting the user’s hands from mechanical, chemical, radiological, and/or electrical hazards, and for preventing harmful or undesirable liquid and/or gas from getting into the gloves. By incorporating such modules ventilating gloves of the present invention allow air to be pumped thereinto and therefrom, thereby allowing the user to control humidity and/or temperature inside such gloves.

FIG. 1A is a schematic diagram of an exemplary ventilation system for a glove, and FIG. 1B is a schematic diagram of an exemplary insulation, protection, and/or waterproof glove incorporating such an exemplary ventila-
tion system of FIG. 1A according to the present invention. As exemplified in both figures, an exemplary ventilation system 10 typically includes an inlet module 20, a pumping module 30, and an outlet module 50, in which the pumping module 30 is disposed between the inlet module 20 and the outlet module 50. The inlet module 20 is mainly an air pathway 21 having an inlet opening 22 in one end and another opening in an opposite end arranged to be in fluid communication with one end of the pumping module 30. The exemplary inlet module 20 also incorporates a valve 23 such as an one-way valve so as to direct air to flow from the inlet module 20 to the outlet module 50 but not in an opposite direction. The exemplary pumping module 30 has a body 31 which is mainly an air chamber having a curvilinear and elastic top 31T and a curvilinear bottom 31B which may be either rigid or elastic. More particularly, the top 31T of the body 31 may be arranged to deform directly or indirectly in response to an input force applied thereto by an user and to change an internal volume of the body 31. That is, the top 31T (or another part of the pumping module 30) is arranged to move and/or to operate between at least one unstressed position and at least one stressed position and to change the internal volume of the body 31 respectively from its maximum value to its minimum value (or vice versa). When the user ceases to apply the input force, the elastic top 31T may return to its unstressed (or stressed) position by its recoil force. In the alternative, at least one conventional recoil unit (not shown in the figure) may be incorporated into the pumping unit 30 such that the recoil unit may develop and then store a recoil energy while the input force is applied thereto and releases the recoil energy in order to move the top 31T (or another movable part of the pumping module 30) back to its unstressed (or stressed) position. In addition, the exemplary outlet module 50 includes five parallel outlet air pathways 51A-51E each of which has at least one outlet opening 52A-52E in one end and another opening in an opposite end arranged to be in fluid communication with another end of the pumping module 30. When desirable, at least one valve 23 may be incorporated along one or more of the outlet pathways 51A-51E in order to direct air from the inlet module 20 to the outlet module 50 (or vice versa).

An exemplary ventilating glove 60 includes the foregoing ventilation system 10 wherein so that air may be pumped in and out of itself in response to various input forces or to at least one movement of at least one part of the glove 60. For example, and as exemplified in FIG. 1B, a ventilating glove 60 includes an upper outer surface 61, a lower outer surface 62, an upper inner surface (not shown in the figure), a lower inner surface (not shown in the figure), and five finger portions 63A-63E. Such a glove 60 also defines an opening 64 through which the user inserts his or her hands thereinto and an interior arranged to receive and to retain a portion of the user’s hand inserted through the opening 64. The foregoing ventilation system 10 may be incorporated into the glove 60 in various arrangements. In one exemplary embodiment, at least a substantial portion of the inlet opening 22 of the inlet unit 20 may be exposed through the upper outer surface 61 of the glove 60 to become in fluid communication with atmosphere, while at least a portion of the top 31T of the pumping module 30 is also exposed through the upper outer surface 61 so as to receive the user input force. The rest of the inlet module 20 such as, e.g., the inlet air pathway 21 and valve 23 and the pumping module 30 may be disposed inside the glove 60, e.g., between the upper outer and inner surfaces and/or between the lower outer and inner surfaces of the body 31. In addition, the outlet air pathways 51A-51E of the outlet module 50 may be incorporated into the corresponding finger portions 63A-63E of the glove 60, with their outlet opening 52A-52E disposed at or near distal ends of such finger portions 63A-63E. More particularly, the outlet openings 52A-52E are desirably arranged to be in fluid communication with the interior of the glove 60 such that air inside the interior of the glove 60 may be in fluid communication with atmosphere through a pathway comprised of the outlet openings 52A-52E, outlet air pathways 51A-51E, pumping module 30, inlet air pathway 21, and inlet opening 22. The outlet pathways 51A-51E and their openings 52A-52E may be incorporated in different locations of the glove 60. In addition, a different number of outlet pathways 51A-51E and/or outlet openings 52A-52E may be employed depending upon various criteria such as, e.g., detailed configurations of the glove 60, design or operational considerations of the inlet, pumping, and/or outlet modules 20, 30, 50, and so on.

In operation, the user puts on the foregoing glove 60 including the exemplary ventilation system 10 of this invention. When the user feels a buildup of moisture in the interior of the glove 60, he or she applies various input forces to the top 31T of the body 31 of the pumping module 30 by, e.g., pressing, pushing or squeezing the top 31T with the other hand. Such an input force deforms the top 31T of the body 31 of the pumping module 30 by moving it to its stressed position, thereby decreasing an internal volume of the body 31 accordingly. Because the one-way valve 23 of the inlet module 20 is arranged to allow an antegrade flow of air through the ventilation system 10 but to prevent a retrograde flow of air therethrough, the input force affects the fresh air to be supplied into the interior of the glove 60 and the humid air to be dispensed out of such an interior through the opening 64 of the glove 60. As the user ceases to apply the input force, the top 31T of the body 31 of the pumping module 30 returns to its original unstressed position by its own recoil force attributed to its elastic properties and/or by a recoil force of at least one conventional recoil unit as described above, thereby restoring the internal volume of the body 31. As the top 31T returns to its unstressed position, pressure inside the body 31 of the pumping module 30 decreases and the body 31 is refilled with fresh air by the antegrade flow of air from atmosphere through the inlet opening 22, inlet air pathway 21, and valve 23. Therefore, a cycle of application and cessation of the input force by the user results in dispensing and filling of the body 31 of the pumping module 30 which in turn effects ventilation of the glove 60 by an amount of air which is determined by a magnitude and/or duration of the input force, configuration of the top 31T of the body 31, elasticity of the body 31, and the like. It is appreciated that the negative pressure inside the body 31 of the pumping module 30 during the cessation period may suck air in the interior of such a glove 60 back thereinto instead of taking in the fresh air of the atmosphere thereinto depending upon relative pneumatic and/or hydraulic resistances of these inlet and/or outlet modules 20, 50. In order to prevent such a retrograde air flow, an additional one-way valve may also be installed along the outlet module 50.
Various pumping modules employing a variety of pumping mechanisms may be utilized to pump air into and out of themselves and to ventilate air into and out of the ventilating gloves of this invention. Any conventional air and/or gas pumps may be used as the pumping modules of the present invention, although their shapes, sizes, configurations, and/or driving mechanisms may have been modified so as to be incorporated into the ventilating gloves of the present invention.

In one aspect of the present invention, an exemplary pumping module may include at least one chamber or body at least a portion of which is arranged to be deform to change its internal volume in response to various input forces applied thereto directly or indirectly by the user. A main feature of this aspect of the present invention is that deformation of the chamber or body is typically localized to the deformable portion thereof. Such pumping modules may also be provided in various embodiments, typical examples of which are described in the following figures.

In one exemplary embodiment, at least a portion of a pumping module is arranged to deform in a direction at least partially transverse to a direction of input and/or output modules. For example, FIGS. 2A and 2B are schematic diagrams of an exemplary pumping module arranged to deform vertically and in its unstressed and stressed positions respectively according to the present invention. A pumping module 30 has a body 31 defining at least one inlet and at least one outlet, where the inlet is arranged to couple with and to be in fluid communication with the inlet pathway 21 of the inlet module 20 which is similar to those of FIGS. 1A and 1B, and where the outlet is also arranged to couple with and to be in fluid communication with the outlet air pathway 51 of the outlet module 50 which is similar to those of FIGS. 1A and 1B. The body 31 of the pumping module 30 may include a top portion similar to that of FIGS. 1A and 1B which is arranged to move or operate between at least one unstressed position and at least one stressed position in response to an input force and to deform along a vertical direction in response thereto. As described herein, an internal volume of the body 31 also changes because of its deformation and air may be pumped into and out of the body 31 through the inlet and outlet modules 20, 50, respectively. It is appreciated that the deformation-type pumping module 30 of this embodiment may be installed in any locations of the glove 60, e.g., at least partially or entirely exposed through the upper and/or lower outer surfaces of the glove, at least partially or entirely hidden between the outer and/or inner surfaces thereof, and the like. Similarly, the deformable portion may further be provided in any location over the body 31 of the pumping module 30, e.g., on its top, bottom, and/or side. When desirable, multiple deformable portions having similar or different deformabilities or elasticities may also be provided on or over the body 31 or at least a substantial portion of the body 31 may be made of an elastic material. Operational characteristics of the pumping module 30 of this embodiment are typically similar or identical to those described in FIGS. 1A and 1B.

FIG. 2C is a schematic diagram of the exemplary pumping module of FIGS. 2A and 2B having a cover thereon according to the present invention. As shown in the figure, such a pumping module 30 is generally similar or identical to those of FIGS. 2A and 2B, except that it includes an additional cover 32 disposed on or over the deformable portion of the body 31 and arranged to receive the input force thereby. Such an embodiment may offer the benefits of protecting the deformable portion of the body 31 from excessive mechanical impact, normal wear and tear, and the like, and of distributing the user input force throughout such that the deformable portion of the body 31 may indirectly receive the input force which may generally be evenly distributed throughout the cover 32. Such a cover 32 may also be, fixedly coupled to the deformable portion of the body 31 or movably coupled over such a portion of the body 31. In addition, the cover 32 may be made of rigid or elastic materials which deform while delivering the input force to the deformable portion of the body 31. Operational characteristics of the pumping module 30 of this embodiment may be typically similar or identical to those described in one or more of FIGS. 1A through 2B.

In another exemplary embodiment, at least a portion of a pumping module is arranged to deform in another direction at least partially parallel to a direction of input and/or output modules. FIGS. 2D and 2E show schematic diagrams of such an exemplary pumping module which is arranged to deform in a horizontal direction and disposed in its unstressed and stressed positions, respectively, according to the present invention. A pumping module 30 is typically similar to that of FIGS. 2A to 2C, except that at least a substantial portion thereof may be made of an elastic or deformable material. Therefore, such a module 30 operates or deforms between at least one unstressed position and at least one stressed position in response to various input forces. An inlet module 20 and an output module 50 are generally similar to those of FIGS. 2A to 2C, except that these modules 20, 50 are typically arranged to translate in a horizontal direction in response to various input forces. Thus, when the input force is applied to one or both of the inlet and outlet modules 20, 50 along a direction which is at least partially parallel to a direction(s) of one or both of an inlet pathway 21 and an outlet air pathway 51, the deformable body 31 of the pumping module 30 is stretched horizontally, an internal volume of the body 31 also changes because of its deformation, and air is pumped into or out of the body 31 through the inlet and outlet air pathways 21, 51. It is noted that the deformation-type pumping module 30 of this embodiment may be installed in any locations of the glove 60, e.g., at least partially or entirely exposed through the upper and/or lower outer surfaces of the glove, at least partially or entirely hidden between the outer and/or inner surfaces thereof, and the like. Similarly, the deformable portion may be provided in any location over the body 31 of the pumping module 30, e.g., on its top, bottom, and/or side. When desirable, only a portion of the body 31 may be arranged to deform as well. Other operational characteristics of the pumping module 30 of this embodiment may be typically similar or identical to those described in one or more of FIGS. 1A through 2C.

FIG. 2F is a schematic diagram of another exemplary deformation-type pumping module having inlet and outlet modules which are axially misaligned according to the present invention. As shown in the figure, a pumping module 30 is typically similar or identical to those of FIGS. 2D and 2E, except that an inlet module 20 and an outlet module 50 are coupled to a body 31 of a pumping module 30 in an off-axis configuration so that the body 31 is arranged to be stretched and at the same time rotated when an input force is applied along one or both of the inlet and outlet modules.
Such an embodiment may offer the benefit of providing flexibility in constructing the ventilation system because the inlet and outlet air pathways may not have to be aligned and because the air pathways may tend to be misaligned or arranged to be off-axis during three-dimensional movements of the glove regardless of their original arrangements. Other operational characteristics of the pumping module of such an embodiment are typically similar or identical to those described in one or more of FIGS. 1A through 2E.

In another aspect of the present invention, an exemplary pumping module may include at least one chamber or body which defines multiple pleats therealong and which is arranged to be folded or to be otherwise deformed with respect to such pleats and to change its internal volume in response to various input forces applied thereto directly or indirectly by the user. A main feature of this aspect of the present invention is that the chamber or body deforms with respect to the pleats and deformation thereof may not necessarily be localized to a specific portion thereof. Such pumping modules may be provided in various embodiments, typical examples of which are described in the following figures.

