



US010393363B2

(12) **United States Patent**
Weaver et al.

(10) **Patent No.:** **US 10,393,363 B2**
(45) **Date of Patent:** **Aug. 27, 2019**

(54) **ILLUMINATION DEVICE FOR A FLUID DELIVERY APPARATUS**

F21V 23/0471 (2013.01); *F21S 10/00* (2013.01); *F21V 23/0442* (2013.01); *F21W 2131/30* (2013.01); *F21Y 2103/33* (2016.08); *F21Y 2115/10* (2016.08); *H05K 1/181* (2013.01);

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(Continued)

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(58) **Field of Classification Search**

CPC .. *F21V 33/004*; *F21V 7/0066*; *F21V 23/0464*; *F21V 23/0471*; *F21V 23/0442*; *F21S 9/046*; *F21S 10/002*; *F21S 10/00*; *E03C 1/02*; *B05B 1/185*; *F21Y 2103/33*; *F21Y 2115/10*; *H05K 2201/10106*; *H05K 1/181*; *H05K 2201/10287*; *H05K 2201/10522*; *F21W 2131/30*; *A61L 2209/12*

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See application file for complete search history.

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(21) Appl. No.: **15/958,674**

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(65) **Prior Publication Data**

US 2018/0306430 A1 Oct. 25, 2018

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(60) Provisional application No. 62/490,008, filed on Apr. 25, 2017.

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(51) **Int. Cl.**

B05B 1/18 (2006.01)
E03C 1/02 (2006.01)
F21S 9/04 (2006.01)
F21V 7/00 (2006.01)
H05K 1/18 (2006.01)

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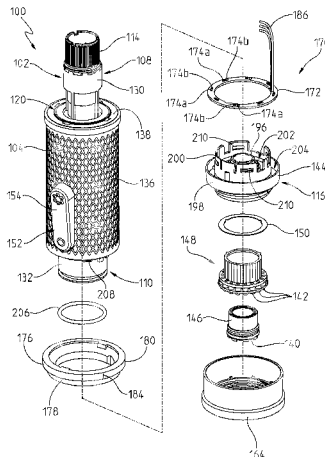
(57) **ABSTRACT**

(52) **U.S. Cl.**

CPC *F21V 33/004* (2013.01); *B05B 1/185* (2013.01); *E03C 1/02* (2013.01); *F21S 9/046* (2013.01); *F21S 10/002* (2013.01); *F21V 7/0066* (2013.01); *F21V 23/0464* (2013.01);

A sprayhead for dispensing water includes a housing and an illumination device supported by the housing. The illumination device includes a plurality of light emitters supported by a substrate, and a translucent light pipe defining a closed loop to diffuse light outwardly from the light emitters.

24 Claims, 11 Drawing Sheets



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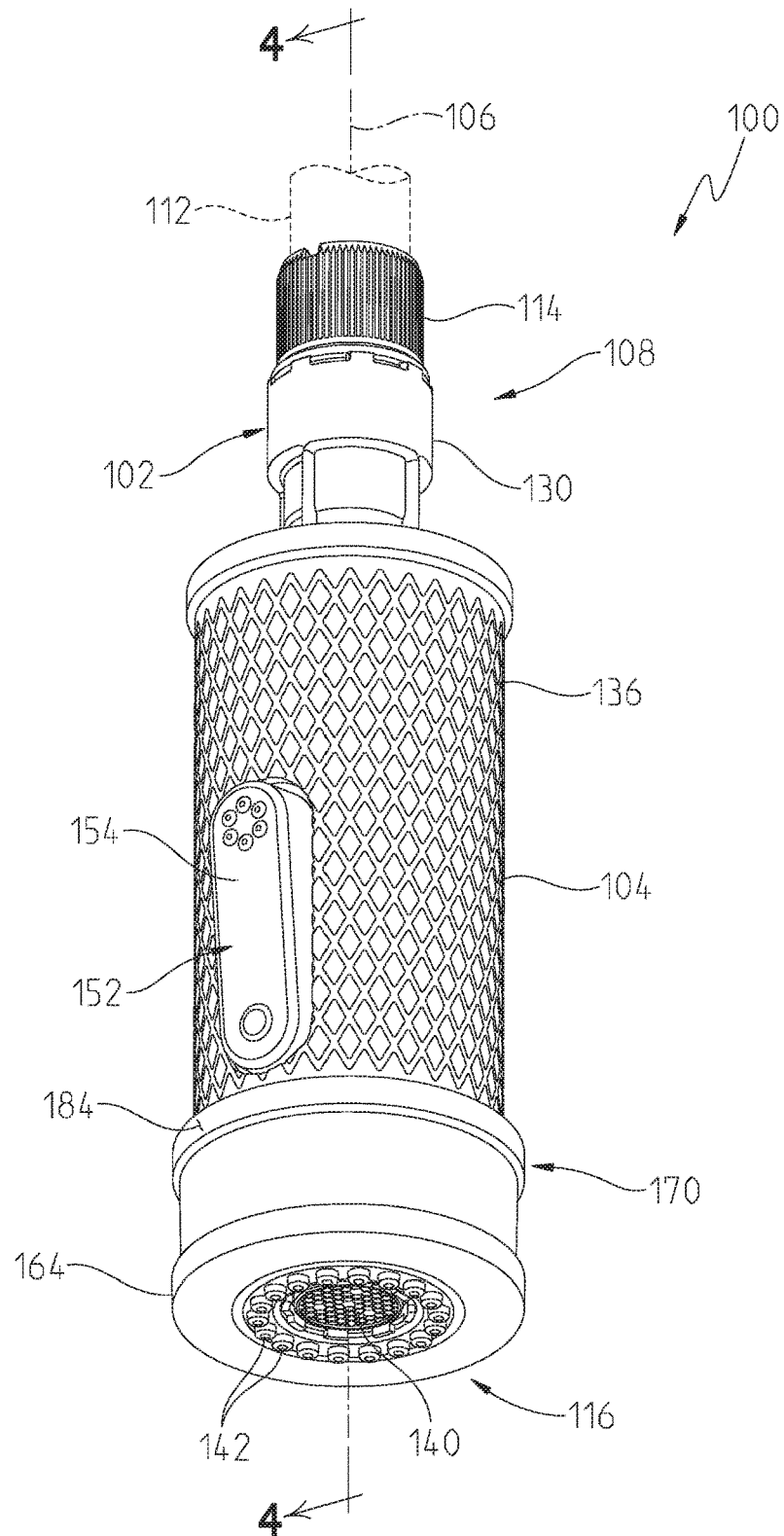
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Fig. 1



