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Apparatus and method for filtering

Abstract

Embodiments of the present disclosure provide an apparatus and method for evacuation. An exemplary apparatus includes a trocar comprising an inlet at a distal end and an exit port at a proximal end, the inlet and the exit port are fluidly connected by a tubular hollow body circumscribing a cavity extending through a longitudinal axis of the trocar, the trocar includes a filter maintained within the cavity operable to filter at least one of fluid and particulates from a flow passing through the cavity. The apparatus further includes a vacuum source fluidly connected to the exit port, the vacuum source operable to pull at least one of fluid and particulates through the inlet, the cavity and the exit port.

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Background/Summary

BACKGROUND OF THE INVENTION

Field of the Invention

(1) Embodiments of the present disclosure relate generally to an apparatus and method for evacuation. The embodiments of the present disclosure relate more particularly to an apparatus and method for evacuation of smoke and particulates during medical procedures.

Description of Related Art

(2) During a medical procedure surgical smoke, plume and/or aerosol can be created. This can occur when a laser or electrosurgical energy is delivered to a cell. When this occurs heat is created. This heat vaporizes the intracellular fluid, which can increase the pressure within the cell. The pressure can cause the cell membrane to burst. When the cell membrane bursts, a plume of smoke containing gas including water vapor is released into the atmosphere of the location of the medical procedure. Simultaneously, the heat created may char the protein and other organic matter within the cell. This can cause thermal necrosis in cells adjacent to the cell with the collapsed membrane. The charring of cells may also release other harmful contaminants into the atmosphere. Examples of such contaminants include carbonized cell fragments and gaseous hydrocarbons.

BRIEF SUMMARY OF THE INVENTION

(3) In view of the foregoing, it is an object of the present disclosure to provide a method and apparatus for evacuation.

(4) A first exemplary embodiment of the present disclosure provides an apparatus for evacuation.

The apparatus includes a trocar including an inlet at a distal end and an exit port at a proximal end, the inlet and the exit port are fluidly connected by a tubular hollow body circumscribing a cavity extending through a longitudinal axis of the trocar, the trocar includes a filter maintained within the cavity operable to filter at least one of fluid and particulates from a flow passing through the cavity. The apparatus further includes a vacuum source fluidly connected to the exit port, the vacuum source operable to pull at least one of fluid and particulates through the inlet, the cavity and the exit port.

(5) A second exemplary embodiment of the present disclosure provides a method of providing. The method includes providing trocar comprising an inlet at a distal end and an exit port at a proximal end, the inlet and the exit port are fluidly connected by a tubular hollow body circumscribing a cavity extending through a longitudinal axis of the trocar, the trocar includes a filter maintained within the cavity operable to filter at least one of fluid and particulates from a flow passing through the cavity. The method further includes providing a vacuum source fluidly connected to the exit port, the vacuum source operable to pull at least one of fluid and particulates through the inlet, the cavity and the exit port.

(6) A third exemplary embodiment of the present disclosure provides a trocar assembly. The trocar assembly includes a hollow body having longitudinal axis bound by a distal end and a proximal end, the hollow body defining a cavity extending through the longitudinal axis of the hollow body. The trocar assembly further includes an inlet disposed at the distal end, and an exit port disposed at the proximal end, the exit port fluidly connected to inlet by the cavity. The trocar assembly still further includes a filter holder disposed within the cavity, the filter holder operable to maintain a filter media.

(7) The following will describe embodiments of the present disclosure, but it should be appreciated that the present disclosure is not limited to the described embodiments and various modifications of the disclosure are possible without departing from the basic principles. The scope of the present disclosure is therefore to be determined solely by the appended claims.

Description

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

(1) FIG. **1** presents a perspective view of an exemplary device suitable for use in performing exemplary embodiments of the present disclosure.

(2) FIG. **2** presents a logic flow diagram in accordance with a method and apparatus for performing exemplary embodiments of the present disclosure.

(3) FIG. **3** presents a side view of an exemplary device suitable for use in performing exemplary embodiments of the present disclosure.

(4) FIG. **4** presents a close-up cross-sectional view of an exemplary device suitable for use in performing exemplary embodiments of the present disclosure.