In one exemplary embodiment, a pumping module is arranged to deform with respect to pleats in a direction at least partially transverse to an input module and/or output module. For example, FIGS. 3A and 3B show schematic diagrams of an exemplary pumping module which defines multiple pleats, deforms vertically, and disposed in its unstressed and stressed positions, respectively, according to the present invention. A pumping module includes a body defining at least one inlet and at least one outlet, where the inlet is arranged to be coupled to and to be in fluid communication with the inlet pathway of the inlet module and where the outlet is arranged to be coupled to and to be in fluid communication with the outlet air pathway of the outlet module. The body of the pumping module defines multiple horizontal pleats therearound and is arranged to move, deform or fold vertically between at least one unstressed position and at least one stressed position in response to an input force applied vertically by the user. Thus, at least a portion or an entire portion of the body vertically deforms or folds by such an input force. Such a deformation changes an internal volume of the body and, as a result, air is pumped into and out of the body respectively through the inlet and outlet pathways. It is appreciated that the bellows-type pumping module of this embodiment may be incorporated into any location of the glove in any arrangement, e.g., at least partially or entirely exposed through the upper and/or lower outer surfaces thereof, at least partially or entirely hidden between the outer and/or inner surfaces thereof, and the like. Similarly, the pleats may be provided in any location of the body of the pumping module, e.g., on its top, bottom, and/or side. In addition, the pleats may also be provided in any number and/or in any arrangement. For example, the pleats may be formed along a portion or an entire portion of one or more sides of the body, the pleats may be arranged at uniform or different distances, the pleats may form acute angles therebetween or the edges may be rounded, and the like. In addition, the body may be made of an elastic or semi-rigid material and may be made to have recoil properties when desirable. Other operational characteristics of the pumping module of this embodiment are typically similar or identical to those described in one or more of FIGS. 1A to 2F.

FIG. 3C is a schematic diagram of the exemplary pumping module having a cover thereon according to the present invention. As shown in the figure, such a pumping module is generally similar or identical to those of FIGS. 3A and 3B, except that it includes an additional cover disposed on one side of the body in order to receive the input force thereby. Such a cover may offer the benefits of protecting the deformable portion of the body from excessive mechanical impact, normal wear and tear, and the like, and distributing the user input force thereon such that the body may indirectly receive the input force which is generally evenly distributed throughout the cover than otherwise. Other characteristics of such a cover are similar or identical to those in FIG. 2C. Other operational characteristics of the pumping module of this embodiment are typically similar or identical to those described in one or more of FIGS. 1A through 3B.

In another exemplary embodiment, a pumping module may be arranged to deform with respect to pleats in a direction at least partially parallel with an input and/or output module. For example, FIGS. 3D and 3E show schematic diagrams of an exemplary pumping module defining multiple vertical pleats, deforming horizontally, and disposed in its unstressed and stressed positions respectively according to the present invention. A pumping module includes a body defining at least one inlet and at least one outlet similar to those of FIGS. 1A to 3C. Contrary to that of FIGS. 3A to 3C, the body of the pumping module defines multiple vertical pleats therearound so that i may move, deform or fold horizontally between at least one unstressed position and at least one stressed position in response to an input force applied horizontally thereto by the user. At least a portion or an entire portion of the body then deforms or folds horizontally by such an input force, and an internal volume of the body changes in response to the deformation, and air is pumped into and out of the body respectively through the inlet and outlet modules. It is noted that such a bellows-type pumping module may be incorporated into any location of the glove in any arrangement, e.g., at least partially or entirely exposed through its upper and/or outer surfaces, at least partially or entirely hidden between its outer and/or inner surfaces, and so on. Similarly, the pleats may be provided in any location of the body of the pumping module, e.g., on its top, bottom, and/or side. In addition, the pleats may also be provided in any number and/or in any arrangement. For example, the pleats may be formed along a portion or an entire portion of one or more sides of the body, the pleats may be arranged at uniform or different distances, the pleats may form acute angles therebetween or the edges may be rounded, and the like. In addition, the body may be made of an elastic or semi-rigid material and may be made to have recoil properties. Because the pumping unit of this embodiment is arranged to be driven by a horizontal force, at least a portion of a side of the body may be typically arranged to receive the input force applied to the body in the horizontally direction. Alternatively, an actuator module which will be described in greater detail below may be incorporated in order to convert a non-horizontal input force into a horizontal driving force. Other
operational characteristics of such a pumping module 30 of this embodiment are typically similar or identical to those described in one or more of FIGS. 1A to 3C.

[0079] FIG. 3F is a schematic diagram of the exemplary pumping module of FIGS. 3D and 3E including inlet and outlet modules which are axially misaligned according to the present invention. As shown in the figure, a pumping module 30 is typically similar or identical to those of FIGS. 3D and 3E, except that an inlet module 20 and an outlet module 50 are coupled to a body 31 of a pumping module 30 in an off-axis configuration so that the body 31 may fold or deform at an angle with respect to pleats when an input force is applied along one or both of the inlet and outlet modules 20, 50. Similar to that of FIG. 1F, this embodiment may offer the benefit of providing flexibility in constructing the ventilation system 10. Other operational characteristics of the pumping module 30 of this embodiment are typically similar or identical to those described in one or more of FIGS. 1A through 3E.

[0080] FIG. 3G is a schematic diagram of another exemplary pumping module having pleats defined in both of horizontal and vertical directions and capable of deforming in both directions according to the present invention. An exemplary pumping module 30 includes a body 31 defining multiple pleats on its sides as well as at top and bottom portions. Upon receiving an input force, the body 31 may deform in a direction of the input forces and/or in a direction at an angle with respect to the input forces. Thus, the body 31 may deform horizontally, vertically or at preset angles. Other operational characteristics of the pumping module 30 of this embodiment are typically similar or identical to those described in one or more of FIGS. 1A through 3F.

[0081] In another aspect of the present invention, an exemplary pumping module may include at least one cylinder or body which defines an internal cavity through which a piston is arranged to translate in response to various input forces applied thereto directly or indirectly by the user. A main feature of this aspect of the present invention is that the piston changes an amount of air contained in the cavity during its translating or reciprocating movements, although a size and a shape of the internal cavity of the body does not change at all. Accordingly, such a syringe-type pumping module does not generally involve deformation of the cylinder or piston. Such pumping modules may also be provided in various embodiments typical examples of which are described in the following figures.

[0082] In one exemplary embodiment, a pumping module includes a cylinder, piston, and separate inlet and outlet air pathways such that air may be transported into and out of the cylinder by two different pathways and that such pathways may be fixedly coupled to the pumping module in order not to move in response to various input forces. For example, FIGS. 4A and 4B show schematic diagrams of such an exemplary pumping module which includes at least one cylinder and at least one matching piston translating through the cylinder and which are respectively in its unstressed (or intake) and stressed (or discharge) positions according to the present invention. A pumping module 30 includes a cylinder or body 35, a piston 36, an inlet module 20, and an outlet module 50. The cylinder 35 defines a cavity therein and the piston 36 is shaped and sized to fit inside the cavity of the cylinder 35 and to translate or otherwise move therealong. The cylinder 35 also defines at least one inlet and at least one outlet, where the inlet couples with and is in fluid communication with an inlet pathway 21 of an inlet module 20, and where the outlet is coupled to and in fluid communication with an outlet air pathway 51 of an outlet module 50. Such a piston 36 may be arranged to receive an input force directly thereby. In the alternative and as described in the figure, a handle 37 may be attached to the piston 36 to receive the input force thereby and to deliver such an input force to the piston 36. The piston 36 may be arranged to translate or to move between at least one unstressed (or intake) position and at least one stressed (or discharge) position in response to various input forces and to take air into the cylinder 35 and/or to discharge air therefrom in response to the input forces. An amount of air contained in the cylinder 35 changes depending upon a location of the piston 36 therein, and air may be pumped into and out of the cylinder 35 through the inlet and outlet modules 20, 50, respectively. It is appreciated that the syringe-type pumping module 30 of this embodiment may be installed in various locations of the glove 60, e.g., at least partially or entirely exposed through the upper and/or lower outer surfaces of the glove 60, at least partially or entirely hidden (or unexposed) between the outer and/or inner surfaces of the glove 60, and so on. Other operational characteristics of the syringe-type pumping module 30 of this embodiment are typically similar or identical to those described in FIGS. 1A through 3F.

[0083] In another exemplary embodiment, a pumping module includes a cylinder, piston, and separate inlet and outlet air pathways, where at least one of such air pathways is arranged to movably couple with the cylinder and moves along with the cylinder in response to various input forces. For example, FIGS. 4C and 4D show schematic diagrams of the pumping module of FIGS. 4A and 4B which couples with an inlet module movably coupling with the cylinder to translate therewith according to the present invention. An exemplary pumping module 30 includes a cylinder or body 35, a piston 36, and an outlet module 50 which are similar or identical to those of FIGS. 4A and 4B. In contrast to the stationary inlet module of FIGS. 4A and 4B which is fixedly coupled to the stationary piston, an inlet module 20 (or its inlet air pathway 21) of this embodiment is preferably arranged to movably couple with the piston 36 and to receive various input forces directly or indirectly from the user. In addition, one end of such an inlet air pathway 21 is arranged to be in fluid communication with an interior of the cylinder 35 through an aperture 38 provided through a portion of the piston 36 such that air may be transported into or out of the cylinder 35 by the translating or reciprocating movement of the piston 36. Accordingly, such an inlet module 20 or, more particularly, its inlet air pathway 21 may preferably be made of at least partly rigid materials to deliver the input force onto the piston 36. It is appreciated that either or both of such a cylinder and piston may be arranged to move in response to the input force and that either or both of such an inlet and outlet module may be arranged to movably couple with such a mobile cylinder and/or piston. Such an embodiment offers the benefit of constructing a more compact pumping module and, therefore, saving spaces. It is also noted that the syringe-type pumping module 30 of this embodiment may be installed in various locations of the glove 60, e.g., at least partially or entirely exposed through the upper and/or lower outer surfaces of the glove 60, at least partially or entirely hidden between the outer and/or inner surfaces of the glove 60, and so on.
surfaces of the glove 60, and the like. Operational characteristics of the syringe-type pumping module 30 of this embodiment are typically similar or identical to those described in FIGS. 1A through 4B.

[0084] In another exemplary embodiment, a pumping module includes a cylinder, piston, and separate inlet and outlet air pathways, where at least a portion of one or both of such air pathways is arranged to be stationarily disposed in the cylinder and where the piston moves over such a portion of such an air pathway. For example, FIGS. 4E and 4F show schematic diagrams of the pumping module of FIGS. 4A and 4B including an inlet module disposed inside the cylinder and over which the piston translates according to the present invention. An exemplary pumping module 30 includes a cylinder or body 35, a piston 36, and an outlet module 50 which are similar or identical to those shown in FIGS. 4A and 4B. An inlet module 20 or its inlet air pathway 21 of this embodiment is fixedly disposed inside the cylinder 35 and across the piston 36. Thus, such a piston 36 is arranged to define an aperture 38 shaped and sized to movably receive the inlet air pathway 21 therethrough so that the translating or reciprocating movement of the piston 36 over the inlet air pathway 21 transports air into and out of the cylinder 35. It is noted that either or both of the inlet and outlet modules 20, 50 may be disposed inside the cylinder 35 over which the piston 36 translates. It is further noted that the syringe-type pumping module 30 of such an embodiment may be incorporated into various locations of the glove 60, e.g., at least partially or entirely exposed through the upper and/or lower surfaces of the glove 60, at least partially or entirely hidden (or unexposed) between the outer and/or inner surfaces of the glove 60, and the like. Other operational characteristics of the syringe-type pumping module 30 of this embodiment are also similar or identical to those described in FIGS. 1A through 4D.

[0085] In another exemplary embodiment, a pumping module includes a cylinder, piston, and separate inlet and outlet air pathways, where at least a portion of one or both of such air pathways is arranged to be stationarily disposed in the cylinder and where the piston is comprised of multiple portions which couple to each other to move in unison over such a portion of the air pathway. For example, FIGS. 4G and 4H are schematic diagrams of the pumping module of FIGS. 4E and 4F with a piston having multiple portions coupled to each other according to the present invention. An exemplary inlet module 20 and outlet module 50 are similar or identical to those of FIGS. 4E and 4F. An exemplary pumping module 30 is also similar or identical to that of FIGS. 4E and 4F, except that its piston 36 includes multiple portions which are mechanically coupled to each other by at least one coupler 38 such that multiple portions of the piston 36 may move in unison while maintaining an airtight sealing therearound and also preventing leakage of air therethrough. Further configurational and/or operational characteristics of the syringe-type pumping module 30 of this embodiment are also similar or identical to those described in FIGS. 1A through 4F.

[0086] In another exemplary embodiment, a pumping module includes a cylinder, piston, and separate inlet and outlet air pathways, where the cylinder defines a single opening which is shared by both of the inlet and outlet modules to transport air thereinto and therefrom. For example, FIGS. 4I and 4J are schematic diagrams of the pumping module of FIGS. 4A and 4B including only a single opening in fluid communication with both an inlet module and an outlet module according to the present invention. As shown in the figures, an exemplary pumping module 30 includes a cylinder 35 which defines a single opening 39 therethrough. An exemplary inlet module 20 and outlet module 50 of such an embodiment are directly connected to each other at the opening 39 such that an interior of the cylinder 35, an inlet air pathway 21, and an outlet air pathway 51 may be in direct fluid communication through the opening 39. By incorporating at least two one-way valves 23, 53 along the inlet and outlet air pathways 21, 51, air may be pumped into and out of the cylinder 35. Such a pumping module 30 generally requires at least one handle 37 to allow the user to move the piston 36 through the cylinder 35 or, conversely, to move the cylinder 35 with respect to the piston 36. When desirable and as shown in the figures, a pair of handles may also be incorporated into the cylinder 35 and the piston 36. Such an embodiment may offer the benefits of reducing a total length of air pathways and of enabling construction of more compact ventilation systems. Other configurational and/or operational characteristics of the syringe-type pumping module 30 of this embodiment are also similar or identical to those described in FIGS. 1A through 4H.