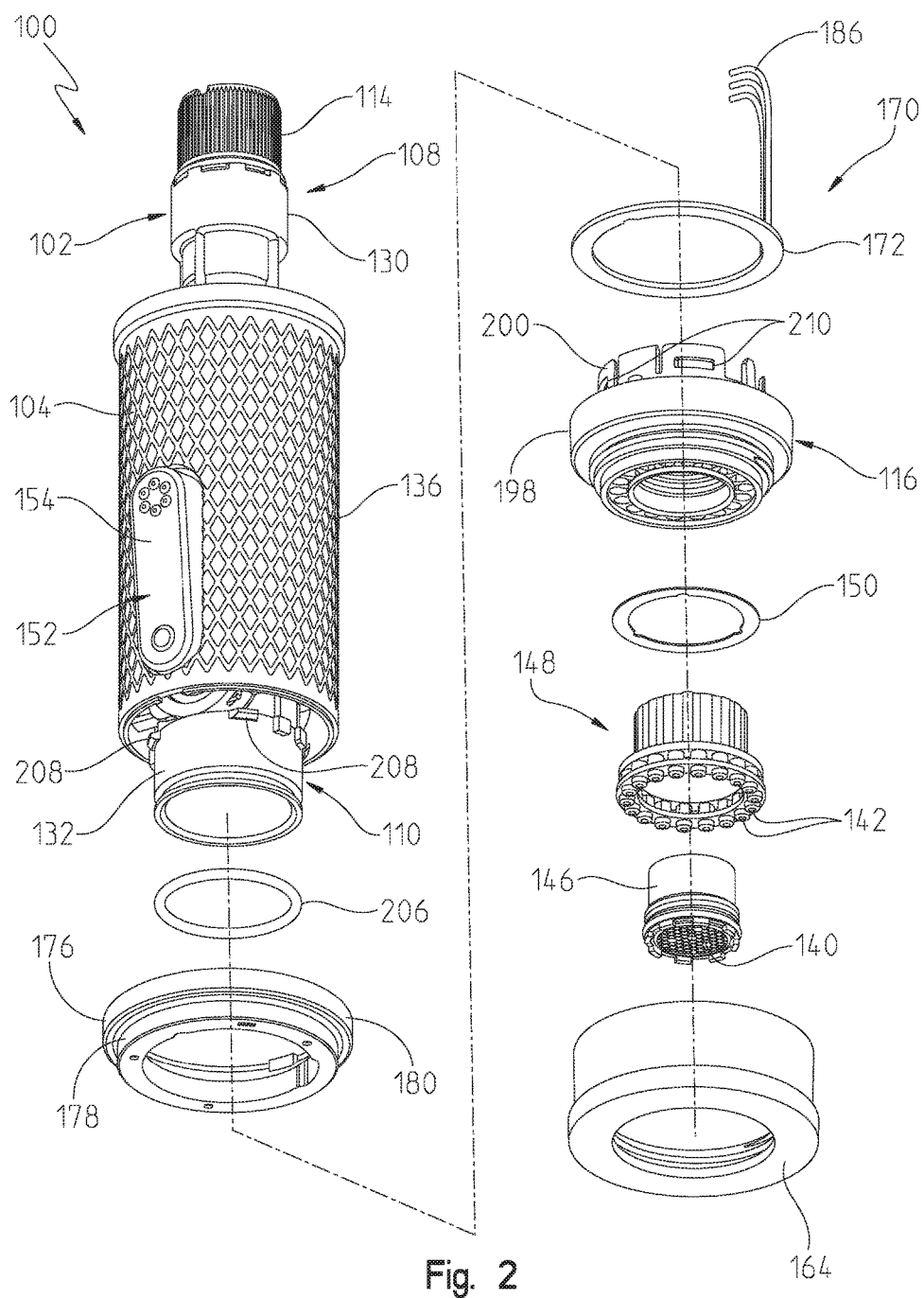


Fig. 2

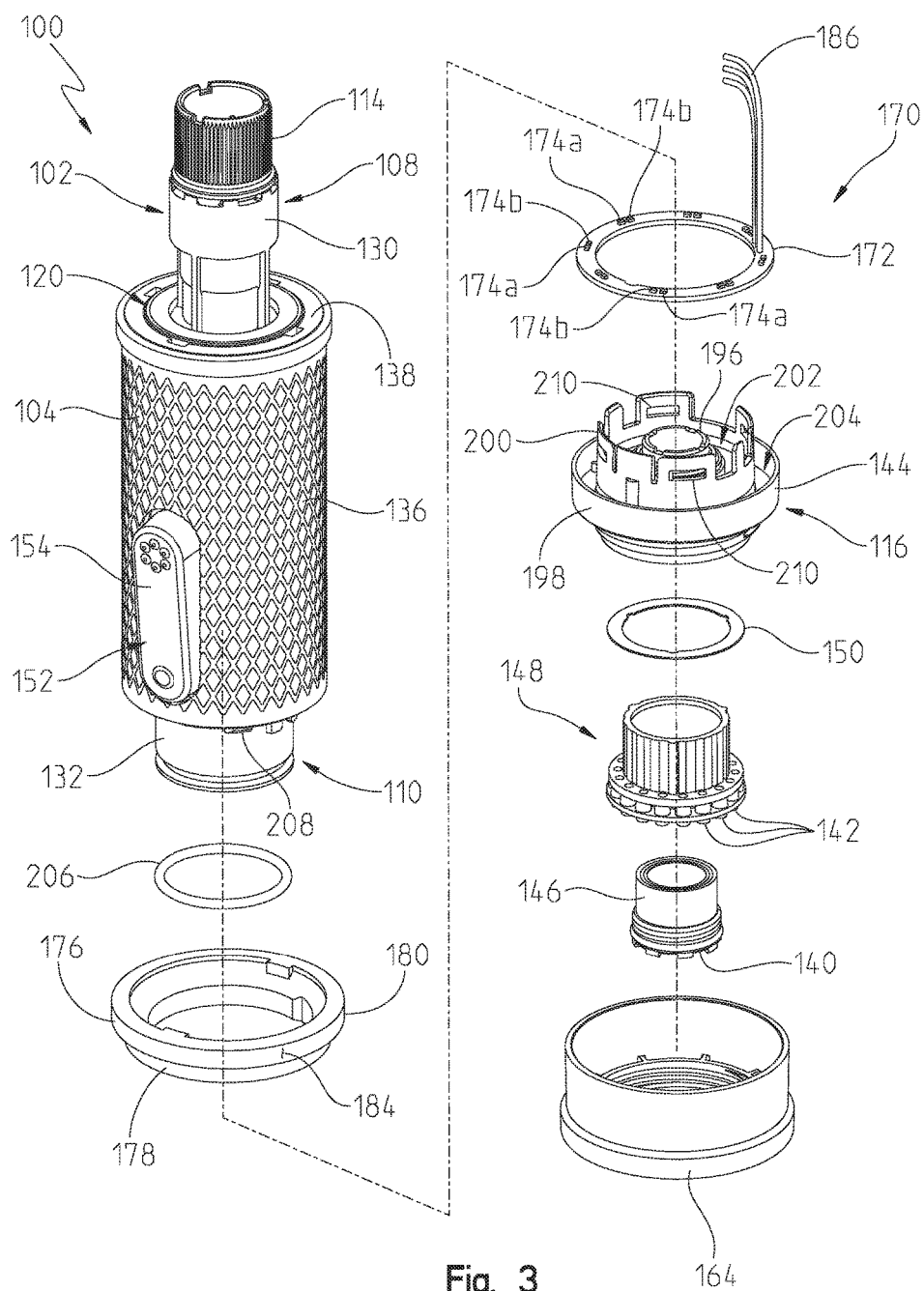


Fig. 3

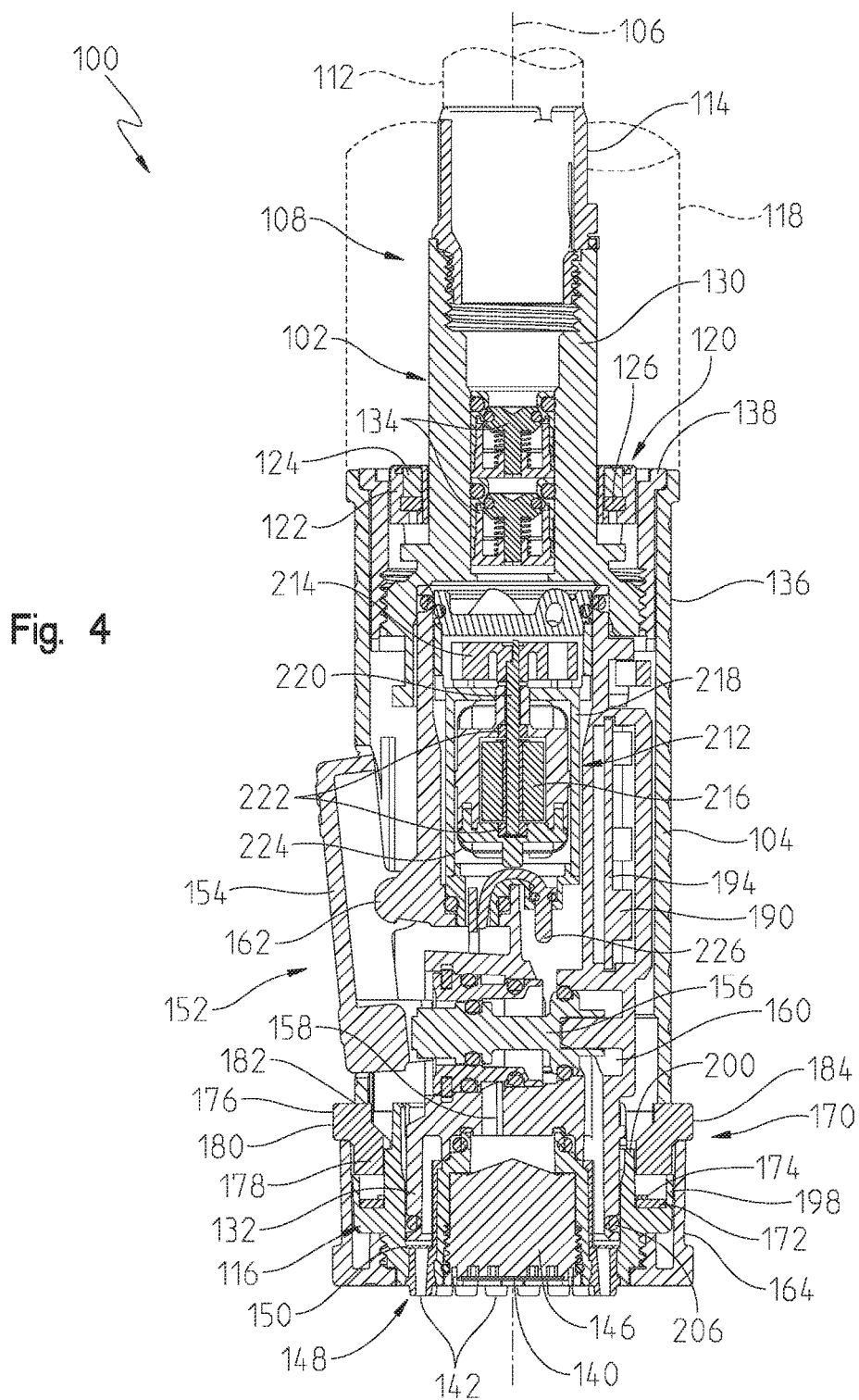


Fig. 4

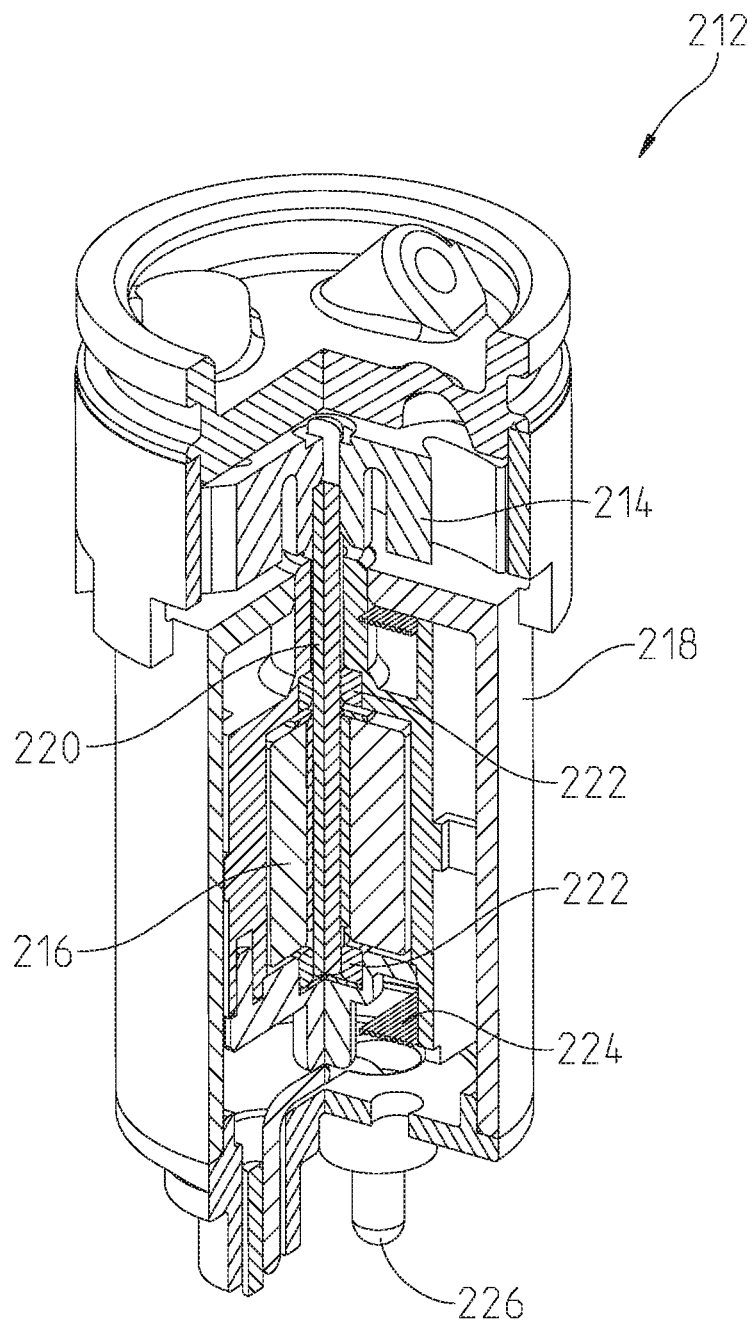


