(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
14 September 2017 (14.09.2017)

WIPO | PCT

(10) International Publication Number
WO 2017/156476 A1

(51) International Patent Classification:
A61C 3/025 (2006.01) *B24C 5/00* (2006.01)
A61C 3/02 (2006.01) *B24C 7/00* (2006.01)
A61C 17/02 (2006.01)

(21) International Application Number:
PCT/US2017/021940

(22) International Filing Date:
10 March 2017 (10.03.2017)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/306,496 10 March 2016 (10.03.2016) US

(72) Inventor; and
(71) Applicant : **RAINEY, J. Tim** [US/US]; P.O. Box 1044, 410 Commerce Residence, Refugio, Texas 78377 (US).

(74) Agents: **WEAVER, Andrew Z.** et al.; 1000 Louisiana Street, Fifty-Third Floor, Houston, Texas 77002 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

WO 2017/156476 A1

(54) Title: DENTAL APPLIANCE

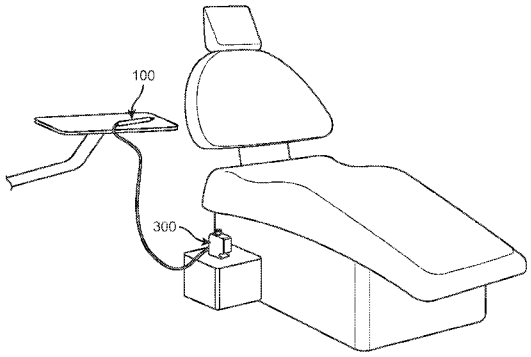

FIG. 1

(57) Abstract: A dental appliance including an applicator body having an inlet end and an outlet end opposite the inlet end. The applicator body having an abrasive outlet extending from the outlet end and defining an abrasive outlet axis that is substantially through the center of the abrasive outlet, and a water outlet extending from the outlet end and defining a water outlet axis that is substantially through the center of the water outlet. Wherein the water outlet axis and the abrasive outlet axis form an angle between about eighteen degrees to about thirty degrees.

DENTAL APPLIANCE

FIELD

[0001] The subject matter herein generally relates to applicators used in dental care, and more specifically to applicators used in combination with water and air.

BACKGROUND

[0002] In the past dentists have relied on drills for dental procedures ranging from removing cavities and preparing teeth for dental crowns to performing a root canal. However, the use of a drill can cause damage to the surrounding healthy tooth structure by causing small fractures throughout the tooth or can chip off portions of sound tooth structure. Recently, dentists have been given an opportunity to perform the same tasks without a dental drill, through the use of air abrasion.

[0003] Using air abrasion, dentists may remove tooth decay with small particles of an abrasive material, rather than using a dental drill. The use of air abrasion allows dentists to complete the same tasks without the conventional side effects of vibration, noise, heat and pressure. Furthermore, air abrasion also allows for significantly less damage to tooth structure than the standard drilling process.

[0004] While the air abrasion process allows dentists to remove tooth decay with less pain, the kinetic energy applied to the crystalline tooth structure can generate a significant static electric charge. This static charge can cause pain, and therefore anesthesia is often required.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] For a better understanding of the disclosed subject matter and to show how it may be utilized, examples thereof will now be described, by way of non-limiting examples only, with reference to the accompanying drawings.

[0006] FIG. 1 is an isometric view of an example of the teeth cleaning apparatus and a standard dental chair;

[0007] FIGS. 2A and 2B are an isometric views of an example applicator according to the disclosure herein;

[0008] FIG. 3 is a cross-sectional view of the applicator of FIG. 2B taken along the lengthwise axis A-A according to the disclosure herein;

[0009] FIG. 4 is an enlarged view of circle III of FIG. 3 of the applicator according to the disclosure herein;

[0010] FIG. 5 is an isometric view of an example pressurization unit according to the disclosure herein;

[0011] FIG. 6 is a bottom view of the pressurization unit of FIG. 5, according to the disclosure herein;

[0012] FIG. 7 is a cross-sectional view across line IV-IV of the pressurization unit of FIG. 6, according to the disclosure herein; and

[0013] FIG. 8 is a top view of an example pressurization unit according to the disclosure herein.