DETAILED DESCRIPTION OF THE INVENTION

(5) Embodiments of the present disclosure provide a trocar assembly fluidly coupled to a vacuum source operable to evacuate gas, smoke, fluids and/or particulates from a surgical area or cavity, such as a body cavity. Embodiments provide that the trocar assembly is operable to be placed partially within a body cavity and when coupled to a vacuum source can evacuate smoke, fluids and/or particulates from the body cavity. Embodiments further provide that the trocar assembly is operable to be placed partially within a body cavity and is operable to passively allow fluid, smoke, gas, and/or particulates to pass through the trocar assembly. Embodiments of trocar assembly is operable to evacuate smoke, fluid and/or particulates by both pressure provided by the body cavity and pressure provided by an external vacuum source. Embodiments of trocar assembly is operable to filter out fluid, contaminants, smoke and/or particulates from a flow that passes through a hollow

cavity within trocar assembly. Embodiments provide that trocar assembly is operable to provide a positive flow rate pressure between 0 mmHg to 20 mmHg and allows a leak rate of 0 liters to 12 liters. Embodiments of vacuum source is operable to provide vacuum pressure between 100 mmHg to 600 mmHg.

(6) Referring to FIG. **1** shown is an exemplary trocar assembly **100** in accordance with embodiments of the present disclosure. Trocar assembly **100** includes a hollow body **102** defining a cavity **104**, and a longitudinal axis **106** bound by a distal end **108** and a proximal end **110**. Hollow body **102** includes a radial exterior surface **126** (shown in FIG. **3**) and a radial interior surface **103**. The radial interior surface **103** defines the outer most radial edge of cavity **104**. The trocar assembly **100** includes an inlet **112** located at the distal end **108** of the trocar assembly **100**. The inlet **112** provides a passageway from the outside environment to the cavity **104** within the hollow body **102**. The trocar **100** also includes an exit port **114** located at the proximal end **110** of the trocar assembly **100**. The exit port **114** provides a passageway from the cavity **104** within the hollow body **102** to the outside environment. The inlet **112**, the cavity **104** and the exit port **114** are fluidly connected to one another such that gas, fluid and/or particulates are able to pass through the inlet **112**, the cavity **104** and the exit port **114**. Embodiments of trocar assembly **100** also include an outlet **115**. Outlet **115** is fluidly connected to cavity **104** and inlet **112** such that gas, fluid and/or particulates are able to pass through the inlet **112**, cavity **104** and outlet **115**. As shown in FIGS. **1** and **3**, outlet **115** can be fluidly connected to tube **117**. In some embodiments, tube **115** is operably and fluidly connected to a vacuum source **128** (shown in FIG. **3**) such that vacuum source **128** can urge, suction and/or evacuate fluid, gas and/or particulates through inlet **112**, cavity **104**, outlet **115** and tube **115**. It should be appreciated that embodiments of vacuum source **128** also include the ability insufflate. In other words, vacuum source **128** is operable to create a flow of gas, fluid and/or particulates through inlet **112**, cavity **104**, outlet **115** and tube **117** in a direction toward or away from vacuum source **128**.

(7) Within the cavity **104** of the hollow body **102** of trocar assembly **100** is a filter holder **116**. The filter holder **116** is operable maintain one or more a filters **118** operable to remove or filter out gas, fluid and/or particulates including smoke and other contaminates that pass through the cavity **104** and the filter **118**. As shown in FIG. **4**, embodiments of filter holder **116** include a rib, lip or rim **132** located along the radial interior surface **103** of body **102**. Rib, lip or rim **132** provides a raised surface that circumscribes the radial interior surface **103** of body **102** at the same position within body **102** with respect to the longitudinal axis **106**. In this regard, embodiments include all portions of filter **118** and filter holder **116**, respectively, being equally spaced from the distal end **108**. Embodiments include filter **118** and filter holder **116** being angled with respect to the longitudinal axis **106** such that a portion of filter **118** and filter holder **116** is closer to the distal end **108** than other portions of filter **118** and filter holder **116**. In this embodiment, filter holder **116** creates a physical obstruction preventing movement of filter **118** within cavity **104**. It should be appreciated that embodiments of filter holder **116** include one or more ribs, lips or rims such that filter **118** is secured in a particular location within cavity **104** thereby preventing movement of filter **118** when a flow of gas, fluid, and/or particulates pass through cavity **104** and filter **118**.