Fig. 5

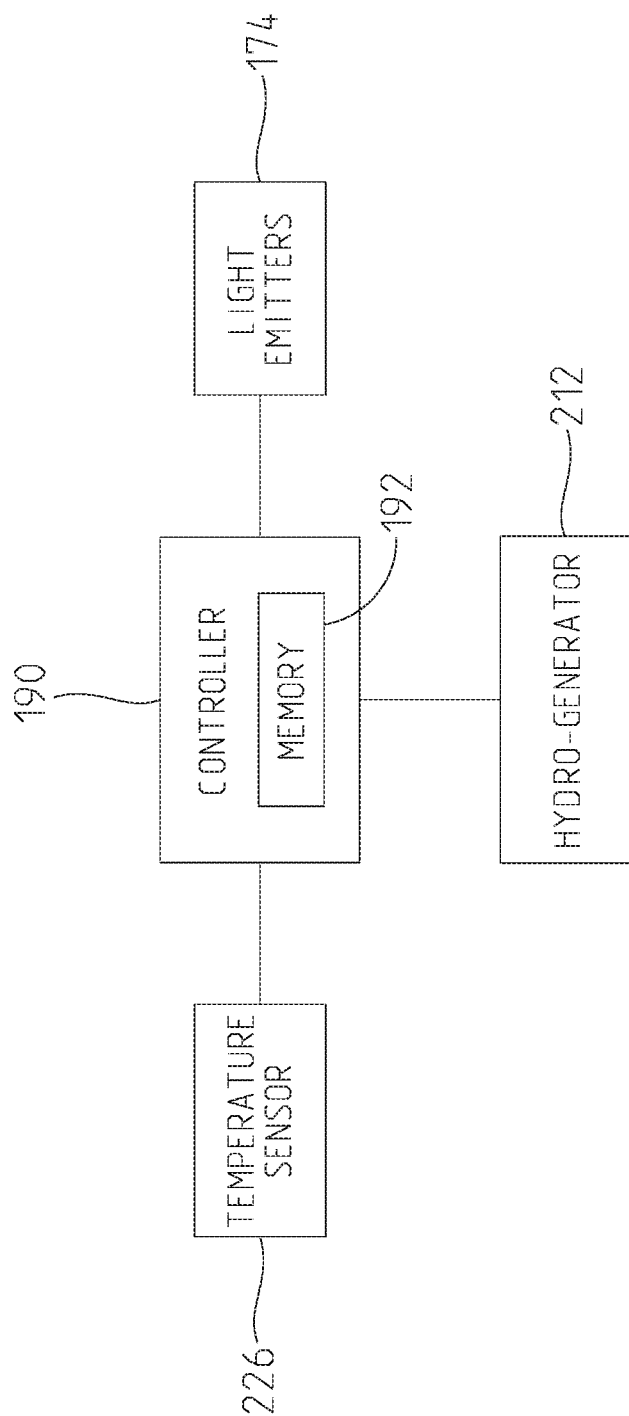


Fig. 6

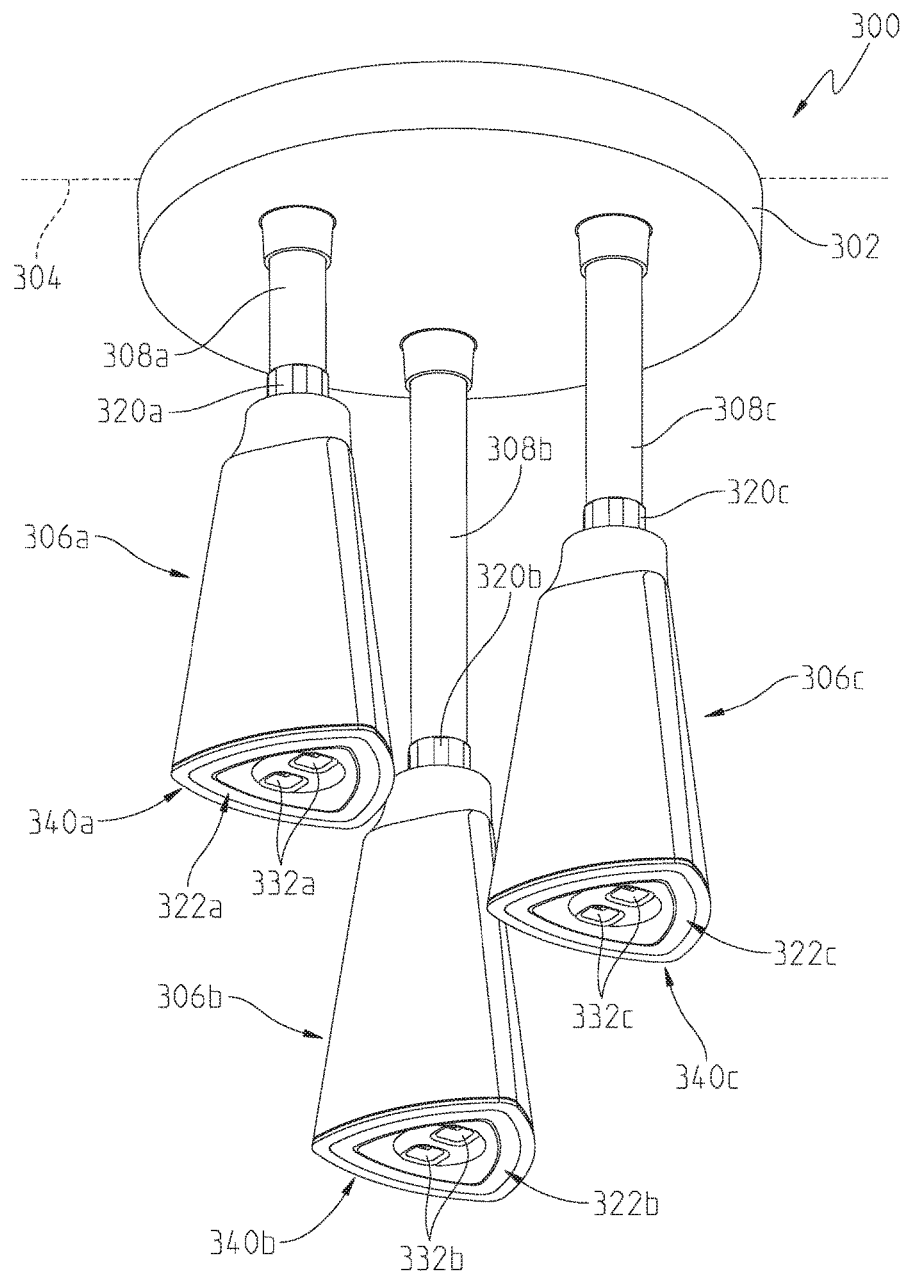


Fig. 7

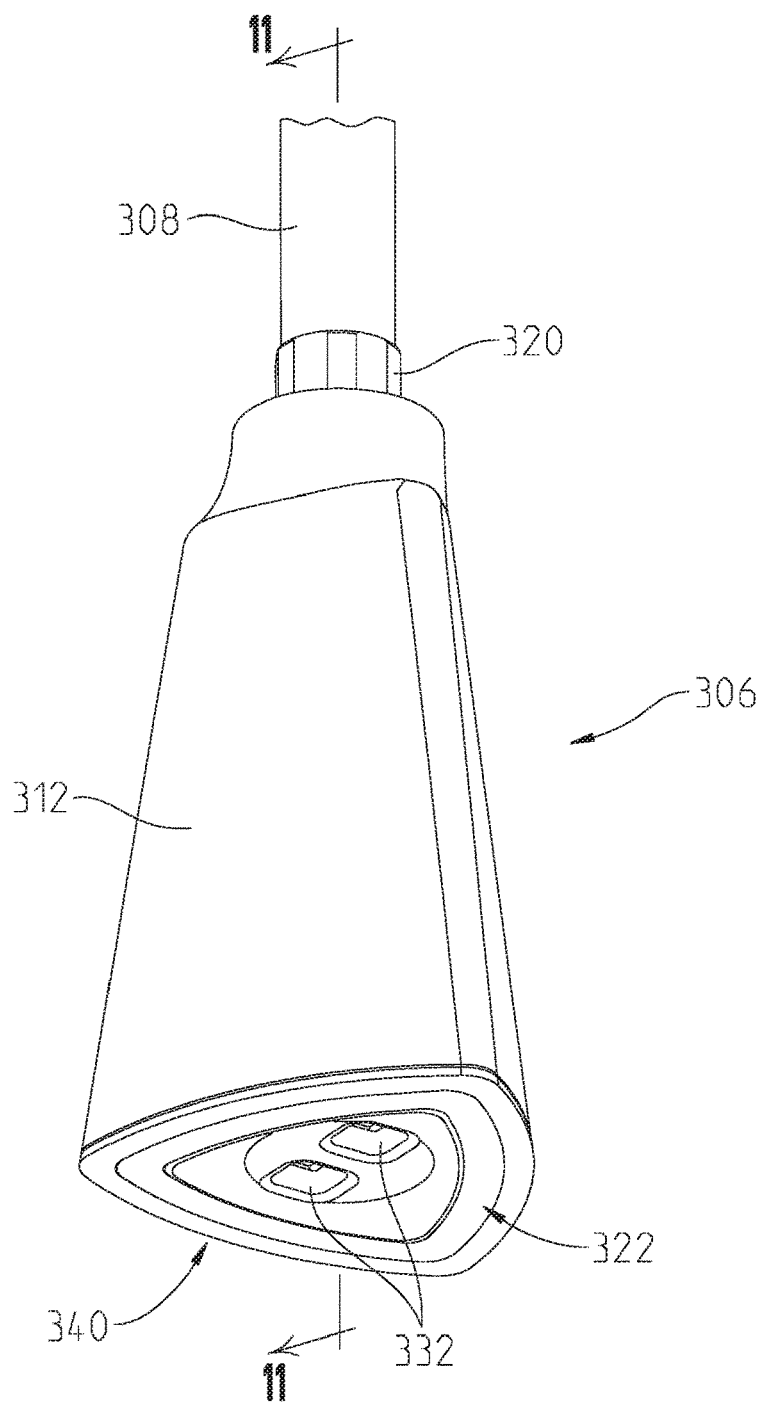


Fig. 8

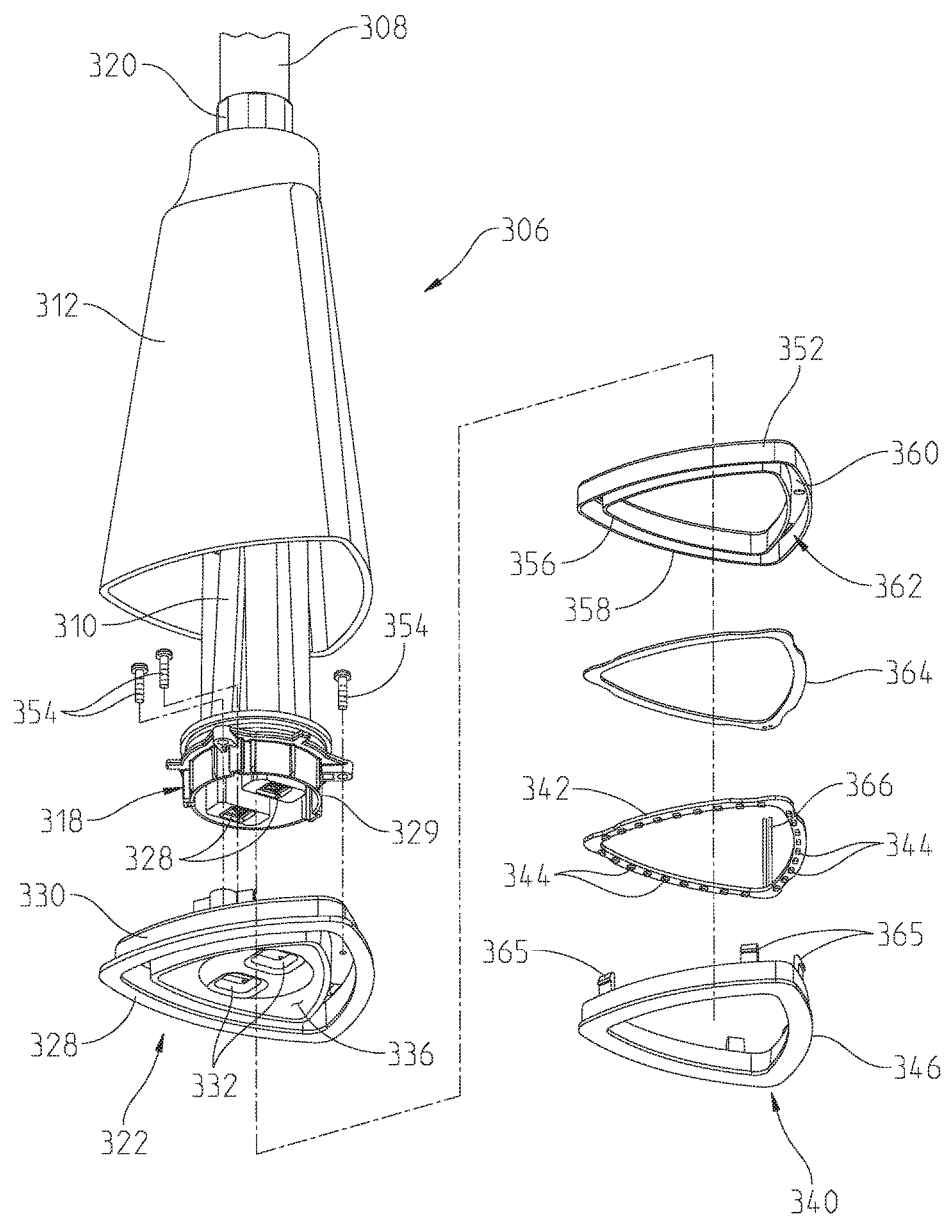