[0087] In another exemplary embodiment, a pumping module includes a cylinder, piston, and separate inlet and outlet air pathways, where the cylinder is disposed in a direction transverse to air pathways of the inlet and/or outlet modules. For example, FIGS. 4K and 4L show schematic diagrams of another exemplary pumping module similar to that of FIGS. 4A and 4B disposed in an upright arrangement according to the present invention. An exemplary inlet module 20 and outlet module 50 are generally similar or identical to those of FIGS. 4A and 4B, whereas an exemplary pumping module 30 includes a cylinder 35 and a piston 36 disposed in a direction perpendicular or transverse to air pathways 21, 51 of the inlet and outlet modules 20, 50. Accordingly, the piston 36 may move vertically with respect to the inlet and outlet air pathways 21, 51 in response to various input forces applied thereto by a user. Other configurational and/or operational characteristics of the syringe-type pumping module 30 of this embodiment are also similar or identical to those described in FIGS. 1A through J.

[0088] Configurational and/or operational variations and/or modifications of the above embodiments of the exemplary ventilation systems and various modules thereof described in FIGS. 1A through 4F also fall within the scope of this invention. First of all, the foregoing inlet, pumping, and outlet modules may be arranged to have any shapes and/or sizes as long as they may be incorporated into the ventilating gloves of the present invention. In addition, such modules may be made of various materials such as, e.g., plastics, metals, and/or laminated fabrics as long as they do not leak air therethrough. Moreover, the foregoing modules of the ventilating gloves may be arranged in different configurations as long as the ventilation system of this invention may pump air into and out of the ventilating gloves. Therefore, the above exemplary figures may be construed as top views, front views, and so on.

[0089] The inlet and/or outlet air pathways may be made of a variety of materials. For example, such air pathways
may be made of a flexible material and/or to have some slack for movements in order to accommodate movements of the pumping module. In the alternative, the air pathways may be made of a rigid material when such pathways are to receive the input force thereby and/or to transmit such an input force therethrough. Multiple flexible and/or rigid inlet and/or outlet air pathways may be used as well to serve both requirements. Such inlet and/or outlet pathways may be arranged to have various configurations. For example, such pathways may be of a tubular configuration or may be comprised of an enclosed planar configuration. When desirable, such air pathways may be arranged to collapse as air pressure therein falls below that of atmosphere. The inlet and/or outlet module may also include multiple inlet and/or outlet air pathways, respectively, and the ventilating system may have multiple inlet and/or outlet modules, and the like. Similarly, the inlet and/or outlet air pathway may define more than one opening. In addition, at least a portion or an entire portion of the inlet and/or outlet module may be flexibly coupled to the ventilating system and, therefore, may not move in response to the input forces. In this embodiment, the inlet and/or outlet module may be coupled to a non-mobile portion of the pumping module or, alternatively, a mobile air pathway may be incorporated between the pumping module and the stationary inlet and/or outlet module. Furthermore and as will be described below in greater detail, multiple inlet and/or outlet air pathways may be provided such that the user may select one or more of such pathways for different purposes.

[0090] Various bodies of the foregoing pumping modules may be arranged to have various shapes or sizes. In general, such bodies may have almost any arbitrary shapes and/or sizes as far as they may contain preset amounts of air in their unstressed and stressed positions. Accordingly, the body may be shaped as any three-dimensional figures, whether rounded in its corners or not, as long as it may move or deform to take in air and dispense air therefrom in direct or indirect response to various input forces. When desirable, such a body may include multiple chambers which may be coupled to each other in a series and/or parallel arrangement or which may be arranged to be separate and to operate independently of each other. A difference therebetween or a stroke volume of the body (or pumping module) may be set at a wide range, depending upon various design considerations. For example, the body may be arranged to extensively deform so that a single application of the input force may result in a great stroke volume. Alternatively, the body may be arranged to deform to a lesser extent but a frequent application of various input forces may result in a sum of stroke volumes equivalent thereto.

[0091] The pumping modules may also be arranged to take in and/or dispense air at least substantially temporally simultaneously with the input forces, except slight time lags for air to travel through the inlet and/or outlet air pathways with finite volumes. Alternatively, the ventilating system 10 may include an optional elastic storage chamber which is arranged to receive air from the pumping module, to store at least a portion of such air therein even after the input force ceases to be applied, and to dispense air therefrom due to a pressure difference developed between itself and the interior of the glove. Such a temporally delayed embodiment may offer a benefit of supplying air into the interior of the glove over a preset prolonged period. Design of such storage chambers and incorporating such into the ventilating system typically depend upon dynamic characteristics thereof examples of which may include, but not be limited to, unstressed volumes of the chambers, elasticities or Young’s moduli of the chamber, and the like.

[0092] The body of any of the above pumping modules may define only one opening which may serve both as the inlet opening and outlet opening. However, in order to pump air into and out of the gloves, the inlet and/or outlet modules may incorporate at least two valves to direct air along preset directions. Such a body of the pumping module may be arranged to have recoil properties so that it may return to its unstressed position by itself without any extra external force. Therefore, such a body may deform to its stressed position while the external input force is being directly or indirectly applied thereto, and may return to its unstressed position when such an input force disappears. Alternatively, an optional conventional recoil elements such as, e.g., springs and elastic strings, may be incorporated into such a pumping module to provide a recoil force to move the pumping module from one to the other of such unstressed and stressed positions.

[0093] As briefly described above, various input forces may be applied to various parts of the above modules either directly or indirectly. For example, at least a portion of the body of the deformable-type pumping module or the bellows-type pumping module and/or such a portion of the piston of the syringe-type pumping module which is either exposed through or hidden under the outer surface of the glove may directly or indirectly receive the input force from the user. In the alternative, at least a portion of the inlet and/or outlet module which is either exposed through or hidden under the outer surface of the glove may be arranged to directly or indirectly receive the input force from the user. In addition, such portions of these modules may be disposed to receive such input forces in various directions as long as air may be transported into and out of the body of the pumping module. Thus, such portions of the above modules may be arranged to receive the input force horizontally, vertically, at a preset constant angle or at varying angles. Moreover, such portions of the above modules may be arranged to deform or to move in a direction which may coincide with or differ from a direction of the input forces by, e.g., arranging such portions to move or deform only along a preset direction, converting a direction and/or a magnitude of the input force by actuator modules of the present invention which will be described in greater detail below, and so on. Furthermore, various portions of the foregoing modules may move or deform in response to the input forces. For example and as exemplified in the foregoing embodiments, the portions directly receiving the input forces may move or deform in response thereto. Alternatively, other portions of the foregoing modules may deform even though such portions do not directly receive the input forces. For example, the exposed or hidden portions of the deformation and/or bellows-type pumping modules may be arranged to first receive the input force, not to move or deform thereby, but to instead deliver the input force to adjacent portions which are arranged to deform or to move by the input forces. In another example, the piston (or another part or module) of the syringe-type pumping module may also be arranged to first receive the input forces, not to move thereby, but to deliver such input forces to other parts or modules which then move or deform by the input force. As long as the pumping module may pump air into and out
of its body, details of such mobile arrangements may not be material to the present invention.

The above pumping modules may also be arranged to pump air into and out of their bodies by various embodiments. For example, the pumping module may be arranged to pump air out of its body into the interior of the glove while the input force is applied thereto and to suck fresh air into its body as the user stops to apply the input force. Conversely, the pumping module may be arranged to suck fresh air into its body while the user applies the input force thereto and to pump the fresh air out of its body into the glove interior while no input force is applied thereto. Alternatively, the pumping module may be arranged to dispense air therefrom into the glove interior and then to suck fresh air thereinto while the input force is applied thereto, and to suck more fresh air thereinto and then to dispense the fresh air therefrom into the glove interior through its return movement when no input force is applied thereto. In order to construct a specific pumping module operating according to one of the foregoing embodiments, the pumping module may be arranged to move or to deform from one of the unstressed and stressed positions to the other thereof in response to the input forces, e.g., from the unstressed position to the stressed position as depicted in the foregoing figures, from the stressed position to the unstressed position when the pumping module couples with a recoil unit which may keep the pumping unit in the biased, stressed position when no input force is applied thereto.

The foregoing pumping modules may further be arranged to move or to deform in response to various input forces applied by the user and/or various movements of the user. As described above, various portions of the above inlet, pumping, and/or outlet modules may deform or move in response to the input forces applied directly thereto or indirectly through the outer surface of the ventilating glove. In addition, when various input forces are applied indirectly to one of such modules, their magnitudes, directions, and/or timing may be altered such that resulting driving forces may be arranged to actually drive one of the above pumping modules. In the alternative and as will be described in greater detail below, various movements of fingers and/or a hand of the user may be converted into various driving forces by various actuator modules.

As described hereinabove, the user may apply the input forces directly to various modules of the ventilating system of the ventilating glove by, e.g., pushing, pulling, pressing, twisting, squeezing, stretching, deforming or otherwise moving the deformable or movable portions of the pumping module, the portions adjacent to such deformable or movable portions, the pistons or cylinders of the pumping module, inlet and/or outlet modules or their air pathways, and so on. In the alternative or in conjunction therewith, the ventilation system may also be arranged such that the user may move his or her fingers and/or hands and that various actuator modules may convert such movements (or input forces) into a driving force which actually drives the pumping module to pump air thereinto and therefrom in order to ventilate air into and out of the ventilating glove of this invention. Following figures exemplify a typical actuator module for the latter aspect of the present invention.

For example, FIG. 5A shows a cross-sectional view of an exemplary ventilating glove which is disposed straight, which includes an inlet module, a pumping module, and an outlet module, and which incorporates an actuator module arranged to convert a movement of a finger of an user into a driving force to drive the pumping module, while FIG. 5B is a cross-sectional view of the exemplary ventilating glove of FIG. 5B which is bent at about 90 degrees according to the present invention. It is noted that FIGS. 5A and 5B are cross-sectional views of the ventilating glove of FIGS. 1A and 1B obtained along a line AB, although an exemplary ventilating glove 60 of FIGS. 5A and 5B are slightly different from that of FIGS. 1A and 1B. An exemplary glove 60 includes a finger portion 63C, an upper outer surface 61, a lower outer surface 62, an upper inner surface 65, and a lower inner surface 66, where insulative and/or protective materials may fill at least a part of a gap space formed between the outer surfaces 61, 62 and inner surfaces 65, 66. An exemplary ventilating system 10 of such a ventilating glove 60 includes an inlet module 20, a pumping module 30, and an outlet module 50 which are similar to those described above, and an actuator module 70. More particularly, the pumping module 30 is disposed in an upper proximal portion of the glove 60 and has an elongated body 31 disposed between the upper outer and inner surfaces 61, 65 of the glove 60. The body 31 also forms a pair of opposing openings, where a proximal opening thereof is in fluid communication with a distal end of an inlet air pathway 21 and a distal opening thereof is in fluid communication with a proximal end of an outer air pathway 51C. The inlet air pathway 21 terminates at an inlet opening 22 provided in a proximal end of the glove 60 to be in fluid communication with the atmosphere, while the outlet air pathway 51C terminates at an outlet opening 52C provided inside the ventilating glove 60 and, more particularly, at a distal tip portion of the upper inner surface 65. A pair of one-way valves such as an inlet valve 231 and an outlet valve 23O are respectively provided along the inlet and outlet air pathways 21, 51C or adjacent to the opposing openings of the body 31 so that atmospheric air may be pumped into an interior of the glove 60 and/or moist air may be pumped out of the glove 60.

The actuator module 70 includes a pair of opposing actuators 71, 72, where an outer actuator 71 is preferably disposed on top of or below the upper outer surface 61 and where an inner actuator 72 is preferably disposed underneath or above the upper inner surface 65 such that a gap space may be formed therebetween. Both actuators 71, 72 are made of an elastic or deformable material and/or have elastic configurations so that they may operate or move between their unstressed and stressed positions in response to a bending (or reverse) movement of the finger of the user and/or a fisting (or reverse) movement of his or her hand. Such outer and inner actuators 71, 72 are operatively coupled to each other so that they may move simultaneously in response to such bending or fisting movements of the user but that they may move or deform by different lengths or extents between their stressed and unstressed positions in response thereto. For example and as described in FIG. 5B, the bending movement of the user's finger stretches the outer actuator 71 farther than the inner actuator 72, while maintaining the operative coupling therebetween. As a result, a distance between the outer and inner actuators 71, 72 and a configuration of the gap space formed therebetween may change accordingly.
In operation, the body 31 of the pumping module 30 is movably or fixedly installed between the outer and inner actuators 71, 72 which are in turn operatively coupled to each other such that both of the actuators 71, 72 may operate, move or deform between their respective unstrained or stressed positions, while mechanically interacting or exerting forces upon each other because of the operative mechanical coupling therebetween. The user puts on the ventilating glove 60 and stretches or finger straight. In this unstrained position, the outer and inner actuators 71, 72 are typically apart by a maximum distance, the gap space formed therebetween attains its maximum value, and, accordingly, the body 31 of the pumping module 30 which may be any of the foregoing deformation-, bellow-, and syringe-type is filled with a preset amount of air as described in FIG. 5A. When the user bends or her finger as shown in FIG. 5B, the outer actuator 71 undergoes a greater deformation than the inner actuator 72. The distance between the actuators 71, 72 then decrease to its minimum value, while the size of the gap space defined therebetween also decreases its minimum value. In response thereto, the deformation portion of the body 31 deforms, the pleats of the body 31 fold, and/or the piston 56 is translated further into the cylinder 35, and air is dispensed from the pumping module 30 into the outlet air pathway 51C in an amount of the preset stroke volume, thereby supplying air into the interior of the body 31. When the user unbends or straightens the finger, both the outer and inner actuators 71, 72 return to their unstrained positions, the distance between the actuators 71, 72 returns to its maximum value, and the gap space regains its original configuration. Thereafter, the deformable body 31 of the pumping module 30 takes in dry air from the atmosphere while returning to its unstrained position due to its own recoil properties and/or optional conventional recoil units incorporated thereto. Accordingly, as the user repeats to bend and straighten the finger, the moist air in the interior of the glove 60 may be replaced by fresh, drier atmospheric air. By supplying the drier air into the interior of the glove 60, accumulation of moist or water inside the glove 60 may be minimized and growth of various harmful microorganisms or fungi therein may be prevented. Therefore, the user may keep his or her hand in a drier more sanitary environment. It is appreciated that any of the foregoing pumping modules may be incorporated into the ventilating gloves. For example, the ventilating glove 60 shown in FIGS. 5A and 5B incorporates the deformation-type pumping module 30 of which the deformable portion is disposed facing one or both of the outer and inner actuators 71, 72. When the bellow-type, pumping module 30 is to be used, the body 31 is generally disposed so that its pleats are at least partially parallel with the outer and/or inner actuators 71, 72 and that the body 31 deforms in a direction at least partially vertical to the actuators 71, 72. When the syringe-type pumping module is to be used, its piston is disposed to translate vertical to the outer and/or inner actuators 71, 72.