(8) Embodiments of filter **118** include a corresponding catch or channel **130** that is operable to interface with the rib, lip or rim **132** of filter holder **116** thereby creating a friction fit between filter **118** and filter holder **116**. It should be understood that FIG. **4** depicts filter **118** and filter **116** being spaced from one another along the longitudinal axis **106** for purposes of illustrating the elements trocar assembly **100**. However, in practice filter **118** with catch **130** can be located in contact with filter holder **116** and rib **132** such that catch **130** corresponds to rib **132**. Embodiments of filter **118** thus provide that filter **118** and catch or ridge **130** is operable to flex such that filter **118** can be removeably and fixedly located within filter holder **116**, but not flex or move to the extent that filter **118** moves during use. In other words, embodiments provide that filter **118** is operable to flex such that it can be fixedly placed in filter holder **116**, but is also ridged enough to cause all gas, fluid,

and/or particulates that pass from inlet **112** to outlet **115** or exit port **114** to also pass through filter **118** rather than around it.

(9) It should also be appreciated that embodiments include filter **118** being fixedly and not removeably attached to filter holder **116**. In this embodiment, filter **118** can be affixed to filter holder **116** and/or the radial interior surface **103** through the use of glue or other adhesive known in the art. Embodiments of the filter **118** include a filtration media membrane that is operable to allow a flow of gas through the filter **118**, but is operable to trap particulates, certain types of gas and/or fluids. Embodiments of filter media include fiber, glass and non-woven materials.

(10) The trocar assembly **100** includes a hollow body **102** with an inlet **112** for receiving air from an evacuator and/or insufflator. In this regard, trocar assembly **100** is operable to have air, gas, and/or fluids passed from an insufflator to outlet **115** through cavity **104** and out inlet **112** into a patient's body or surgical site **101**. Trocar assembly **100** is also operable to air, gas, fluids, and/or particulates pass from a patient's body or surgical site **101** through inlet **112** through cavity **104** and out outlet **115**. Trocar assembly is also operable to allow air, gas, and/or fluids to pass through the exit port **114**, the cavity **104** and the inlet **112**. The trocar **100** can include a tool entry port **120** with a one-way gasket disposed therein. The trocar **100** includes a tool exit port **122** at the distal end **108** of the trocar assembly **100**. Embodiments of trocar assembly **100** include a plurality of holes or passageways **124** (shown in FIG. **3**) located adjacent inlet **112** around the radial exterior surface **126** of body **102**. Passageways **124** provide a passageway from the radial exterior surface **126** of body **102** to cavity **104** and exit port **114**. It should be appreciated that embodiments of the present disclosure include trocar assembly **100** not having passageways **124** and having a uniform solid radial exterior surface **126** extending throughout the longitudinal axis **106** of body **102**.

(11) In practice, the trocar assembly **100** is inserted through an incision in a patient during a medical procedure to provide a pathway to a cavity inside the body of a patient. The insufflation air from vacuum source **128** passes through trocar assembly **100** into the cavity of the patient. A tool can also pass through trocar assembly **100** via exit port **114**, cavity **104** and tool exit port **122**, however, it should be appreciated that embodiments include trocar assembly **100** only being used for insufflation and/or evacuation of gas from the surgical site. The insufflation air from vacuum source **128** keeps the cavity in the patient pressurized to enlarge the surgical area for a surgical or diagnostic procedure conducted through an entry site. Surgical and/or diagnostic tools may be introduced into the cavity of the patient through the trocar **100**. A scope inserted through the trocar **100** may provide imaging of the area inside the cavity.

(12) An electrosurgical device may be inserted through the trocar **100** to enable the user to perform a surgical procedure inside the cavity of the patient. The removal of surgical smoke from the cavity of the patient may be desired in the case of electrocautery of electrosurgical procedures that produce surgical smoke.