Fig. 9

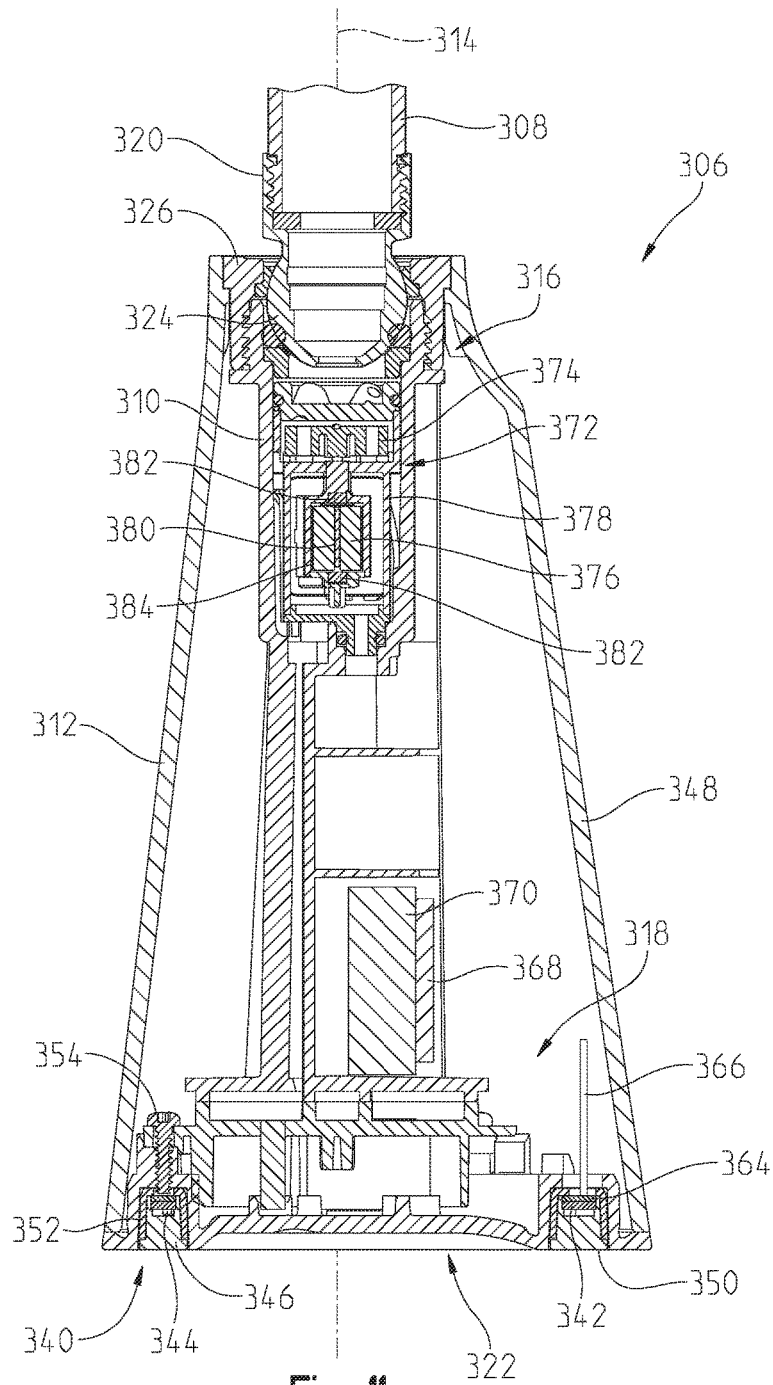


Fig. 11

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ILLUMINATION DEVICE FOR A FLUID DELIVERY APPARATUS

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to U.S. Provisional Patent Application, Ser. No. 62/490,008, filed Apr. 25, 2017, the disclosure of which is expressly incorporated herein by reference.