Various actuator modules using a variety of force transmitting and/or converting mechanisms may be utilized to pump air into and out of the pumping modules and to ventilate air into and out of the ventilating gloves of this invention. Configurational and/or operational details of such actuator modules may depend upon, e.g., types of movements of the user to be exploited thereby, pumping mechanisms of the pumping modules, and the like. Roughly speaking, the actuator modules of the present invention may be classified into transmitting actuator modules for purely serving as transmission lines of various input forces which cause movements of various portions of the ventilating gloves, converting actuator modules for converting the input forces into driving forces which are different from the input forces in at least one aspect and serves to actually drive the pumping module, and hybrid actuator modules for both transmitting at least a portion of the input force and also for converting at least another portion of the input force to generate the foregoing driving force.

In one aspect of the present invention, exemplary actuator modules are operatively coupled to various deformation-type pumping modules to achieve deformation of at least portions of the pumping modules, thereby changing their internal volumes in response to various user movements caused by various input forces applied thereto directly or indirectly. A main feature of this aspect of the present invention is that the actuator modules transmit the input forces and/or generate driving forces from the input forces to deform the deformable portions of the pumping modules. Such actuator modules may be provided in various embodiments, typical examples of which are shown in the following figures.

In one exemplary embodiment, an actuator module is arranged to transmit an input force along the same direction of the input force and at least a portion of a pumping module is arranged to deform in the same direction thereby. For example, FIGS. 6A and 6B are schematic diagrams of an exemplary actuator module which operatively couples with a deformation-type pumping module, where such an actuator module is arranged to transmit an axial input force in the same direction and such a pumping module is in its unstrained and stressed positions, respectively, according to the present invention. An exemplary pumping module 30 is similar to those of FIGS. 2A and 2B, except that its inlet and outlet openings are disposed off a center axis of its body 31. In addition, an exemplary inlet module 20 and outlet module 50 are also similar to those shown in FIGS. 2A and 2B. An exemplary actuator module 70 has a proximal actuator 73A disposed adjacent to or in parallel with an inlet air pathway 21 of the inlet module 20 and a distal actuator 73B disposed adjacent to or in parallel with an outlet air pathway 51 of the outlet module 50. The proximal and distal actuators 73A, 73B are also coupled to opposing ends of the body 31 along a center axis 33 of the body 31. Accordingly, one or both of the actuators 73A, 73B receive an input force applied therealong and transmits the input force thereby to the body 31 of the pumping module 30 in order to effect deformation of the body 31 and to dispense air out of the body 31 and into an interior of the glove 60 through an outlet opening 52. The actuators 73A, 73B may be arranged to receive the input force by various embodiments such that, e.g., the user may pull or stretch one or both of the rigid or elastic actuators 73A, 73B. Alternatively, the actuators 73A, 73B may be arranged to receive the input force when the user pushes or squeezes one of both of such actuators 73A, 73B as well.

In another exemplary embodiment, an actuator module is similarly arranged to transmit an input force along parallel but off-axis directions of the input force such that at least a portion of a pumping module is arranged to deform by a resulting torque. For example, FIG. 6C shows a schematic diagram of another exemplary actuator module.
operatively coupling with a deformation-type pumping module, where the actuator module is arranged to transmit an axial input force in parallel but off-axis directions according to the present invention. An exemplary ventilating system 10 includes an inlet module 20, a pumping module 30, and an outlet module 50 which are similar or identical to those of FIGS. 6A and 6B. An actuator module 70 similarly includes a proximal actuator 73A and a distal actuator 73B which are coupled to two ends of a body 31 of the pumping module 30, but not located along a center axis 33 of the body 31. Accordingly, an input force applied to one or both of the actuators 73A, 73B results in a torque which pulls, stretches, pushes or squeezes the body 31 while deforming it around a center of the body 31. Other configurational and/or operational characteristics of the actuator module 70 of this embodiment are also similar or identical to those described in FIGS. 6A and 6B.

[0104] In another exemplary embodiment, an actuator module is arranged to convert an input force to a driving force acting in a direction different from that of the input force and driving a pumping model in its direction but not in that of the input force. For example, FIGS. 6D and 6E show schematic diagrams of an exemplary actuator module operatively coupled to another deformation-type pumping module and arranged to convert an axial input force into a transaxial driving force, where the pumping module is in its unstressed and stressed positions, respectively, according to the present invention. An exemplary ventilating system 10 includes an inlet module 20, a pumping module 30, and an outlet module 50 which are generally similar to those shown in FIGS. 6A and 6B, except that a proximal guide 41A and a distal guide 41B may be provided near opposing portions of the body 31. An exemplary actuator module 70 includes an actuator 73 extending from a proximal portion of the inlet module 20, biased downward by the proximal guide 41A near a proximal end of the body 31 of the pumping module 30, covering a top portion of the body 31, biased again downward by the distal guide 41B, and terminating at a distal end of the outlet module 50. The actuator 73 is further arranged to be moved or deformed by, e.g., being pulled, pushed or stretched by an input force generally acting in a direction parallel with the actuator 73, while being biased by the pair of guides 41A, 41B to cover the top portion of the body 31. Accordingly, the actuator 73 and guides 41A, 41B may convert the horizontally acting input force into a transaxial driving force which acts in a direction transverse to the input force and, normal to the top portion of the body 31.

[0105] In operation, the body 31 of the pumping module 30 is movable or fixedly installed between the outer and inner surfaces of the glove, over or below one or both of such surfaces, and the like. Both ends of the actuator 73 are operatively coupled to different portions of the glove such that movements of an user's finger and/or hand may pull, stretch, push or otherwise move the actuator 73 by the input force acting in the direction of the actuator 73. When no input force is applied thereto, the actuator 73, maintains its unstressed configuration, while the body 31 has its maximum volume. As the actuator 73 is horizontally stretched or pulled to its stressed configuration, the proximal and distal guides 41A, 41B convert the horizontally acting input force into the driving force which normally (or vertically) presses, squeezes, and/or pushes the body 31 inwardly. Because the actuator 73 is arranged to indirectly or directly contact the top portion of the body 31, a deformable portion of the body 31 deforms inwardly and the volume of the body 31 decreases to its minimum value by such a driving force. The one-way valves directs a preset amount (i.e., the stroke volume) of air to be dispensed from the body 31 into an interior of the glove through an outlet opening 52 of the outlet module 50. The fresh air supplied by such a ventilating system 10 boosts moist air out of the glove. As the user moves his or her finger or hand back to its previous position, the actuator 73 moves back to its original unstressed configuration through its own recoil properties and/or by optional conventional recoil units incorporated thereto. The body 31 moves back to its unstressed position to regain its maximum value, while the one-way valves direct fresh atmospheric air to fill the body 31 of the pumping module 30 for a next cycle of ventilation. Other configurational and/or operational characteristics of the actuator module 70 of this embodiment are also similar or identical to those described in FIGS. 6A through 6C.

[0106] In another exemplary embodiment, an actuator module is arranged to convert an input force to another driving force which drives a pumping model in its direction but not in the direction of the input force. For example, FIG. 6F is a schematic diagram of another exemplary actuator module operatively coupling with a deformation-type pumping module, where the actuator module is arranged to convert off-axis input forces into transaxial driving forces according to the present invention. An exemplary ventilating system 10 has an inlet module 20, a pumping module 30, and an outlet module 50 which are all similar to those shown in FIGS. 6A and 6B, except that an actuator module 70 includes an actuator 73 which extends from a proximal portion of the inlet module 20, covers various portions of the body 31 along its curvilinear contour, and terminating at a distal end of the outlet module 50. The actuator 73 is similarly arranged to be moved or otherwise deformed by being pulled, pushed or stretched by an input force and converts the input force into a driving force which acts in a direction normal to the portions of the body 31 which are in contact therewith. When desirable, various guides (not shown in the figure) may be incorporated to guide the movement and/or deformation of the actuator 73. Other configurational and/or operational characteristics of the actuator module 70 of this embodiment may be also similar or identical to those described in FIGS. 6A through 6E.

[0107] In another aspect of the present invention, exemplary actuator modules may also operatively couple with various bellow-type pumping modules to deform at least portions of the pumping modules, thereby changing their internal volumes in response to various user movements exerted by various input forces applied thereto directly or indirectly. A main feature of such an aspect of this invention is that the actuator modules transmit the input forces and/or convert such into driving forces to fold one or more pleats of the bellow-type pumping modules. Such actuator modules may also be provided in various embodiments, typical examples of which are shown in the following figures.

[0108] In one exemplary embodiment, an actuator module is arranged to transmit an input force along the same direction of the input force and at least a portion of a pumping module is arranged to deform in the same direction thereby. For example, FIG. 7A is a schematic diagram of an exemplary actuator module operatively coupling with a
bellow-type pumping module and transmitting an axial input force in the same direction according to the present-invention. An exemplary inlet module 20 and outlet module 50 are similar or identical to those of FIGS. 3D and 3E, except that they are in fluid communication with lower ends of a body 31 of an exemplary pumping module 30, not with center portions of the body 31. A pumping module 30 is similar to those of FIGS. 3D and 3E and includes a body 31 with multiple pleats 34 defined on its top and bottom. An actuator module 70 includes a proximal actuator 73A and a distal actuator 73B each coupled to opposing center portions of the body 31 along a central axis of the body 31. Accordingly, one or both of the actuators 73A, 73B may receive an input force applied thearealong and/or may be actuated by various movements of a finger and/or hand of the user caused by such an input force, and transmits the input force to the body 31 of the pumping module 30 to cause the body 31 to fold horizontally along one or more pleats 34, thereby transporting fresh air from atmosphere into the body 31, transporting moist air from the interior of the glove into the body 31, to dispense air out of the body 31 into an interior of the glove 60, to dispense moist air out of the body 31 to the atmosphere, and the like. The actuators 73A, 73B may be arranged to receive the input force and/or to be actuated by various embodiments such that, e.g., the user may pull or stretch one or both of the rigid or elastic actuators 73A, 73B. Alternatively, the actuators 73A, 73B may be arranged to receive the input force and/or may be actuated when the user pushes or squeezes one of both of the actuators 73A, 73B as well. Further configurational and/or operational characteristics of such an actuator module 70 of this embodiment are also similar or identical to those described in FIGS. 3D to 3E.

[0109] In another exemplary embodiment, an actuator module is arranged to receive and to convert an axial input force into a transaxial driving force and to fold at least a portion of a bellow-type pumping module along one or more pleats. For example, FIG. 78 is a schematic diagram of another exemplary actuator module operatively coupling with a bellow-type pumping module and converting an axial input force into a transaxial driving force which is normal or transverse to the input force according to the present invention. An exemplary inlet module 20 and outlet module 50 are similar or identical to that of FIG. 7A, whereas an exemplary pumping module 30 includes a body 31 with multiple pleats 34 defined on its sides such that the pleated body 31 may move or deform horizontally between its stressed and unstressed positions. An exemplary actuator module 70 includes a proximal actuator 73A and a distal actuator 73B, where the proximal actuator 73A generally extends along an inlet air pathway 21 of the inlet module 20 and coupling with a bottom of the body 31 while being upwardly biased by a guide 41B and where the distal actuator 73B extends along an outlet air pathway 51 of the outlet module 50 and coupling with a top of the body 31 while being biased downwardly by another guide 41A. Therefore, when one or both of the actuators 73A, 73B directly receive an input force and/or are actuated by the movement of the user’s finger or hand caused by such an input force applied horizontally therealong, the guides 41A, 41B convert the horizontal input force into a vertical driving force which may cause the body 31 to move or deform by being folded vertically along the pleats 34 and to dispense air out of the body 31 into an interior of the glove 60 or into the atmosphere through an outlet opening 52. Such actuators 73A, 73B may also be arranged to directly receive the input force and/or may be actuated by various user movements based on various embodiments so that, e.g., the user may pull or stretch one or both of the rigid or elastic actuators 73A, 73B. Alternatively, the actuators 73A, 73B may also be arranged to receive various input forces and/or may be actuated by the user movements when the user pushes, pressed, and/or squeezes one of both of such actuators 73A, 73B. Other operational and/or configurational characteristics of the actuator module 70 of this embodiment are also similar or identical to those described in FIGS. 3D, 3E, and 7A.
[0111] In another exemplary embodiment, an actuator module is similarly arranged to transmit an input force along parallel but off-axis directions of the input force such that at least a portion of a pumping module is arranged to fold by a resulting torque. For example, FIG. 7E shows a schematic diagram of another exemplary actuator module which is operatively coupled to a bellow-type pumping module and arranged to transmit an axial input force and/or to convert an axial movement along a parallel but off-axis direction into a driving force according to the present invention. An exemplary an inlet module 20, a pumping module 30, and an outlet module 50 are similar or identical to those shown in FIGS. 7C and 7D, except that an inlet air pathway 21 and an outlet air pathway 51 of the inlet and outlet modules 20, 50 are connected to a body 31 of the pumping module 30 in its center portions of opposing sides thereof. An actuator module 70 includes a proximal actuator 73A and a distal actuator 73B which are coupled to two ends of a body 31 of the pumping module 30 but not located along a center axis of the body 31. Thus, an input force applied to one or both of such actuators 73A, 73B and/or a horizontal movement of such actuators 73A, 73B effecting such an input force results in a torque which pulls, stretches, pushes, and/or squeezes the body 31 while folding it around its center. Other configurational and/or operational characteristics of the actuator module 70 of this embodiment are also similar or identical to those described in FIGS. 6C and 7A through 7D.