DETAILED DESCRIPTION

[0014] Various examples of the disclosure are discussed in detail below. While specific implementations are discussed, it should be understood that this is done for illustrative purposes only, are should not be considered as limiting. A person skilled in the relevant art will recognize that other components and configurations can be used without departing from the scope of the disclosure. Additional features and advantages of the disclosure will be set forth in the description which follows, and in part will be obvious from the description, or can be learned by practice of the herein disclosed principles. The features and advantages of the disclosure can be realized and obtained by means of the instruments and combinations particularly pointed out in the appended claims.

[0015] The phraseology and terminology employed herein are for the purpose of description and should not be regarded as liming. For example, the use of a singular term, such as, “a” is not intended as limiting of the number of items.

[0016] Several definitions that apply throughout this disclosure swill now be presented. The terms “comprising,” “including,” and “having” are used interchangeably in this disclosure. The terms “comprising,” “including,” and “having” means to include, but not necessarily be limited to the things so described.

[0017] As used here, the term “coupled” is defined as connected, whether directly or indirectly through intervening components, and is not necessarily limited to physical connections. The term “substantially” is defined to be essentially conforming to the particular dimension, shape, or other word that substantially modifies, such that the component need not be

exact. For example, substantially rectangular means that the object in question resembles a rectangle, but can have one or more deviations from a true rectangle.

[0018] Further, any term of degree such as, but not limited to, "about" or "approximately," as used in the description and the appended claims, should be understood to include the recited values or a value that is three times greater or one third of the recited values. For example, about 3 mm includes all values from 1 mm to 9 mm.

[0019] In at least one example, an applicator to clean teeth can have a body, the body having an inlet end, an outlet end, and a lengthwise axis running there between. The body can house an abrasive inlet tube and a water inlet tube, and further include a water outlet positioned at the outlet end and in fluidic communication with the water inlet tube via a water tube. An abrasive outlet can be positioned at the outlet end and placed in fluidic communication with the abrasive inlet tube via an abrasive tube. In at least one example, a central axis of the abrasive outlet (also referred to herein as "an abrasive outlet axis") and a central axis of the water outlet (also referred to herein as "a water outlet axis") form an angle. The angle can be between about eighteen (18) to about thirty (30) degrees. In at least one example, the angle can be between about nineteen (19) degrees to about twenty-six (26) degrees. In at least one example, the angle can be between about twenty (20) degrees to about twenty-four (24) degrees. In at least one example, the angle can be about twenty-two (22) degrees. The angles described above have been found to impart desirable effects, as will be discussed herein in greater detail. However, one of skill in the art would understand that other angles which achieve the same desirable effect can also be used without departing from the disclosure herein. In at least one example, the pressurization unit can be configured to expel a water stream from the water outlet at a pressure sufficient to ground any electricity created by application of an abrasive.

[0020] In an at least one example, the central axis of the abrasive outlet and the central axis of the water outlet can form an angle configured to pull the water stream parallel to the abrasive stream.

[0021] In an at least one example, the pressure at which the abrasive stream is expelled from the abrasive outlet can be at least 55 pounds per square inch (psi), or about 379.2 kilopascals (kPa). In an alternative example, the pressure at which the abrasive stream exits the

abrasive outlet can be supersonic. In an alternative example, the flow of the abrasive is at supersonic speed.