(13) Surgical smoke can be removed from the cavity of the patient through the cavity **104** of the trocar assembly **100**. When vacuum source **128** is activated it can urge or suction gas, fluids and/or particulates to pass from the cavity within the patient through inlet **112**, cavity **104**, outlet **115** and tube **117**. As the flow of gas, fluids, and/or particulates pass through cavity **104** they pass through filter **118** wherein filter **118** operably filters out particular gases, fluids and/or particulates from the flow. Alternatively, the exit port **114** or outlet **115** of the trocar assembly **100** can be maintained in an open position to allow a passive flow of gas from the cavity of the patient. In this embodiment, the passive flow of gas occurs because there is a pressure differential between the gas inside of the patient the surrounding atmosphere such that the higher pressure from within the cavity of the patient causes gas, fluids and/or particulates to flow from the cavity of the patient through trocar assembly **100** to the surrounding atmosphere.

(14) For the embodiment that the outlet **115** of the trocar assembly **100** is connected to a vacuum source **128**, the vacuum source **128** is operable to create a pressure urging a flow of fluid, smoke and/or particulates to pass through the inlet **112**, the cavity **104** and the outlet **115** of the trocar

assembly **100**. Filter **118** can be permanently affixed to filter holder **116** within cavity **104** of trocar assembly **100** or can be removeably affixed to filter holder **116** prior to activation of vacuum source **128**. Filter **118** is thus operable to remove contaminates, particulates and/or liquid from the flow. In the embodiment that trocar assembly **100** is not connected to a vacuum source, trocar assembly **100** is operable to allow a flow of fluid and/or particulates when the exit port **114** gasket is in an open position. In this embodiment trocar assembly **100** is operable to allow a flow until the internal pressure within the cavity of the patient reaches a predetermined threshold. Embodiments provide that exit port **114** can be configured to an open position, a closed position or an intermediate position wherein a flow is partially obstructed.

(15) Reference is now made to FIG. **2**, which presents a summary of the above teachings. Block **200** presents providing trocar comprising an inlet at a distal end and an exit port at a proximal end, the inlet and the exit port are fluidly connected by a tubular hollow body circumscribing a cavity extending through a longitudinal axis of the trocar, the trocar includes a filter maintained within the cavity operable to filter at least one of fluid and particulates from a flow passing through the cavity; and (b) providing a vacuum source fluidly connected to the exit port, the vacuum source operable to pull at least one of fluid and particulates through the inlet, the cavity and the exit port. Then block **202** specifies wherein the trocar and the vacuum source is operable to provide a positive pressure flow rate through the inlet, the cavity and the exit port of between 0 mmHg to 22 mmHg.

(16) Following block **202**, block **204** states wherein the filter comprises a filter media membrane. Block **206** relates wherein the filter is comprised of at least one of fiber, glass, and non-woven materials. Next, block **208** indicates wherein the trocar passively allows a flow of the at least one of fluid and particulates through the inlet, the cavity, and the exit port when the vacuum source is not creating a vacuum. Block **210** states wherein the filter further comprises a liquid trap and a filter media. Then block **212** specifies wherein the exit port comprises a gasket operable to allow a flow of the least one of fluid and particulates in a first position and obstruct a flow of the at least one of fluid and particulates in a second position.

(17) The logic diagram on FIG. **2** may be considered to illustrate the operation of a method. The logic diagram may also be considered a specific manner in which components of a device are configured to be provided, whether such a device is an apparatus, a trocar assembly, a vacuum source, or one or more components thereof.

(18) It is to be understood that any feature described in relation to any one embodiment may be used alone, or in combination with other features described, and may also be used in combination with one or more features of any other of the embodiments, or any combination of any other of the embodiments. Furthermore, equivalents and modifications not described above may also be employed without departing from the scope of the invention, which is defined in the accompanying claims.

(19) This disclosure has been described in detail with particular reference to a presently preferred embodiment, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention. The presently disclosed embodiments are therefore considered in all respects to be illustrative and not restrictive. The scope of the invention is indicated by the appended claims, and all changes that come within the meaning and range of equivalents thereof are intended to be embraced therein.