[0112] In another exemplary embodiment, an actuator module is arranged to convert an input force or movement of a hand and/or finger of an user to another driving force which drives a pumping module in its direction but not in a direction of the input force. For example, FIG. 7F shows a schematic diagram of another exemplary actuator module which is operatively coupled to a bellow-type pumping module and converts an off-axis input force and/or movement of an user effecting such an input force into a transaxial driving force normal or transverse to the input force according to the present invention. An exemplary inlet module 20, a pumping module 30, and an outlet module 50 are similar to those shown in FIGS. 7C to 7E. While an actuator module 70 includes an actuator 73 extending from a proximal portion of the inlet module 20, covering various portions of the body 31 along its curvilinear contour, and then terminating at a distal end of the outlet module 50. The actuator 73 is similarly arranged to be moved or otherwise deformed by being pulled, pushed or stretched by an input force and converts the input force into a driving force which acts in a direction normal to the portions of the body 31 which are in contact therewith. When desirable, various guides (not shown in the figure) may be incorporated to guide the movement and/or deformation of the actuator 73. Other configurational and/or operational characteristics of the actuator module 70 of this embodiment may be also similar or identical to those described in FIGS. 6F and 7A through 6E.

[0113] In another aspect of the present invention, exemplary actuator modules may also operatively couple with various syringe-type pumping modules so as to move or translate pistons of the pumping modules, thereby changing their internal volumes in response to various user movements effecting by various input forces applied thereto directly or indirectly. A main feature of this aspect of the present invention is that the actuator modules transmit the input forces and/or convert such into driving forces to move or translate the pistons of the syringe-type pumping modules. Such actuator modules may be provided in various embodiments similar to those described in FIGS. 6A to 6F and 7A to 7F, where the deformation and/or bellow-type pumping modules of such figures may be replaced by the exemplary syringe-type pumping modules of FIGS. 4A to 4L, and where various actuators and/or guides shown in FIGS. 6A to 6F and 7A to 7F are incorporated thereinto in order to move the pistons with respect to the cylinders and vice versa.

[0114] Configurational and/or operational variations and/or modifications of the above embodiments of the exemplary ventilation systems and various modules thereof described in FIGS. 6A through 7F and those described in conjunction therewith also fall within the scope of the present invention. For example, the foregoing actuator modules may be arranged to have any shapes and/or sizes as far as they may be incorporated to the ventilating gloves of the present invention. In addition, such actuator modules may be made of various materials such as, e.g., plastics, metals, and/or laminated fabrics as long as they may transmit various input forces and/or convert various movements of the user’s finger and/or hand effecting such input forces. Such actuator modules may also be arranged in different configurations as long as the ventilation system of the present invention may pump air into and out of the ventilating gloves. Therefore, the above exemplary figures may be construed as top views, front views, and so on.

[0115] The actuator module may be incorporated to the ventilating glove in various embodiments. For example, at least a portion of such an actuator module may be movably or fixedly coupled to the body of the pumping module so as to facilitate transmission and/or conversion of various user input forces and/or user movements. In another example, at least a portion of the actuator module may be movably or fixedly coupled to one or more outer and/or inner surfaces of the ventilating glove so as to facilitate reception of various user input forces and/or user movements. At least a portion of such an actuator module and/or its actuator may be exposed through the outer and/or inner surface of the glove so that the user may apply various input forces thereto and/or may move such a portion in various directions. Alternatively, an entire portion of the actuator module and/or its actuator may also be disposed below the outer surface of the glove. When desirable, covers may be provided movably or fixedly over the actuator module and/or its actuator to receive the input force and to transmit the input force onto the actuator module and/or its actuator. When such an actuator is arranged to convert the input force to the driving force, the foregoing guides may also be incorporated in order to bias the actuator in various directions as described above. Such guides may be arranged to roll to facilitate the deformation and/or movement of the actuator. It is again appreciated that, in any of exemplary embodiments described hereinabove and hereinafter, the main objective of the actuator module of this invention is to transmit and/or convert the input force such that the pumping module may pump air into and out of itself. Thus, the actuator module may be arranged to allow direct movements and/or deformations of at least a portion of the pumping module in response to the user input force or user
movement or to allow deformations of the gap space which in turn changes the internal volume of the body of the pumping module.

[0116] As described above, the actuator module may include a single actuator which may be coupled to the body of the pumping module or may include multiple actuators which operate in unison to deform or move at least a portion of the body of the pumping module. Such actuators may be constructed as rods or strings which move or deform (e.g., stretch or elongate) in a single dimension. The actuators may also be provided as planes, plates or slabs which may move or translate vertically, horizontally or at angles in two dimensions. In the alternative, the actuators may be configured as curvilinear planes or sheets which move or deform (e.g., bend, twist, stretch, or elongate) in three dimensions. Detailed configurations of the actuator modules and their actuators may also depend upon, e.g., types of the input forces and/or the movements of the user's finger or hand, mechanisms of the pumping modules, and the like. Regardless of their structural arrangements and/or operating mechanisms, the actuator modules and their actuators are designed to move or deform at least a portion of the pumping module. Accordingly, the pumping module and/or its body may preferably be supported by a stationary and/or mobile part of the ventilating glove so that the input and/or driving force may not be wasted in moving the entire body instead of moving or deforming the movable or deformable portion thereof. In addition, when the actuator of the actuator module is arranged to enclose at least a portion of the body of the pumping module therein, the aforementioned support may become only optional.

[0117] As described herein, the actuator module may include multiple actuators arranged to transmit the input force therealong and/or to convert such an input force into the driving force. In one example, such actuators may be arranged to operate separately or independently of each other and to transmit or to convert the input force. In such an embodiment, each actuator may be separately coupled to the body of the pumping module, the outer and/or inner surfaces of the glove, and the like, although such actuators are not directly coupled to each other. Therefore, each of such actuators may be arranged to receive a different input force or to be actuated by a different user movement. In another example, at least some of such actuators may also be coupled to each other to operate in unison to transmit or to convert such an input force. In such an embodiment, at least some actuators may be actuated by a single input force and/or user movement. In either embodiment, different actuators may be arranged to perform different functions such that, e.g., some actuators may only transmit the input force, others may convert such an input force into the driving force, and so on.

[0118] The actuators of the actuator modules may be disposed in various arrangements, although the disposition is generally determined by the directions of the input forces applied thereto and/or types of movements of the glove (or hand or fingers of the user) to be exploited thereby. Therefore, such an actuator may be, e.g., disposed linearly or axially along the finger portion and then optionally extending to the palm and/or backhand portion of the glove, disposed to twirl or to twist around the finger portion and optionally extending to the palm and/or backhand portion, disposed to extend across, to be at an angle with or to be transverse to at least one finger in a curvilinear path and then optionally extending to the palm and/or backhand portion, disposed at least substantially or entirely in the backhand and/or palm portion, and the like. It is to be understood that detailed disposition and arrangements of such an actuator are to be determined by a designer who decides in which direction the input force is applied and/or what movements of which portion of the glove he or she wants to exploit. Therefore, a single or multiple actuators may be arranged to be actuated by a single or multiple input forces and/or by a single or multiple movements of a single or multiple portions of the glove, where such input forces and movements may be along one or multiple directions and where such input forces and movements may have different amplitudes and displacements, respectively. In addition, a single or multiple actuators may be arranged to receive the input force directly or indirectly or may be actuated by the movements directly or indirectly. Moreover, when multiple actuators are to be incorporated, they may be disposed in the same or different portions of the glove, may be actuated by identical or different input forces or movements of the glove, may have identical or different configurations and/or operating mechanisms, may be operatively coupled to each other, or may operate independently of each other.

[0119] Other modules of the ventilating system may also be disposed according to the configurational and/or operational characteristics of the actuator module. First of all, the inlet module, outlet module or pumping module may be entirely exposed, partially exposed or disposed between the outer and inner surfaces of the glove as described above. As far as the actuator module may receive the input force and/or exploit various movements of the glove and may drive the pumping module, detailed disposition of the other modules are not generally critical to the scope of the present invention. Therefore, exact locations of the inlet and/or outlet openings, inlet and/or outlet air pathways, and valves may also vary depending upon various characteristics of the actuator module and its actuators. Secondly, the inlet module, outlet module, and/or pumping module do not have to be disposed between or adjacent to the actuator as long as the body of the pumping model may receive the input force and/or may be driven by the driving force generated by the actuator module. When desirable, a force-transmission unit may be incorporated to transmit the input and/or driving force to the pumping module which is disposed far from the actuator module. Thirdly, any portion of the inlet and/or outlet modules may be arranged to be stationary and not to move along with the deformable or movable portion of the pumping module and/or the actuator of the actuator module. Furthermore, any of the above modules of the ventilating system may be operatively combined to form an unitary article. For example and as described in FIGS. 4C and 4D, the inlet and pumping modules may be combined. Similarly, the outlet and pumping modules may be combined to allow the outlet module or at least a portion thereof in order to move along with the piston or cylinder of the pumping module, the actuator and pumping modules may be combined to facilitate the direct transmission of the driving force onto the pumping module, and so on.

[0120] As described herein, one or more conventional valves may be disposed along the inlet and/or outlet air pathways to direct a flow of air through the ventilating system. In general, conventional one-way valves may be used to allow an anterograde flow of air but to prevent a
retrograde flow thereof. Other valves may be used to direct the flow of air, examples of which may include, but not be limited to, pressure-regulating valves, three-way valves, and so on. The inlet and/or outlet air pathway may also be made of collapsible materials which may serve as the one-way valve such that it opens under a favorable pressure gradient there across and closes under an opposite pressure gradient.

[0121] The actuator module and its actuator of the present invention may be arranged to be actuated by various user movements. In one exemplary embodiment, such an actuator module may be actuated by fisting-unfisting movements of multiple fingers moving between their fisting and unfisting positions. The fisting position generally represents a position where multiple fingers are bent inwardly at one or more finger joints toward a palm and where such fingers may contact each other or may contact the palm. In contrary, the unfisting position refers to a position where at least some of such fingers are at least partially stretched from the fisting position, at least partially straightened from the fisting-position, and/or bent at lesser extents not to touch each other and/or not to touch the palm. As exemplified in FIGS. 5A and 5B, the actuator module of this embodiment may be fixedly or movably incorporated into the outer and/or inner surfaces of one or more finger portions, palm portion, and/or backhand portion of the ventilating glove in order to exploit different distances of movement and/or deformation between the inner and outer (or palm and back) portions of such finger portions of the glove. Accordingly, the actuators disposed in such inner and outer (or palm and back) portions move or deform by a different distance or extent, the size of the gap space defined between the actuators may change due to such movements, and the body of the pumping module may also change its internal volume pump air into or out of itself. Alternatively, such actuator module may be arranged to be pulled, pushed, squeezed or otherwise moved or deformed, by such movements, the actuator(s) of the actuator module may then transmits the input force to the pumping module, and the body of the pumping module may change its internal volume to pump air into and out of itself. When it is preferable to handle a thumb which moves generally transverse to or at angles with respect to other fingers, the actuator may be disposed over, below or between outer and inner thumb portions of the glove to move transverse to or at angles with respect to other finger portions of the glove. It is to be understood that the above fisting and unfisting positions are those defined relative to each other such that, e.g., the fingers may have only to be bent by greater angles in the fisting position than in the unfisting position. Accordingly, the actuator module may be constructed in various embodiments each of which may adopt a different set of fisting and unfisting positions as long as such fisting and unfisting movements may cause the pumping module to pump air thereinto and therefrom. It is also appreciated that the pumping module may also be arranged to be in its unstressed (or intake) position and stressed (or dispense) position in any of the foregoing fisting, unfisting, and/or any in-between positions by appropriately coupling the actuator module to the pumping module. For example and as described hereinabove, when the actuator module is arranged to control the size of the gap space in which the body of the pumping module is disposed, the pumping module may be arranged such that it is in its unstressed (or stressed) position when the actuator is in the fisting position, in the unfisting position or in the middle or in any intermediate position between or other than the above fisting and unfisting positions.