[0022] In at least one example, the abrasive inlet tube and the water inlet tube can protrude, at least in part, from the inlet end of the applicator and can be communicatively coupled with an abrasive outlet and a water outlet protruding, at least in part, from the outlet end of the applicator. In addition, the inlet end of the applicator can be configured to communicate with a pressurization unit. The pressurization unit can have a main water line and a main air line, wherein a diameter across a cross-section of the main water line is smaller than a diameter across a cross-section of the main air line. The pressurization unit can further include a funnel, the main air line can enter the funnel at a first end and exit through an abrasive discharge nozzle. A reservoir can be configured to communicate with the funnel of the pressurization unit via a venturi point. Additionally, a main water line can pass through the housing of the pressurization unit. The first end of a water hose can be in fluidic communication with the water inlet tube and a second end of the water hose can be in fluidic communication with the main water line. Similarly, the first end of an abrasive hose can be in fluidic communication with the abrasive inlet tube and a second end of the abrasive hose can be in fluidic communication with the abrasive discharge nozzle.

[0023] The reservoir can include a removable cap and an opening, and the reservoir can be configured to hold an abrasive material. The opening can be configured to create a pressure difference in the reservoir such that when the pressurization unit is in use the abrasive material is expelled through the opening of the reservoir and out the abrasive discharge nozzle. In at least one example, the abrasive material can be aluminum oxide.

[0024] FIG. 1 illustrates an applicator 100 for cleaning teeth, the applicator 100 is shown connected to a pressurization unit 300, as it would appear in a standard dental office. Referring to FIG. 2A, an applicator 100 to be used to clean teeth is illustrated. The applicator 100 can be used in combination with the pressurization unit 300 described below with reference to FIGS. 5-8. In at least one example, the applicator 100 can contain an abrasive inlet tube 10 and a water inlet tube 20 protruding, at least in part, from the inlet end 70 of the applicator 100, a water tube 110 and an abrasive tube 120 (as shown in FIG. 3) extending lengthwise throughout the length of the applicator body 90, and an abrasive outlet 30 and a water outlet 40, protruding from an outlet end 80 of the applicator 100. In an alternative

example, the applicator 100 can have an abrasive passage and a water passage formed within the applicator body 90, such that the abrasive inlet tube 10 and abrasive outlet 30 and the water inlet tube 20 and water outlet 40 are coupled via the passage, respectively. For example, the abrasive inlet tube 10, water inlet tube 20, abrasive outlet 30, and water outlet 40 can include a threaded end (or any other suitable means for connection) to facilitate coupling. The applicator 100 can also include a cover 50, which can be used to protect the outlet end from dirt and other damage. FIG. 2B shows the lengthwise axis A-A of the applicator 100.

[0025] FIG. 3 shows a cross-sectional view of an example of an applicator 100, having the applicator body 90 removed, illustrating the connection between the water tube 110 and the water outlet 40, and between the abrasive tube 120 and the abrasive outlet 30. The abrasive inlet tube 10, abrasive tube 120, and abrasive outlet 30 are in fluidic communication and can provide a pathway capable of transporting an abrasive, that the abrasive inlet 10, abrasive tube 120, and abrasive outlet 30 can be configured to maintain a consistent diameter throughout the applicator body 90. A similar pathway, capable of transporting water, is provided by the water inlet tube 20, water tube 110, and water outlet 40. In at least one example, the abrasive pathway is located above the water pathway.

[0026] The point at which materials that are expelled from the outlet end 80 of the applicator 100 meet (as illustrated by the central axes B-B and C-C of FIG. 4) can be modified by adjusting the angle at which the abrasive outlet 30 is coupled with the abrasive tube 120. In at least one example, the abrasive outlet 30 is angled downward at a 45 degree angle from the abrasive tube 120.