BACKGROUND AND SUMMARY OF THE DISCLOSURE

The present invention relates to fluid delivery devices and, more particularly, to an illumination device for a sprayhead.

Illumination devices associated with fluid delivery devices are known. Such illumination devices may include indicator lights for providing a visual indication of a status or a condition of fluid delivery device and/or water flowing from the fluid delivery device, and nightlights associated with lavatory faucets. Such illumination devices typically include a single light source, or a plurality of light sources providing for discrete areas of illumination (i.e. "hot spots").

The present disclosure provides for an illumination device associated with a sprayhead that provides a light pipe illuminated by at least one light emitter. Illustratively, the sprayhead may comprise a pull-down sprayhead configured to be releasably coupled to a delivery spout of a faucet, or a pendant showerhead configured to be suspended downwardly from a ceiling in a shower stall.

According to an illustrative embodiment of the present disclosure, a sprayhead includes a housing defining a longitudinal axis, a waterway received within the housing, a sprayface fluidly coupled to the waterway and supporting a water outlet, and an illumination device supported by the housing. The illumination device includes a substrate, a plurality of light emitters supported by the substrate, and a translucent light pipe defining a closed loop to diffuse light from the light emitters outwardly away from the housing. A hydro-generator may be in fluid communication with the waterway to provide electricity to the illumination device.

According to a further illustrative embodiment of the present disclosure, a pull-down sprayhead for a faucet includes a housing defining a longitudinal axis extending between a proximal end and a distal end, a waterway received within the housing, a sprayface fluidly coupled to the waterway and defining a water outlet, and an illumination device supported by the housing. The illumination device includes a substrate, a plurality of light emitters supported by the substrate, and a translucent light pipe including an outer illumination surface extending perpendicular to the longitudinal axis of the housing. The translucent light pipe defines a closed loop to diffuse light outwardly from the light emitters outwardly to the outer illumination surface.

According to another illustrative embodiment of the present disclosure, a pendant showerhead includes a housing defining a longitudinal axis, a waterway received within the housing, a sprayface fluidly coupled to the waterway and including a water outlet, and an illumination device supported by the sprayface. The illumination device includes a substrate, a plurality of light emitters supported by the substrate, and a translucent light pipe defining a closed loop

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surrounding the water outlet to diffuse light from the light emitters outwardly in a direction parallel to the longitudinal axis.

Additional features and advantages of the present invention will become apparent to those skilled in the art upon consideration of the following detailed description of the illustrative embodiment exemplifying the best mode of carrying out the invention as presently perceived.

BRIEF DESCRIPTION OF DRAWINGS

The detailed description of the drawings particularly refers to the accompanying figures, in which:

FIG. 1 is a perspective view of an illustrative sprayhead including an illumination device of the present disclosure;

FIG. 2 is a top exploded perspective view of the illustrative sprayhead of FIG. 1;

FIG. 3 is a bottom exploded perspective view of the illustrative sprayhead of FIG. 1;

FIG. 4 is a cross-sectional view taken along line 4-4 of FIG. 1;

FIG. 5 is a perspective view, in partial cross-section, of the hydro-generator of the illustrative sprayhead of FIG. 1;

FIG. 6 is a block diagram of various components of the illustrative sprayhead of FIG. 1;

FIG. 7 is a perspective view of an illustrative pendant showerhead assembly of the present disclosure;

FIG. 8 is a perspective view of an illustrative pendant showerhead of FIG. 7;

FIG. 9 is a bottom exploded perspective view of the illustrative pendant showerhead of FIG. 8;

FIG. 10 is a top exploded perspective view of the illustrative pendant showerhead of FIG. 8; and

FIG. 11 is a cross-sectional view taken along line 11-11 of FIG. 8.

DETAILED DESCRIPTION OF THE DRAWINGS

For the purposes of promoting an understanding of the principles of the present disclosure, reference will now be made to the embodiments illustrated in the drawings, which are described herein. The embodiments disclosed herein are not intended to be exhaustive or to limit the invention to the precise form disclosed. Rather, the embodiments are chosen and described so that others skilled in the art may utilize their teachings. Therefore, no limitation of the scope of the claimed invention is thereby intended. The present invention includes any alterations and further modifications of the illustrated devices and described methods and further applications of the principles of the invention which would normally occur to one skilled in the art to which the invention relates.

Referring initially to FIGS. 1-2, an illustrative embodiment fluid delivery device is shown in the form of a pull-down sprayhead or faucet wand **100**. The illustrative sprayhead **100** includes a waterway **102** received within an outer shell or housing **104**, and extending along a longitudinal axis **106** between an inlet or proximal end **108** and an outlet or distal end **110**. A hose **112** is fluidly coupled to the inlet end **108** of the waterway **102** by a conventional fluid connector **114**, and a sprayface **116** is fluidly coupled to the outlet end **110** of the waterway **102**.

The hose **112** is illustratively formed of a flexible polymer (e.g., cross-linked polyethylene (PEX)) for being slidably received within a delivery spout **118** of a faucet (FIG. 4). More particularly, the faucet wand **100** may be removably coupled to an outlet of the delivery spout **118** in a conven-

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tional manner. The sprayhead **100** illustratively includes a coupler **120** for releasably coupling the sprayhead **100** to the outlet of the delivery spout **118**. The coupler **120** illustratively includes a housing **122** overmolded around a magnet **124** and a backing plate **126**. As is known, the magnet **124** is configured to releasably couple with a magnetically attractive material (not shown) supported by the delivery spout **118**.

The waterway **102** illustratively includes an upper or proximal portion **130** defining the inlet end **108**, and a lower or distal portion **132** defining the outlet end **110**. Both proximal and distal portions **130** and **132** of the waterway **102** may be formed of a polymer, such as polyamide. Check valves **134** may be received within the proximal portion **130** of the waterway **102** to prevent the backflow of water from the sprayhead **100** into the hose **112** (FIG. 4).

The housing **104** illustratively includes a cylindrical outer housing wall **136** receiving the waterway **102** and coaxially aligned with the longitudinal axis **106**. Illustratively, the housing **104** may be formed of a metal or a metal plated polymer, such as acrylonitrile butadiene styrene (ABS). A nut **138** may threadably engage with a distal end of the proximal portion **130** of the waterway **102** to secure the waterway **102** from moving axially in a distal direction within the housing **104**.

The sprayface **116** illustratively includes a stream outlet **140** and a spray outlet **142**. More particularly, the sprayface **116** includes a body **144** supporting a conventional aerator **146** defining the stream outlet **140**, and a nozzle assembly **148** defining the spray outlet **142**. An annular filter or screen is illustratively supported by the sprayface **116** upstream from the nozzle assembly **148**.

A diverter valve assembly **152** may be fluidly coupled to the waterway **102** to illustratively alternate fluid communication between the inlet end **108** of the waterway **102** and the stream outlet **140** (e.g., aerator **146**) and the spray outlet **142** (i.e., nozzle assembly **148**). (FIG. 4) A user interface, illustratively a rocker arm **154**, is configured to move a piston **156** and thereby toggle flow between a first passageway **158** in fluid connection with the stream outlet **140** and a second passageway **160** in fluid connection with the spray outlet **142**. More particularly, the rocker arm **154** is configured to pivot about a protrusion **162** in response to user input which, in turn, causes axial movement of the piston **156**.

A cap **164** may threadably engage with a distal end of the sprayface body **144** to secure the waterway **102** and the sprayface body **144** from moving axially in a proximal direction within the housing **104**. As such, the nut **138** and the cap **164** cooperate with the outer wall **136** of the housing **104** to secure the waterway **102**, the sprayface **116** and associated components relative to the housing **104**.