[0122] In another exemplary embodiment, such an actuator module may be actuated by stretching-unstretching (or relaxing) movements of at least one finger which moves between its stretching and unstretching positions, where the stretching position refers to a position where the finger is stretched farther beyond its natural resting position, and where the unstretching position represents a position where the finger is bent back to its original resting position. In a converse exemplary embodiment, the actuator module may be actuated by bending-unbending (or relaxing) movements of at least one finger moving between its bending and unbending positions, where the bending position refers to a position where the finger is bent inward farther beyond its natural resting position, and where the unbending position represents the above unstretching position. Such actuator modules of both embodiments are generally disposed in the joint portion of the finger to exploit the stretching, unstretching, bending, and unbending movements of the finger. It is to be understood that the foregoing stretching, unstretching, bending, and unbending positions are those defined relative to each other so that, e.g., the finger may have only to be stretched or bent by a greater angle in the unstretching or bending position than in the stretching or unbending position. Accordingly, such actuator modules may be constructed in various embodiments which adopt different sets of stretching-unstretching or bending-unbending positions as long as such stretching-unstretching or bending-unbending movements cause the pumping modules to pump air into and out of itself. It is appreciated that the pumping module may also be arranged to be in its unstressed (or intake) position and stressed (or dispense) position in any of the above stretching, unstretching, bending, unbending, and/or in-between positions by appropriately coupling the actuator module to the pumping module. Detailed configurational characteristics, disposition arrangements, and/or operation mechanisms of the actuator of the above embodiments may be similar or identical to those of the above fisting-unfisting embodiment except that the actuators of the above embodiments may be actuated by the above movements of a single or multiple fingers. It is also appreciated that the actuator module of such embodiments may include multiple actuators which may be incorporated into different finger portions of the ventilating glove and/or different palm or backhand portions such that the actuator module may be actuated by the different movement(s) of various portions of the glove.

[0123] In another exemplary embodiment, the actuator module may further be actuated by squeezing-unsqueezing (or relaxing) movements between at least two fingers moving between their squeezing and unsqueezing (or relaxing) positions, where the squeezing position refers to a position where the fingers are squeezed farther beyond their natural resting position to contact and to press each other, and where the unsqueezing (or relaxing) position represents the resting
position thereof in which the fingers may or may not touch each other but they do not press each other. It is appreciated that such squeezing and unsqueezing positions only relate to whether the fingers contact and press each other and, therefore, the fingers may be bent or stretched in any of such positions. The actuator module of this embodiment may be fixedly or movably incorporated into adjacent side finger portions of the glove, whereas the body of the pumping module may be disposed in, such side finger portions or in any other portions of the glove as far as the actuators of the actuator module may be operatively coupled to the body of the pumping module, may move or deform at least a portion of the body of the pumping module or may change the size of the gap space enclosing the body of the pumping module to take air into or to dispense air therefrom. It is to be understood that the above squeezing and unsqueezing positions are those defined relative to each other such that, e.g., the fingers may have only to press each other by a greater force in the squeezing position than in the unsqueezing position. Therefore, the actuator module may also be constructed in various embodiments which may adopt different sets of squeezing and/or unsqueezing positions as long as such squeezing and unsqueezing movements may cause the pumping module to pump air thereinto and therefrom. It is appreciated that the pumping module may be arranged to be in its unstressed (or intake) position and stressed (or dispense) position in any of the above squeezing, unsqueezing, and/or in-between positions. Detailed configurational characteristics, disposition arrangements, and/or operation mechanisms of the actuator of the above embodiment are generally similar or identical to that of the above fisting-unfisting embodiment, except that the actuators of this embodiment may be actuated by the adjacent fingers. It is further appreciated that the actuator module of this embodiment may include multiple actuators incorporated into different finger portions of the ventilating glove and/or different palm and/or backhand portions so that the actuator module may be actuated by the different movement(s) of various portions of the glove.

In another exemplary embodiment, another actuator module may also be actuated by pressing-unpressing (or relaxing) movements of at least one finger which may move between its pressing and unpressing (or relaxing) positions toward and away from the palm of the hand, respectively, where the pressing position represents a position where the finger moves toward the palm or contacts and presses the palm, and where the unpressing (or relaxing) position represents the resting position of the finger in which the finger does not touch the palm and does not press the palm. Such an actuator module of this embodiment generally involves an interaction between at least one finger and the palm and, therefore, is different from the foregoing infringer embodiments which involve the movements of the fingers (e.g., the fisting-unfisting, stretching-unstretching, and bending-unbending movements) and from the interfinger movements such as the squeezing-unsqueezing movements between multiple fingers. The actuator of such an embodiment may be fixedly or movably incorporated into the finger portion and/or the palm portion or, alternatively, in the joint portion of the finger, as far as the pressing and/or bending movements of at least one finger against and/or with respect to the palm may generate the driving force which may be capable of pumping air into and out of the body of the pumping module. It is to be understood that the above pressing and unpressing positions are those defined relative to each other so that, e.g., the finger may have only to press the palm by a greater force or at a greater angle in the pressing position than in the unpressing position. Accordingly, the actuator module may also be constructed in various embodiments employing different sets of pressing and/or unpressing positions as long as such pressing and unpressing movements may cause the pumping module to pump air into and out of itself. It is appreciated that the pumping module may be arranged to be in its unstressed (or intake) position and stressed (or dispense) position in any of the above pressing, unpressing, and/or in-between positions as well. Detailed configurational characteristics, disposition arrangements, and operation mechanisms of the actuator of the above embodiment are generally similar or identical to that of the above fisting-unfisting embodiment, except that the actuators of this embodiment may be actuated by the finger movements with respect to the palm. It is also appreciated that the actuator module of this embodiment may include multiple actuators incorporated into different finger portions of the ventilating glove and/or different palm and/or backhand portions so that the actuator module may be actuated by the different movement(s) of various portions of the glove.

In addition to the aforementioned finger and/or hand movements, the actuator modules may be arranged, to be actuated by movements of other parts of the glove and/or user as well. For example, the actuator module may be disposed in the palm portion of the glove and actuated as the user pushes the actuator thereof by his or her hand or presses the actuator against an object he or she is holding. Similarly, the actuator may be disposed in the backhand portion of the glove and actuated as the user pushes the actuator by his or her other hand or presses such against other objects. In addition, such an actuator module may be operatively coupled to a suit (or body) of the user such that movements of other parts of his or her suit (or body) may actuate the actuator module. Examples of such parts may include, but not be limited to, the wrist portion, arm portion, upper body portion, waist portion, and the like.

It is appreciated that the user may apply various input forces which may act axially, radially or transaxially along the actuator of the actuator module, air pathways of the inlet and or outlet modules, and/or body of the pumping module. Thus, the actuator modules of the above embodiments may have to be arranged to receive such axial, transaxial or radial input forces and/or to exploit the axial, radial or transaxial movements of the glove effected by such input forces, and its actuator may also have to be designed to be actuated by such forces or movements in order to generate the driving force which may also act axially, transaxially or radially upon the deformable or movable portion of the body of the pumping module. When desirable, conventional force-transmitting devices such as universal joints or power-transmitting cable maybe employed in order to change the directions of the input and/or driving forces into a favorable direction. In addition, conventional gears may be employed so as to amplify or to attenuate the input and/or driving forces and conventional energy storage devices may be used so as to store mechanical energy applied by the user and to use such an energy thereafter.

As described above, the ventilating system may include one or more conventional recoil units to absorb at least a portion of the mechanical energy of the user input
force which may be applied to various modules of the system and to utilize such portion of the energy to move or deform the same or different modules from one to the other of the stressed and unstressed positions. For example, such a recoil unit may be incorporated to the pumping module so as to store at least a portion of the energy applied to move or deform the movable or deformable portion of the body of the pumping module from its unstressed (or intake) to stressed (or dispense) position and thereafter to move such a movable or deformable portion of the body back to its unstressed position. Depending upon the configuration, the recoil unit may also be used to move the movable or deformable portion from the unstressed position to the stressed position. Similarly, the recoil unit may further be incorporated into the actuator module to store at least a portion of the mechanical energy applied thereto and to utilize such a portion of the energy to move the actuator module from one to the other of the unstressed and stressed positions. As described above, the body of the pumping module and/or the actuator of the actuator module may be made of elastic materials and/or have elastic configurations to elicit recoil properties. Such a body and/or actuator may also be incorporated with the recoil unit to augment the recoil movements thereof or to provide the recoil force as the body and/or actuator may move from its unstressed position to its stressed position.

[0128] The actuator and/or pumping modules may be arranged to pump air into and out of the body of the pumping module in various temporal arrangements. In its simplest example, the actuator module is arranged to transmit the input force and/or driving force onto the pumping module at least substantially simultaneously with the application of the input force, accounting for a non-negligible but small period of time lag caused by air to fill and flow through various chambers and conduits of the inlet, outlet, and pumping modules. In another embodiment, the actuator module is arranged to transmit the input and/or driving forces onto the pumping module in a preset period of time after receiving the input force. Such an embodiment generally requires at least one energy storage unit and/or elastic chamber which may release the stored mechanical energy over time and/or at an user command. In addition, the ventilating system may incorporate a controller which may control such an energy storage unit to release such energy based on a preset pattern. For example, the actuator module may drive the pumping module to supply air to an elastic chamber in response to the input and/or driving forces, where such an elastic chamber stores the air and thereafter releases the air through the outlet module at a preset flow rate or only after it receives the user command.

[0129] The ventilating system may also include a pumping module which is an electric fan arranged to pump air into and/or out of an interior of a glove. For example, FIG. 8A shows a schematic diagram of an exemplary electric pumping module arranged to transport air in a direction which is transverse to a shaft thereof according to the present invention. An exemplary fan-type pumping module 30 includes a body 42, a rotating shaft 43 disposed in a center of the body 42, and multiple impellers 44 coupled to the shaft 43. At least one air inlet 45 and at least one air outlet 46 are preferably covered to prevent flow of air therethrough and, therefore, to direct air from the air inlet 45 to the air outlet 46. More particularly, such impellers 44 are generally vertically oriented such that air may be pumped inside the body in a direction at least substantially transverse or vertical to the shaft 43 from, e.g., right to left. Alternatively, FIG. 8B describes a schematic diagram of another exemplary electric pumping module arranged to pump air in a direction parallel with its shaft according to the present invention. Such an exemplary fan-type pumping module 30 also includes a body 42, a rotating shaft 43, multiple impellers 44 coupled to the shaft 43 at an angle, and at least one air inlet 45 and at least one air outlet 46 disposed in opposing ends of the body 42. Similar to the above example, a top and a bottom of the body 42 are also preferably covered so that air may be pumped from the air inlet 45 to the air outlet 46. More particularly, such impellers 44 are generally slanted such that air may be pumped inside the body in a direction at least partially parallel with the shaft 43, e.g., either upward or downward. Such electrical pumping modules may be disposed in any location of the glove and the selection of either embodiment of FIG. 9A or 9B may depend upon a space available in such a location. These electric pumping modules 30 may operate by an electric current provided by, e.g., a solar cell assembly disposed thereon and capable of converting solar energy into electrical energy, an internal power supply such as a battery, a rechargeable battery or a generator capable of converting various movements of the glove into the electric current, an external power supply, and so on.

[0130] As described above, the main function of the ventilating system of this invention is to achieve ventilation, i.e., providing fresh air into the interior of the glove by the pumping module and dispensing moist air out of such by the fresh air, or dispensing moist air out of the interior of the glove by such a pumping module and allowing the fresh air to fill the interior thereof by a pressure difference between the interior of the glove and atmosphere. When desirable, conventional dehumidifiers may be installed along the inlet and/or outlet module to remove moist from the air stream fed into the interior of the glove and to reduce humidity thereof. Such a dehumidifier may be constructed as a disposable unit and/or as a rechargeable unit so that the user may discard an old unit and load a new unit whenever the unit is saturated with moist Conversely, conventional humidifiers may be used to add moist into the dry air to control the humidity inside the glove at a proper level. Such humidifiers may be any article such as a wet sponge disposed along the inlet and/or outlet module which may also be refilled with water when dried out. Such an embodiment may be preferable for protection gloves to be used in the desert or other areas of dry weather.

[0131] The ventilating system of the present invention may also be utilized to control a temperature of the air delivered into the interior of the glove, thereby controlling the temperature of such an interior as well. For example, FIG. 9A describes a schematic diagram of an exemplary inlet and/or outlet module with a temperature control unit according to the present invention. An exemplary temperature control unit 90 is comprised of multiple air pathways which include a first or short air pathway 93 and a long or second air pathway 94 and which share a common air inlet 91 and air outlet 92. In this exemplary embodiment, an on-off, needle or control valve 95 is also disposed along the first air pathway 93 such that an amount of air flowing through the first and second pathways 93, 94 may be
controlled by the user. The temperature control unit 90 is incorporated as a part of the inlet and/or outlet module of the ventilating glove and preferably disposed near the hand of the user such that air may absorb thermal energy emitted by the hand.

[0132] In operation, the user puts on the ventilating glove incorporating the above temperature control unit 90. When the user does not want to heat air supplied to an interior of such a glove, the user may open the valve to direct the air through the first air pathway 93. Because the shorter first air pathway 93 has a smaller pneumatic resistance than the longer second air pathway 94, the incoming fresh air may predominantly flow through the shorter first air pathway 93.

In addition, the air may flow through the shorter first air pathway 93 in a relatively shorter period of time and, therefore, may not be able to absorb enough thermal energy to be heated. As the user wants the fresh air to be heated, he or she may close the valve 95, thereby shutting down the first air pathway 93. As the fresh atmospheric air may flow through the longer second air pathway 94 and over a longer period of time, the air may absorb more thermal energy from the hand and achieve a higher temperature. In addition, when the valve 95 is not an off valve but a control valve, the user may control an amount of air flowing through both of the first and second air pathways 93, 94 and heat the air to an optimal temperature.

[0133] Alternatively, FIG. 9B is a schematic diagram of an exemplary inlet and/or outlet module having another temperature control unit according to the present invention. Such an exemplary temperature control unit 90 similarly includes a first or short air pathway 93 and a long or second air pathway 94 sharing a common air inlet 91 and air outlet 92. In this exemplary embodiment, however, a three-way valve 95 is installed in a junction between the air pathways 93, 94 to allow the user to select whether fresh air may flow through the shorter first air pathway 93 or through the longer second air pathway 94. Such a temperature control unit 90 is also incorporated as a part of the inlet and/or outlet module and preferably disposed near the hand of the user so that air may absorb thermal energy emitted by the hand.