[0027] Referring to FIG. 4, an enlarged view of the outlet end 80 of the applicator 100 is shown. The abrasive outlet 30 has a central axis B-B, the abrasive outlet 30 is positioned such that the central axis B-B of the abrasive outlet 30 is at an angle; in at least one example, the angle can be about 45 degrees downward from the lengthwise axis A-A (as shown in FIG. 2B) of the applicator 100. Similarly, the water outlet 40 includes a central axis C-C. The abrasive stream and the water stream are expelled from the abrasive outlet 30 and the water outlet 40, respectively, and can form an angle θ. In at least one example, the abrasive stream meets the water stream at an angle θ, which can be from about eighteen (18) degrees to about thirty (30) degrees. The pressure at which the abrasive stream is expelled can be adjusted based on a desired outcome. In at least one example, the pressure at which the

abrasive stream is expelled from the applicator 100 can be determined by the pressure of the air stream entering the pressurization unit 300. For example, standard dental compressors can be set to cycle between 80 psi (about 551.6 kPa) and 120 psi (about 827.4 kPa). Due to the venturi effect of the pressurization unit 300, the pressure at which the abrasive stream is expelled is lower than the pressure at which the air stream enters the unit. In at least one example, the pressure of the air stream entering the unit is such that the abrasive stream is expelled at about 55 psi (about 379.2 kPa). In an alternative example, the pressure of the air stream entering the unit is set such that the pressure the abrasive stream is expelled from the applicator 100 is supersonic. In an alternative example, the flow of the abrasive is at supersonic speed.

[0028] Referring to FIG. 5, a pressurization unit 300 is shown. The pressurization unit 300 has a reservoir 320 comprising a cap 310, an abrasive discharge nozzle 340, a main water line 290, a main air line 280, and an adapter 360, protruding from a housing 330. The pressurization unit 300 can be configured to connect to a dental compressor via the adapter 360. In at least one example, the adapter 360 can be a Midwest adapter. Most dental practices in the United States use compressors outfitted with a Midwest connector to connect dental hand pieces to the compressor. The adapter 360 can be configured to guide a water stream and an air stream provided by the dental compressor, into the main water line 290 and the main air line 280 throughout the pressurization unit 300 (as shown in FIG. 6). Furthermore, standard dental compressors, such as those commonly used throughout the United States, are equipped with a one-half inch round bar surrounding the compressor. The hanger 270 of the pressurization unit 300 is configured to accept the standard one-half inch round bar, at least one means for connection 260 (for example, a screw) can be provided to clamp the pressurization unit 300 onto the round bar, allowing the pressurization unit 300 to be used hands-free. FIG. 6 illustrates the pressurization unit 300 from another angle, showing the adapter 360, main water line 290, and main air line 280. While only the Midwest adapter is discussed in detail, those of skill in the art should understand that any other suitable connection means can also be utilized.

[0029] FIG. 7 illustrates the pressurization unit 300 shown in FIG. 5, having the housing 330 partially removed. The pressurization unit 300 can include a main air line 280 (as shown in FIG. 6), a funnel 370, and a reservoir 320. The air stream can enter the

pressurization unit 300 through the main air line 280, which connects to the funnel 370 via a funnel inlet 350. The reservoir 320 can have a tube 322 (as shown in FIG. 8) configured to attach the reservoir 320 to the funnel 370 via a venture point 380. The reservoir 320 can be configured to hold an abrasive material and can create an atomizer effect at venturi point 380 when an air stream is sent through the pressurization unit 300. As the air stream passes below the tube 322, a drop in air pressure can occur. The drop in air pressure can cause the abrasive material to enter the tube 322. The airborne abrasive can then be expelled through the abrasive discharge nozzle 340, creating an abrasive stream. The reservoir cap 310 can further comprise a control screw 390, which can act as a needle valve allowing for increased control of the flow of the abrasive stream. Additionally, a water stream can enter the housing 330 through the adapter 360 via the main water line 290 and exit through the opposite side of the housing 330. The main water line 290 is disposed within the housing 300 of the pressurization unit 300; however, no pressure change occurs within the water stream as it passes throughout the pressurization unit 300.

[0030] An abrasive hose 200 and a water hose 210 can be provided to transport the abrasive stream and the water stream, respectively, from the pressurization unit 300 to the applicator 100.