A light assembly or illumination device **170** is supported by the housing **104** and is configured to direct light radially outwardly relative to the longitudinal axis **106**. The illumination device **170** illustratively includes a substrate **172** supporting a plurality of light emitters **174**. A translucent light pipe or diffuser **176** defines a closed loop to diffuse light outwardly from the light emitters **174**.

The light pipe **176** is illustratively formed of a translucent material (e.g., a polymer or acrylic) and extends laterally outwardly from the outer wall **136** of the housing **104**. More particularly, the light pipe **176** is positioned longitudinally intermediate the outer wall **136** of the housing **104** and the cap **164**. Illustratively, the light pipe **176** includes an annular ring configured to transmit light radially outwardly. The annular ring illustratively includes an annular distal portion **178** and an annular proximal portion **180**. The distal portion

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178 extends parallel to the longitudinal axis **106** and is configured to transmit light from the light emitters **174** in an axial direction. The proximal portion **180** extends radially outwardly from the distal portion **178** within a gap or opening **182** between the housing **104** and the cap **164** for transmitting light radially toward an outer illumination surface **184**. The outer illumination surface **184** defines a closed loop and is positioned radially outside of the outer wall **136** of the housing **104**.

The light emitters **174** illustratively comprise a plurality of light emitting diodes (LEDs) circumferentially spaced on the substrate **172**. Illustratively, the substrate **172** comprises a printed circuit board (e.g., a glass reinforced epoxy laminate sheet) including a plurality of electrically conductive traces (e.g., formed of copper) supported thereon for coupling the LEDs to wires **186**. The wires **186** may be in electrical communication with a controller **190** including a memory **192** supported on a printed circuit board **194** (FIGS. 4 and 6).

The body **144** of the sprayface **116** illustratively includes concentric inner, outer and intermediate walls **196**, **198**, **200**. An inner annular space **202** is defined intermediate the inner wall **196** and the intermediate wall **200**, and an outer annular space **204** is defined intermediate the outer wall **198** and the intermediate wall **200**. The distal end of the distal portion **132** of the waterway **102** is illustratively received within the inner annular space **202**. An o-ring **206** provides a seal between the waterway **102** and the intermediate wall **200** of the sprayface **116**. Tabs **208** on the distal portion **132** of the waterway **102** are received in openings **210** in the intermediate wall **200** of the sprayface **116** couple the sprayface **116** to the waterway **102**.

The substrate **172** of the illumination device **170** is received within the outer annular space **204** of the sprayface body **144**, with the light emitters **174** facing a proximal direction. The distal portion **178** of the light pipe **176** is likewise received within the outer annular space **204** in distal spaced relation to the light emitters **174**.

A power source is in electrical communication with the light emitters **174**. Illustratively, the power source includes a hydro-generator **212** fluidly coupled to the waterway **102**. More particularly, an impeller **214** of the hydro-generator **212** is positioned within the water flow path defined by the distal portion **132** of the waterway **102**. Magnets **216** are received within a housing **218** and coupled to the impeller **214** via a shaft **220** rotatably supported by bearings **222**. As such, rotation of the impeller **214** by water flow through the waterway **102** causes similar rotation of the magnets **216**. Coils **224** are supported within the housing **218** and proximate the magnets **216**. As is known, rotation of the magnets **216** relative to the coils **224** generates electricity which is then provided to the light emitters **174**.

A temperature sensor **226** is provided within the flow passageway of the distal portion **132** of the waterway **102**. Illustratively, the temperature sensor **226** may comprise a negative temperature coefficient (NTC) thermistor in electrical communication with the controller **190**.

The light emitting diodes **174** may each be configured to emit visible light of the same color (e.g., white LEDs), or may be configured to emit visible light of different colors (blue/red bi-color LEDs). Alternatively, different light emitting diodes **174** may be configured to emit different colors (e.g., alternating blue and red LEDs). In the illustrative embodiment, sixteen (16) different LEDs **174** are supported on the substrate in eight circumferentially spaced groups of two LEDs **174a**, **174b**. Illustratively, the first LEDs **174a** are blue color LEDs, and the second LEDs **174b** are red color

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LEDs. As may be appreciated, the separate blue and red color LEDs **174a**, **174b** may be replaced red/blue bi-color LEDs. Additionally, the number and relative positioning of the LEDs **174** may vary.

In operation of an illustrative embodiment, light emitters **174a** generate light of a first color (e.g., blue) when the signal from the temperature sensor **226** detects a first water temperature, and light emitters **174b** generate light of a second color (e.g., red) when the signal from the temperature sensor **226** detects a second water temperature greater than the first water temperature. Illustratively, the first and second light emitters **174a**, **174b** blend the light of the first color and the light of the second color and generate light of a third color when the signal from the temperature sensor **226** detects a third water temperature between the first water temperature and the second water temperature.

Illustratively, when water flows through the faucet sprayhead **100**, the hydro-generator **212** creates power required for electrical components, including the temperature sensor **226** to detect the water temperature dispensed from the sprayface **116**, and to display corresponding colored light from the light emitters **174**.

In a further illustrative embodiment of the present disclosure as shown in FIGS. **7** and **8**, a pendent showerhead assembly **300** includes a base **302** configured to be fixed to a ceiling **304** of a shower stall and supporting a plurality pendent showerheads **306**. While three pendant showerheads **306a**, **306b**, **306c** are shown in FIG. **7**, any number of showerheads **306** may be supported by the base **302** (i.e., at least one). Illustratively, a support tube or arm **308** fluidly couples each pendent showerhead **306** to a fluid supply (illustratively a flow control valve) and suspends the showerhead **306** from the base **302**.

Each showerhead **306** within the assembly **300** is substantially identical. With reference to FIGS. **8-11**, an illustrative showerhead **306** includes a waterway **310** received within an outer housing or shell **312**, and extending along a longitudinal axis **314** between an inlet or proximal end **316** and an outlet or distal end **318**. The support arm **308** is fluidly coupled to the inlet end of the waterway **310** by a conventional fluid connector **320**, and a sprayface **322** is fluidly coupled to the outlet end **318** of the waterway **310**. The fluid connector **320** illustratively includes a ball joint **324** to permit adjustment of the showerhead **306** about at least two orthogonal axes (FIG. **11**). A nut **326** threadably engages with the proximal end **316** of the waterway **310** to fluidly couple the support tube **308** with the waterway **310**.

The sprayface **322** illustratively includes a base **328** with an upwardly extending sidewall **330**. Water outlet openings **332** are formed within the base **328** of the sprayface **322** and extend between an upper surface **334** and a lower surface **336**.

Fluid devices, such as nozzles, are illustratively received within the outlet openings **332**. In an illustrative embodiment, a pair of multi-dimensional fluid dispensers or fluidic devices **328** are supported by a receiving body **329** of the outlet end **318** of the waterway **310** and are in fluid communication with the support tube **308**. As further detailed herein, a multi-dimensional fluidic device **328** is configured to produce a stream or jet of water moving in at least two dimensions. Additional details of illustrative fluidic devices are provided in US Patent Application Publication No. 2013/0299608 to Spangler et al., the disclosure of which is expressly incorporated herein by reference.

A light assembly or illumination device **340** is supported by the sprayface **322** and is configured to direct light outwardly in a direction parallel to the longitudinal axis **314**.

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The illumination device **340** illustratively includes a substrate **342** supporting a plurality of light emitters **344**. A translucent light pipe or diffuser **346** is coupled to the substrate **342** and defines a closed loop laterally surrounding the water outlet openings **332**. More particularly, the housing **312** includes an outer housing wall **348**, and the light pipe **346** is supported within the sprayface **322** laterally intermediate the water outlets **332** and the housing wall **348**. The light pipe **346** is configured to transmit light outwardly in a direction parallel to the axis **314** of the showerhead **306** toward an outer illumination surface **350**. The outer illumination surface **350** illustratively defines a closed loop positioned laterally outside of the water outlets **332** and flush with the adjacent outer surface **336** of the sprayface **322**.