[0134] In operation, the user puts on the ventilating glove incorporating the above temperature control unit 90. When the user does not want to heat air supplied to an interior of such a glove, the user may adjust the valve to direct the air through the first air pathway 93. Because the shorter length thereof, the first air passes through the first air pathway 93 without or only minimally being heated. When the user adjusts the valve to direct the air through the second air pathway 94, the air may flow through the longer second air pathway 94 over a longer period of time and absorb more thermal energy from the hand to achieve a higher temperature.

[0135] Configurational and/or operational variations and/or modifications of the above embodiments of the exemplary temperature control units described in FIGS. 9A and 9B also fall within the scope of this Invention. For example, the foregoing short and long air pathways do not have to be coupled to each other and do not have to share the common air inlet and/or outlet. By providing additional air inlets and outlets and by disposing additional valves, amounts of air flowing through independent and uncoupled long and short air pathways may be readily controlled. The temperature control unit may include more than two air pathways and/or multiple valves as well to individually regulate the amounts of air flowing through such air pathways. Moreover, various valves may be disposed in various locations along the pathways as long as such valves may control the amounts of air flowing through at least one of such pathways. As described above, the temperature control unit is generally incorporated into the inlet or outlet module of the ventilation system. However, the temperature control unit may be incorporated as a separate module or different pathways of such a unit may be incorporated into different locations of the ventilating system.

[0136] In order to increase an amount of heat transferred onto the incoming air, the outgoing moist air may be arranged to transfer at least a portion of its thermal energy to the incoming air. For example, the ventilating system may include an additional exhaust module which is arranged to take in moist air from the interior of the glove and to discharge such to atmosphere. By disposing air pathways of the exhaust module adjacent to the air pathways of the inlet and/or outlet module, the incoming fresh air may be able to absorb the thermal energy from the outgoing moist air. Design of such heat exchange mechanisms may be well known to those of ordinary skill in mechanical and/or chemical engineering. In contrary to the foregoing heating mechanism, the incoming air may also be arranged to cool down before it reaches the interior of the glove. For example, those workers subject to a high temperature environment such as steel manufacturing industry may not want to ventilate their gloves with the hot air. The above temperature control unit may then be utilized to discard at least a portion of the thermal energy of the hot incoming air by transferring such to the outgoing moist air.

[0137] The above ventilating system of the present invention may also be incorporated with a variety of cartridges capable of adding molecules contained therein to the incoming air. For example and as described hereinabove, cartridges containing water may be used to increase humidity of the incoming air. In addition, such cartridges may contain antibacterial, antiviral, and/or other pharmaceutical agents and be arranged to add such molecules to the incoming air, e.g., in order to kill microorganisms inside the glove, to suppress growth of such microorganisms, to provide a pharmaceutical treatment to the skin of the hand, and so on. Such cartridges may also include various fragrances to suppress odor inside the glove. Such cartridges may be designed to be disposable such that the user may discard used cartridges and load new ones. Alternatively, such cartridges may include a feeding part through which the user may add water, pharmaceutical agents, and/or fragrances when needed.

[0138] As described herein, the ventilating system of the present invention may be applied to provide various ventilating gloves designed for a variety of purposes. For example, such gloves may be used to protect hands from cold and/or hot weather by, e.g., heating or cooling air supplied to an interior of the gloves. Such gloves may also be used to maintain a humidity of the interior of the gloves under a preset level by, e.g., supplying dry atmospheric air and/or supplying air through a dehumidifier unit to the interior of the glove while dispensing moist air therefrom. Alternatively, such gloves may be used to maintain a humidity of the interior of the gloves above a preset level by, e.g.,
supplying air through a humidifier unit to the interior of the glove. Accordingly, the user may be able to keep his or her hands under a more sanitary and/or comfortable condition than otherwise. In addition, such gloves may be used to maintain a temperature of the interior of the gloves over a preset level or as high as possible by, e.g., heating the incoming air by the thermal energy of the hand, cooling down the incoming air by the hand, and the like. Such gloves of the present invention may further be used to protect the hands from various mechanical, chemical, electrical, magnetic, and/or radioactive hazards, while ventilating air in and out of themselves. Furthermore, the ventilating gloves of the present invention may minimize undesirable growth of microorganisms inside the gloves by reducing the humidity therein.

[0139] It is to be understood that, while various aspects and embodiments of the present invention have been described in conjunction with the detailed description thereof, the foregoing description is intended to illustrate and not to limit the scope of the invention, which is defined by the scope of the appended claims. Other embodiments, aspects, advantages, and modifications are within the scope of the following claims.

What is claimed is:

1. GENERAL CONFIGURATIONS: VENTILATING GLOVES

Pa1. a ventilating glove having a body configured to define at least one opening to receive at least a portion of a hand of an user therethrough and to also define an interior configured to extend from said opening inwardly into said body and to retain said portion of said hand of said user therein comprising:

Ba1.1 Pumping Module and Input Force

at least one pumping module coupling with said body and capable of at least one of supplying air to said interior of said body and dispensing air therefrom by an input force applied by said user.

Ba1.2 Pumping Module and Movement

at least one pumping module coupling with said body and capable of at least one of supplying air to said interior of said body and dispensing air therefrom in response to at least one movement of at least a portion of said body.

Ba1.3 Pumping Module and Actuator Module for Input Force

at least one pumping module coupling with said body and capable of at least one of supplying air to said interior of said body and dispensing air therefrom by a driving force; and

at least one actuator module operatively coupling with said pumping module and configured to receive an input force applied by said user and then to convert said input force into said driving force by changing at least one of an amplitude, a direction, and a timing of application of said input force.

Ba1.4 Pumping Module and Actuator Module for Movement

at least one pumping module coupling with said body and capable of at least one of supplying air to said interior of said body and dispensing air therefrom by a driving force; and

at least one actuator module operatively coupling with said pumping module and configured to convert at least one movement of at least a portion of said body into said driving force by changing at least one of an amplitude, a direction, and a timing of application of an input force which is applied by said user and configured to cause said movement of said portion of said body.

DCs Dependent Claims of Ba1.1 to Ba1.4

D01. said pumping module may be any of the following pumping modules.

D02. said pumping module supplies air thereto in response to said input force and/or movement.

D03. said pumping module dispenses air thereto in response to said input force and/or movement.

D04. said actuator module may be any of the following actuator modules.

D05. said movement of said portion of body may be any of the following movements of said body.

D06. said input force may be applied to any module of said glove.

Pa2. A ventilating glove including a body which has at least one mobile portion and is configured to define at least one opening to receive at least a portion of a hand of an user therethrough, to define an interior extending from said opening inwardly into said body and retaining said portion of said hand of said user therein comprising:

Ba2.1 Pumping Module with Positions and Input Force

at least one, pumping module coupled to said body, configured to operate between at least one on-position and at least one off-position, configured to move from one to the other of said positions by an input force applied by said user, and capable of at least one of supplying air to said interior of said body in one of said positions and dispensing air therefrom in the other of said positions.

Ba2.2 Pumping Module with Positions and Movement

at least one pumping module coupled to said body, configured to operate between at least one on-position and at least one off-position, configured to move from one to the other of said positions in response to at least one movement of said mobile portion of said body, and capable of at least one of supplying air to said interior of said body in one of said positions and dispensing air therefrom in the other of said positions.

Ba2.3 Pumping Module with Positions and Actuator Module for Input Force

at least one pumping module coupled to said body, configured to operate between at least one on-position and at least one off-position, configured to move from one to the other of said positions by a driving
force, and capable of at least one of supplying air to said interior of said body in one of said positions and dispensing air therefrom in the other of said positions; and

at least one actuator module operatively coupling with said pumping module and configured to receive an input force applied by said user and then to convert said input force into said driving force by changing at least one of an amplitude, a direction, and a timing of application of said input force.

**Ba.2.4 Pumping Module with positions and Actuator Module for Movement**

at least one pumping module coupled to said body, configured to operate between at least one on-position and at least one off-position, configured to move from one to the other of said positions by a driving force, and capable of at least one of supplying air to said interior of said body in one of said positions and dispensing air therefrom in the other of said positions; and

at least one actuator module operatively coupling with said pumping module and configured to convert at least one movement of said mobile portion of said body to said driving force by changing at least one of an amplitude, a direction, and a timing of application of an input force which is applied by said user and configured to cause said movement of said mobile portion of said body.

**DCs Dependent Claims of Ba.2.1 to Ba.2.4**

**D01.** said pumping module may be any of the following pumping modules.

**D02.** said pumping module supplies air thereto in response to said input and/or driving force.

**D03.** said pumping module dispenses air therefrom in response to said input and/or driving force.

**D04.** said actuator module may be any of the following actuator modules.

**D05.** said movement of said portion of body may be any of the following movements of said body.

**D06.** said input and/or driving force may be applied to any module of said glove.

2. **SPECIFIC CONFIGURATIONS: VENTILATION SYSTEMS**

**Pa.1 A ventilation system for transporting air in and out of a glove including a body which defines at least one opening for receiving at least a portion of a hand of an user therethrough and which defines an interior extending from said opening inwardly into said body and is configured to retain said portion of said hand of said user, said ventilation system comprising:**

at least one inlet module configured to be one of directly and indirectly coupled to said body, to have at least one inlet air pathway, and to define at least one inlet opening disposed in one end of said inlet air pathway and capable of being in fluid communication with one of said interior of said body and an exterior of said body;

at least one outlet module configured to be one of directly and indirectly coupled to said body, to have at least one outlet air pathway, and to define at least one outlet opening disposed in one end of said outlet air pathway and capable of being in fluid communication with the other of said interior of said body and said exterior of said body;

**Ba.1.1 Inlet, Outlet; Pumping Modules and Input Force+Valve**

at least one pumping module configured to one of directly and indirectly couple with said body, capable of being in fluid communication with the other end of said inlet air pathway and with the other end of said outlet air pathway, and capable of at least one of supplying air from said exterior into said interior of said body and dispensing air from said interior to said exterior of said body through an input force applied by said user, and

**Ba.1.2 Inlet, Outlet, Pumping Module and Movement+Valve**

at least one pumping module configured to one of directly and indirectly couple with said body, capable of being in fluid communication with the other end of said inlet air pathway and with the other end of said outlet air pathway, and capable of at least one of supplying air from said exterior into said interior of said body and dispensing said air from said interior to said exterior of said body in response to at least one movement of at least a portion of said body; and

**Ba.1.3 Inlet, Outlet, Pumping Modules with Positions and Input Force+Valve**

at least one pumping module configured to one of directly and indirectly couple with said body, to operate between at least one on-position and at least one off-position, and to move from one to the other of said positions by an input force applied by said user, and capable of at least one of supplying air from said exterior into said interior of said body in one of said positions and dispensing said air out of said interior to said exterior of said body in the other of said positions; and

**Ba.1.4 Inlet, Outlet, Pumping Modules with Positions and Movement+Valve**

at least one pumping module configured to one of directly and indirectly couple with said body, to operate between at least one on-position and at least one off-position, and to move from one to the other of said positions in response to at least one movement of at least a portion of said body and said glove, and capable of at least one of supplying air to said interior of said body in one of said positions and dispensing air from said interior to said exterior of said body in the other of said positions; and

at least one valve disposed in at least one of said modules and configured to direct said air in a preset direction therealong.
DCs Dependent Claims of Ba1.1 to Ba1.4

D01. said pumping module may be any of the following pumping modules.
D02. said pumping module supplies air thereto in response to said input, force and/or movement.
D03. said pumping module dispenses air therefrom in response to said input force and/or movement.
D04. any of the following actuator modules may be incorporated.
D05. said movement of said portion of body may be any of the following movements of said body.
D06. said input force may be applied to any part of said pumping module.

Pa2. A ventilation system for transporting air in and out of a glove in response to at least one input force applied thereto by an user and including a body defining at least one opening to receive at least a portion of a hand of an user therethrough and further defining an interior configured to extend from said opening inwardly into said body and to retain said portion of said hand of said user therein, said ventilation system comprising:

(at least one inlet module configured to be one of directly and indirectly coupled to said body, to have at least one inlet air pathway, and to define at least one inlet opening disposed in one end of said inlet air pathway and capable of being in fluid communication with one of said interior of said body and an exterior of said body;
at least one outlet module configured to be one of directly and indirectly coupled to said body, to have at least one outlet air pathway, and to define at least one outlet opening disposed in one end of said outlet air pathway and capable of being in fluid communication with the other of said interior of said body and said exterior of said body;

Ba2.1 Inlet, Outlet, Pumping Modules, Actuator Module for Input Force+Valve

(at least one pumping module configured to one of directly and indirectly couple with said body, capable of being in fluid communication with the other end of said inlet air pathway and with the other end of said outlet air pathway, and capable of at least one of supplying air from said exterior to said interior of said body and dispensing air from said interior to said exterior of said body by at least one driving force;

(at least one actuator module operatively coupling with said pumping module and configured to receive said input force and to convert said input force into said driving force by changing at least one of an amplitude, a direction, and a timing of application of said input force; and

(at least one valve disposed in at least one of said modules and configured to direct said air in a preset direction therealong.

Ba2.2 Inlet, Outlet, Pumping Modules, Actuator Module for Movement+Valve

(at least one pumping module configured to one of directly and indirectly couple with said body, capable of being in fluid communication with the other end of said inlet air pathway and with the other end of said outlet air pathway, and capable of at least one of supplying air from said exterior into said interior of said body and dispensing air from said interior to said exterior of said body by at least one driving force;

(at least one actuator module operatively coupling with said pumping module and configured to convert at least one movement of at least a portion of said body into said driving force by changing at least one of an amplitude, a direction, and a timing of application of said input force configured to effect said movement of said portion of said body; and

(at least one valve disposed in at least one of said modules and configured to direct said air in a preset direction therealong.