Claims

1. An apparatus for evacuation, the apparatus comprising: a trocar comprising an inlet at a distal end, an outlet, and an exit port at a proximal end, the inlet, the outlet, and the exit port are fluidly connected by a tubular hollow body circumscribing a cavity extending through a longitudinal axis of the trocar, the trocar includes a filter maintained within the cavity operable to filter at least one of fluid and particulates from a flow passing through the cavity, wherein the filter further comprises

a liquid trap operable to filter liquid and a filter media operable to filter particulate materials; and a vacuum source fluidly connected to the exit port, the vacuum source operable to pull at least one of fluid and particulates from the cavity through the inlet, the cavity and the outlet, wherein the trocar passively allows a flow of the at least one of fluid and particulates through the inlet, the cavity, and the outlet when the vacuum source is in an off position, wherein the trocar passively allows a flow of the at least one of fluid and particulates through the inlet, the cavity, and the exit port when the exit port is in an open position, and wherein the exit port is operable to allow a surgical tool to pass through the exit port to the cavity and the inlet.

2. The apparatus according to claim 1, wherein the trocar and the vacuum source are operable to provide a positive pressure flow rate through the inlet, the cavity and the exit port of between 0 mmHg to 22 mmHg.

3. The apparatus according to claim 1, wherein the filter media comprises a filter media membrane.

4. The apparatus according to claim 1, wherein the vacuum source is operable to provide pressure between 100 mmHg to 600 mmHg.

5. The apparatus according to claim 1, wherein the filter is comprised of at least one of fiber, glass, and non-woven materials.

6. The apparatus according to claim 1, wherein the outlet comprises a gasket operable to allow a flow of the least one of fluid and particulates in a first position and obstruct a flow of the at least one of fluid and particulates in a second position.

7. A method of forming, the method comprising: (a) forming a trocar comprising an inlet at a distal end, an outlet, and an exit port at a proximal end, the inlet and the exit port are fluidly connected by a tubular hollow body circumscribing a cavity extending through a longitudinal axis of the trocar, the trocar includes a filter maintained within the cavity operable to filter at least one of fluid and particulates from a flow passing through the cavity, wherein the filter further comprises a liquid trap operable to filter liquid and a filter media operable to filter particulate materials; and (b) connecting a vacuum source fluidly to the outlet, the vacuum source operable to pull at least one of fluid and particulates through the inlet, the cavity and the outlet, wherein the trocar passively allows a flow of the at least one of fluid and particulates through the inlet, the cavity, and the outlet when the vacuum source is in an off position, wherein the trocar passively allows a flow of the at least one of fluid and particulates through the inlet, the cavity, and the exit port when the exit port is in an open position, and wherein the exit port is operable to allow a surgical tool to pass through the exit port to the cavity and the inlet.

8. The method according to claim 7, wherein the trocar and the vacuum source are operable to provide a positive pressure flow rate through the inlet, the cavity and the exit port of between 0 mmHg to 22 mmHg.

9. The method according to claim 7, wherein the filter media comprises a filter media membrane.

10. The method according to claim 7, wherein the filter is comprised of at least one of fiber, glass, and non-woven materials.

11. The method according to claim 7, wherein the outlet comprises a gasket operable to allow a flow of the least one of fluid and particulates in a first position and obstruct a flow of the at least one of fluid and particulates in a second position.

12. A trocar assembly comprising: a hollow body having a longitudinal axis bound by a distal end and a proximal end, the hollow body defining a cavity extending through the longitudinal axis of the hollow body; an inlet disposed at the distal end; an outlet disposed at the proximal end, the outlet fluidly connected to the inlet by the cavity; an exit port disposed at the proximal end, the exit port fluidly connected to the inlet by the cavity; and a filter holder disposed within the cavity, the filter holder operable to maintain a filter, wherein the filter further comprises a liquid trap operable to filter liquid and a filter media operable to filter particulate materials, and wherein the trocar assembly passively allows a flow of at least one of fluid and particulates through the inlet, the cavity, and the exit port when a vacuum source fluidly coupled to the exit port is in an off position,

and wherein the trocar passively allows a flow of the at least one of fluid and particulates through the inlet, the cavity, and the exit port when the exit port is in an open position, and wherein the exit port is operable to allow a surgical tool to pass through the exit port to the cavity and the inlet.