The illumination device **340** further illustratively includes an upper housing **352** coupled to the sprayface **322** and supporting the light emitters **344**. More particularly, fasteners **354** illustratively couple the upper housing **352** and the sprayface **322** to the receiving body **329** of the waterway **310**. The upper housing **352** includes inner and outer walls **356** and **358** extending downwardly from a base **360**. A cavity or recess **362** is defined between the walls **356** and **358** and receives the substrate **342**. An adhesive gasket **364** may be used to secure the substrate **342** within the cavity **362** such that the light emitters **344** are supported on a lower surface of the substrate **342**. In a further illustrative embodiment, a potting material (e.g., a transparent resin) may be used to secure the substrate **342** and the light emitters **344** within the cavity **362**. Additionally, the potting material may enclose the substrate **342** and the light emitters **344** to provide a seal from humidity and water.

The light pipe **346** is illustratively coupled to the upper housing **352** by flexible tabs **365** extending upwardly from an upper surface of the light pipe **346**, through openings or slots **367** formed within the upper housing **352**, and received within openings or slots **369** formed within the sprayface **322**. In alternative embodiments, the light pipe **346** may be held in place by being sandwiched between the nut **326**, the shell **348**, the waterway **310** and the faceplate **322**. It may be appreciated that other coupling means may be substituted therefor.

The light emitters **344** illustratively comprise a plurality of light emitting diodes (LEDs) circumferentially spaced on the substrate **342**. Illustratively, the substrate **342** comprises a printed circuit board (e.g., a glass reinforced epoxy laminate sheet) including a plurality of electrically conductive traces (e.g., formed of copper) supported thereon for coupling the LEDs to wires **366**. The wires **366** may be in electrical communication with a controller **368** supported on a printed circuit board **370**. A potting material (e.g., a transparent resin) may seal the controller **368** and the printed circuit board **370** from humidity and water.

A power source is in electrical communication with the light emitters **344**. Illustratively, the power source includes a hydro-generator **372** fluidly coupled to the waterway **310**. More particularly, an impeller **374** of the hydro-generator **372** is within the water flow path defined by the waterway **310**. Magnets **376** are received within a housing **378** and coupled to the impeller **374** via a shaft **380** rotatable supported by bearings **382**. As such, rotation of the impeller **374** by water flow through the waterway **310** causes similar rotation of the magnets **376**. Coils **384** are supported within the housing **378** and proximate the magnets **376**. As is known, rotation of the magnets **376** relative to the coils **384** generates electricity which is then provided to the light emitters **344**.

Although the invention has been described in detail with reference to certain preferred embodiments, variations and modifications exist within the spirit and scope of the invention as described and defined in the following claims.

The invention claimed is:

1. A sprayhead comprising:
 - a housing defining a longitudinal axis;
 - a waterway received within the housing;
 - a sprayface fluidly coupled to the waterway and supporting a water outlet; and
 - an illumination device supported by the housing, the illumination device including a substrate, a plurality of light emitters supported by the substrate, and a translucent light pipe defining a closed loop to diffuse light from the light emitters outwardly away from the housing.
2. The sprayhead of claim 1, wherein the sprayhead comprises a pull-down sprayhead configured to be releasably coupled to a delivery spout of a faucet.
3. The sprayhead of claim 2, wherein the light pipe includes an annular ring configured to transmit light radially outwardly from the longitudinal axis.
4. The sprayhead of claim 3, wherein the light emitters comprise a plurality of circumferentially spaced light emitting diodes.
5. The sprayhead of claim 3, further comprising a diverter valve assembly fluidly coupled to the waterway, wherein the sprayface includes a stream outlet and a spray outlet, the diverter valve assembly configured to divert water between the stream outlet and the spray outlet.
6. The sprayhead of claim 1, wherein the sprayhead comprises a pendant showerhead configured to be suspended downwardly from a ceiling.
7. The sprayhead of claim 6, further comprising a pendant arm and a coupler fluidly coupling the waterway to the pendant arm, the coupler including a ball joint such that the housing is supported for rotation about at least two orthogonal axes.
8. The sprayhead of claim 6, wherein the housing includes an outer housing wall, and the light pipe is supported within the spray face laterally intermediate the water outlet and the housing wall.
9. The sprayhead of claim 1, further comprising a hydro-generator fluidly coupled to the waterway and in electrical communication with the illumination device.
10. A pull-down sprayhead for a faucet, the sprayhead comprising:
 - a housing defining a longitudinal axis extending between a proximal end and a distal end;
 - a waterway received within the housing;
 - a sprayface fluidly coupled to the waterway and defining a water outlet; and
 - an illumination device supported by the housing, the illumination device including a substrate, a plurality of light emitters supported by the substrate, and a translucent light pipe including an outer illumination surface extending perpendicular to the longitudinal axis of the housing, the translucent light pipe defining a closed loop to diffuse light from the light emitters outwardly to the outer illumination surface.
11. The sprayhead of claim 10, further comprising a hydro-generator fluidly coupled to the waterway and in electrical communication with the illumination device.
12. The sprayhead of claim 10, wherein the light pipe includes an annular ring configured to transmit light radially outwardly.

13. The sprayhead of claim 12, wherein the annular ring includes a distal portion extending parallel to the longitudinal axis and configured to transmit light from the light emitters in an axial direction, and a proximal portion extending radially outwardly from the distal portion and configured to transmit light toward the outer illumination surface.

14. The sprayhead of claim 12, wherein the light emitters comprise a plurality of circumferentially spaced light emitting diodes.

15. The sprayhead of claim 10, further comprising a diverter valve assembly fluidly coupled to the waterway, wherein the sprayface includes a stream outlet and a spray outlet, the diverter valve assembly configured to divert water between the stream outlet and the spray outlet.

16. The sprayhead of claim 10, further comprising a coupler configured to releasably couple the housing to a delivery spout of a faucet.

17. The sprayhead of claim 10, further comprising:

- a temperature sensor configured to detect the temperature of water within the waterway; and
- a controller in electrical communication with the temperature sensor, the controller configured to change the color of light emitted by the light emitters in response to the temperature detected by the temperature sensor.

18. The sprayhead of claim 17, wherein the plurality of light emitters include a first light emitter configured to generate light of a first color when the signal from the temperature sensor detects a first water temperature, a second light emitter configured to generate light of a second color when the signal from the temperature sensor detects a second water temperature greater than the first water temperature, and the first and second light emitters blend the light of the first color and the light of the second color and generate light of a third color when the signal from the temperature sensor detects a third water temperature between the first water temperature and the second water temperature.

19. A pendant showerhead comprising:

- a housing defining a longitudinal axis;
- a waterway received within the housing;
- a sprayface fluidly coupled to the waterway and including a water outlet; and
- an illumination device supported by the sprayface, the illumination device including a substrate, a plurality of light emitters supported by the substrate, and a translucent light pipe defining a closed loop surrounding the water outlet to diffuse light from the light emitters outwardly in a direction parallel to the longitudinal axis.

20. The showerhead of claim 19, further comprising a pendant arm and a coupler fluidly coupling the waterway to the pendant arm, the coupler including a ball joint such that the housing is supported for rotation about at least two orthogonal axes.

21. The showerhead of claim 19, further comprising a hydro-generator fluidly coupled to the waterway and in electrical communication with the illumination device.

22. The showerhead of claim 19, wherein the housing includes an outer housing wall, and the light pipe is supported within the spray face laterally intermediate the water outlet and the housing wall.

23. The showerhead of claim 22, wherein the translucent light pipe includes an outer illumination surface extending parallel to an outer surface of the sprayface.

24. The showerhead of claim 19, further comprising a multi-dimensional fluidic device received within the water outlet.

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