Ba2.3 Inlet, Outlet, Pumping Modules with Positions, Actuator Module for Input Force+Valve

(at least one pumping module configured to one of directly and indirectly couple with said body, to operate between at least one on-position and at least one off-position, and to move from one to the other of said positions by at least one driving force, capable of being in fluid communication with the other end of said inlet air pathway and with the other end of said outlet air pathway, and capable of at least one of supplying air from said exterior into said interior of said body in one of said positions and dispensing air from said exterior to said interior of said body in the other of said positions;

(at least one actuator module operatively coupling with said pumping module and configured to receive said input force and to convert said input force into said driving force by changing at least one of an amplitude, a direction, and a timing of application of said input force; and

(at least one valve disposed in at least one of said modules and configured to direct said air in a preset direction therealong.

Ba2.4 Inlet, Outlet, Pumping Modules with Positions, Actuator Module for Movement+Valve

(at least one pumping module configured to one of directly and indirectly couple with said body, to operate between at least one on-position and at least one off-position, and to move from one to the other of said positions by at least one driving force, capable of being in fluid communication with the other end of said inlet air pathway and with the other end of said outlet air pathway, and capable of at least one of supplying air from said exterior into said interior of said body in one of said positions and dispensing air from said interior to said exterior of said body in the other of said positions;

(at least one actuator module operatively coupling with said pumping module and configured to convert at least one movement of at least a portion of said body effected by said input force to said driving force by
modulating at least one of an amplitude, a direction, and a timing of application of said input force; and at least one valve disposed in at least one of said modules and configured to direct said air in a preset direction therealong.

DCs Dependent Claims of Ba2.1 to Ba2.4

D01. said inlet and/or outlet pathway may be tubular and/or planar.

D02. said inlet and/or outlet pathway may be rigid and/or deformable (or collapsible).

D03. said pumping module may be any of the following pumping modules.

D04. said pumping module supplies air therethrough to said input and/or driving force.

D05. said pumping module supplies air therefrom to said input and/or driving force.

D06. any of the following actuator modules may be incorporated.

D07. said movement of said portion of body may be any of the following movements of said body.

D08. said input and/or driving force may be applied to any part of said pumping module.

3. SPECIFIC CONFIGURATIONS: PUMPING MODULES

Pa1 A pumping module of a ventilation system for ventilating air in and out of a glove in response to at least one of at least one input air force applied to at least a portion thereof by an user and at least one movement of at least a portion of said glove, wherein said glove has a body forming at least one outer surface and at least one inner surface, defining at least one opening which is configured to receive at least a portion of a hand of said user therethrough, and also defining an interior which is configured to extend inwardly into said body from said opening so as to retain said portion of said hand therein, said pumping module comprising:

Ba1.1 Deformable Pump and Input Force

a chamber which defines at least one inlet for receiving air therethrough and at least one outlet for dispensing air therethrough,

(1) wherein said chamber is configured to be disposed between said outer and inner surfaces of said body, to indirectly receive said input force through at least one of said outer and inner surfaces, and to change its internal volume as a result of deformation of said chamber including at least one of said pleats effected by said input force and wherein said chamber is capable of receiving air through said inlet and dispensing air through said outlet as a result of a change in said internal volume.

(2) wherein a portion of said chamber is configured to be disposed between said outer and inner surfaces of said body, wherein another portion of said chamber is configured to be exposed through said outer surface, wherein said chamber is configured to one of directly and indirectly receive said input force by said another portion and to change its internal volume in response thereto, and wherein said chamber is capable of one of receiving air through said inlet and dispensing said air through said outlet as a result of a change in said internal volume.

(3) wherein said body defines at least one gap space between at least portions of said outer and inner surfaces, wherein at least a portion of said body is configured to undergo said movement and to alter at least one configuration of said gap space in response to said movement, and wherein at least a portion of said chamber is configured to be disposed inside said gap space and is capable of one of receiving air through said inlet and dispensing air through said outlet in response to a change in said configuration of said gap space.

Ba1.2 Bellow Pump and Input Force

a chamber which defines at least one inlet for receiving air therethrough, at least one outlet for dispensing air therethrough, and a plurality of foldable pleats by which said chamber is configured to deform;

(1) wherein said chamber is configured to be disposed between said outer and inner surfaces of said body, to indirectly receive said input force through at least one of said outer and inner surfaces, and to change its internal volume as a result of deformation of said chamber including at least one of said pleats effected by said input force and wherein said chamber is capable of one of receiving air through said inlet and dispensing air through said outlet as a result of a change in said internal volume.

(2) wherein a portion of said chamber is configured to be disposed between said outer and inner surfaces of said body, wherein another portion of said chamber is configured to be exposed through said outer surface, wherein said chamber is configured to one of directly and indirectly receive said input force by said another portion and to change its internal volume in response thereto, and wherein said chamber is capable of one of receiving air through said inlet and dispensing said air through said outlet as a result of a change in said configuration of said gap space.

Ba1.3 Syringe Pump and Input Force

at least one cylinder which defines at least one inlet for receiving air therethrough, at least one outlet for dispensing air therethrough, and a cavity therein; and at least one piston configured to move inside said cavity between at least one intake position and at least one discharge position and capable of taking air into said cavity in said intake position and dispensing air out of said cavity in said discharge position,
(1) wherein said cylinder and piston are configured to be disposed between said outer and inner surfaces of said body, wherein said piston is configured to indirectly receive said input force through at least one of said outer and inner surfaces, to reciprocate along said cavity between said positions in response thereto, and to change an amount of air contained inside said cavity to a maximum value in said intake position and to a minimum value in said discharge position, and wherein said cylinder is configured to receive air through said inlet in said intake position and then to dispense air through said outlet through said outlet in said discharge position due to a change in said volume thereof.

(2) wherein at least a substantial portion of said cylinder is configured to be disposed between said outer and inner surfaces of said body, wherein at least a portion of said piston is configured to be exposed through said outer surface and to directly receive said input force thereby, to reciprocate along said cavity between said positions in response thereto, and to change a volume of said cavity to a maximum value in said intake position and then to a minimum value in said discharge position, and wherein said cylinder is configured to receive air through said inlet in said intake position and then to dispense air through said outlet in said discharge position due to a change in said internal volume.

(3) wherein said body defines at least one gap space between at least portions of said outer and inner surfaces, wherein at least a portion of said body is configured to undergo said movement and to alter at least one configuration of said gap space as a result of said said movement, and wherein at least a portion of at least one of said piston and cylinder is configured to be disposed in said gap space and is capable of one of receiving air through said inlet and dispensing air through said outlet as a result of a change in said configuration of said gap space.

D01. a single opening serves as both of said inlet and outlet openings.

D02. said chamber has a recoil property and/or includes a recoil unit.

D03. said pumping module supplies air thereto in response to said input force.

D04. said pumping module dispenses air therewithin in response to said input force.

D05. said movement of said portion of body may be any of the following movements of said body.

D06. said input force may be applied to any any part of said pumping module.

4. SPECIFIC CONFIGURATIONS: ACTUATOR MODULES

Pa1 An actuator module of a ventilating system for ventilating air in and out of a glove in response to at least one movement of at least a portion of said glove effective by at least one input force applied to at least a portion of said glove by an user, wherein said system has at least one pumping module configured to be coupled to said body of said glove and to pump air into and out of itself, said actuator module comprising:

Ba1.1 General

at least one actuator configured to be operatively coupled to said pumping module, to at least one of deform and move in response to said movement of said portion of said glove, to convert said input force into a driving force which has at least one of an amplitude, a direction, and a timing of application different from that of said input force and which is delivered to said pumping module so as to at least one of pump air thereinto and pump air therefrom.

Ba1.2 Actuator Modules with Positions

at least one actuator configured to be operatively coupled to said pumping module, to at least one of deform and move between at least one on-position and at least one off-position in response to said movement of said portion of said glove, and to convert said input force into a driving force while moving from said off-position to said on-position, wherein said driving force is configured to have at least one of an amplitude, a direction, and a timing of application different from that of said input force and to be delivered to said pumping module in order to at least one of pump air thereinto and pump air therefrom.

Pa2 An actuator module of a ventilation system for ventilating air in and out of a glove in response to at least one movement of at least a portion of said glove effective by at least one input force applied to at least a portion of said glove by an user, wherein said glove includes a body forming at least one finger portion configured to receive at least one finger of a hand of said user, at least one backhand portion, and at least one palm portion and wherein said system includes at least one pumping module configured to be coupled to said body of said glove and to pump air into and out of itself, said actuator module comprising:

Ba1.1 Fisting-Unfisting

at least one actuator configured to be operatively coupled to said pumping module, to at least one of deform and move in response to at least one of a fisting and unfisting movement of at least one of said finger portion, and to convert said input force into a driving force which has at least one of an amplitude, a direction, and a timing of application different from that of said input force and which is delivered to said pumping module so as to at least one of pump air thereinto and pump air therefrom.

Ba1.2 Stretching-Unstretching

at least one actuator configured to be operatively coupled to said pumping module, to at least one of deform and move in response to at least one of a stretching and unstretching movement of at least one of said finger portion, and to convert said input force into a driving force which has at least one of an amplitude, a direction, and a timing of application different from that of said input force and which is delivered to said pumping module in order to at least one of pump air thereinto and pump air therefrom.
Ba1.3 Bending-Unbending
at least one actuator configured to be operatively coupled to said pumping module, to at least one of deform and move in response to at least one of a bending and unbending movement of at least one of said finger portion, and to convert said input force into a driving force which has at least one of an amplitude, a direction, and a timing of application different from that of said input force and is delivered to said pumping module so as to at least one of pump air thereinto and pump air therefrom.

Ba1.4 Squeezing-Relaxing
at least one actuator configured to be operatively coupled to said pumping module, to at least one of deform and move in response to at least one of a squeezing and relaxing movement between said palm portion and at least one of said finger portion, and to convert said input force into a driving force which has at least one of an amplitude, a direction, and a timing of application different from that of said input force and which is delivered to said pumping module to at least one of pump air thereinto and pump air therefrom.

Ba1.5 Interfinger Squeezing
at least one actuator configured to be operatively coupled to said pumping module, to at least one of deform and move in response to at least one of a squeezing and relaxing movement between a plurality of said finger portions, and to convert said input force into a driving force which has at least one of an amplitude, a direction, and a timing of application different from that of said input force and which is delivered to said pumping module in order to at least one of pump air thereinto and pump air therefrom.

5. GENERAL METHODS

Pm1 A method of ventilating air into and out of a glove defining an interior comprising the steps of:

Bm1.1 Simplest
supplying fresh air from atmosphere into said interior of said glove; and

dispensing moist air inside said interior of said glove out of said interior thereof.

Bm1.2 Active Pumping module
providing a pumping module capable of pumping air thereinto and therefrom; and

supplying fresh atmospheric air into said interior of said glove by said pumping module; and

replacing moist air inside said interior of said glove therefrom by said fresh air.

Bm1.3 Active Pumping module
providing a pumping module capable of pumping air thereinto and therefrom; and

dispensing moist air in said interior of said glove therefrom by said pumping module; and

allowing fresh air to flow into said interior of said glove.

Pm2 A method of ventilating air into and out of a glove defining an interior comprising the steps of:

Bm2.1 Active Pumping
providing a pumping module capable of pumping air thereinto and therefrom; and

manipulating said pumping module so as to pump fresh air from atmosphere into said interior of said glove while pushing out moist air inside said interior of said glove therefrom by said fresh air.

Bm2.2 Passive Pumping
providing a pumping module capable of pumping air thereinto and therefrom; and

manipulating said pumping module so as to pump out moist air inside said interior of said glove to atmosphere, thereby allowing fresh air to move into said interior of said glove.

Pm3 A method of controlling humidity of air in an interior of a glove comprising the steps of:

Bm3.1 Active Pumping
providing a pumping module capable of pumping air thereinto and therefrom; and

manipulating said pumping module in order to pump dry air from atmosphere into said interior of said glove while pushing out moist air in said interior of said glove therefrom by said dry atmospheric air, thereby controlling said humidity approximately at a level of said atmosphere.

Bm3.2 Passive Pumping
providing a pumping module capable of pumping air thereinto and therefrom;

manipulating said pumping module in order to pump out moist air in said interior of said glove to atmosphere; and

allowing dry air in atmosphere to move into said interior of said glove, thereby controlling said humidity approximately at a level of said atmosphere.

Pm4 A method of controlling temperature of air ventilated into an interior of a glove comprising the steps of:

Bm4.1 Different Lengths
providing a plurality of air pathways for flowing air therethrough and having different lengths;

disposing said air pathways adjacent to said interior of said glove;

allowing air to absorb thermal energy from said interior while flowing through said plurality of said air pathways for different temporal durations due to said different lengths thereof; and

selecting one of said air pathways, thereby controlling said temperature of air flowing through said one of said air pathways.
Bm4.2 Heat Exchange between Air

providing at least one first air pathway for flowing fresh air into said interior of said glove;

providing at least one second air pathway for flowing moist air out of said interior thereof; and

disposing said first and second air pathways adjacent to each other, thereby allowing a heat exchange between said fresh air and said moist air.

6. PRODUCTS-BY-PROCESSES

Modify preambles of other apparatus claims of the foregoing [1] to [4]

Then use bodies of any method claims of the foregoing [5]

DCs Dependent Claims

Same as those for the apparatus claims and/or method claims of the foregoing [1] to [4]

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