[0031] In at least one example, the pathway created from the main water line 290, through the water hose 210, water inlet tube 20, water tube 110, and to the water outlet 40 can be configured to maintain a consistent pressure. The pressure at which the water stream is expelled from the applicator 100 can be adjusted based on a desired outcome. For example, the pressure at which each of the water stream and the abrasive stream are expelled can be adjusted in order to change the angle θ at which the abrasive stream and the water stream meet. As described above, in at least one example the angle θ can be from about eighteen (18) degrees to about thirty (30) degrees.

[0032] In an alternative example, the pressure of the abrasive stream can be adjusted such that when the abrasive stream and the water stream meet, the water stream is turned parallel to the abrasive stream, creating a water curtain around the abrasive stream. The water curtain can be used to ground any static electric charge caused by the kinetic energy of the air abrasion process. Grounding the electric charge can allow the procedure to progress painlessly, without the need for anesthesia.

[0033] The subject matter described herein is susceptible to variations, modifications and/or additions other than those specifically described and it is to be understood that this disclosure includes all such variations, modification, and/or additions which fall within the scope of the above description. Thus, it will be understood that the above-described examples of the present disclosure, including any particular examples, are merely possible examples of implementations, set forth for a clear understanding of the principles of the disclosure. Many variations and modifications can be made to the above-described example(s) of the disclosure without departing substantially from the spirit and principles of the disclosure. All such modifications and variations are intended to be included herein within the scope of this disclosure and protected by the following claims.

CLAIMS

What is claimed is:

1. A dental appliance comprising:

an applicator body having an inlet end and an outlet end opposite the inlet end;

an abrasive outlet extending from the outlet end and defining an abrasive outlet axis that is substantially through the center of the abrasive outlet; and

a water outlet extending from the outlet end and defining a water outlet axis that is substantially through the center of the water outlet,

wherein the water outlet axis and the abrasive outlet axis form an angle between about eighteen degrees to about thirty degrees.

2. The dental appliance as recited in claim 1, further comprising an abrasive inlet extending from the inlet end of the applicator body.

3. The dental appliance as recited in claim 2, wherein the abrasive inlet extends substantially perpendicular to the inlet end of the applicator body.

4. The dental appliance as recited in claim 2, wherein the abrasive inlet is an abrasive inlet tube that is substantially cylindrical.

5. The dental appliance as recited in claim 2, wherein the abrasive inlet is threaded to the inlet end of the applicator body.

6. The dental appliance as recited in claim 2, further comprising an abrasive passage formed within the applicator body and configured to couple the abrasive inlet to the abrasive outlet.

7. The dental appliance as recited in claim 2, further comprising an abrasive tube located within the applicator body and configured to couple the abrasive inlet to the abrasive outlet.

8. The dental appliance as recited in claim 1, further comprising a water inlet extending from the inlet end of the applicator body.

9. The dental appliance as recited in claim 8, wherein the water inlet extends substantially perpendicular to the inlet end of the applicator body.

10. The dental appliance as recited in claim 8, wherein the water inlet is a water inlet tube that is substantially cylindrical.

11. The dental appliance as recited in claim 8, wherein the water inlet is threaded into the inlet end of the applicator body.

12. The dental appliance as recited in claim 8, further comprising a water passage formed within the applicator body and configured to couple the water inlet to the water outlet.

13. The dental appliance as recited in claim 8, further comprising a water tube located within the applicator body and configured to couple the water inlet to the water outlet.

14. The dental applicant as recited in any of the preceding claims, wherein the water outlet axis and the abrasive outlet axis form an angle between about nineteen degrees to about twenty-six degrees.

15. The dental applicant as recited in any one of claims 1-13, wherein the water outlet axis and the abrasive outlet axis forms an angle of about twenty-two degrees.

16. A system for use in a dental procedure comprising:

an applicator comprising:

an applicator body having an inlet end and an outlet end opposite the inlet end,

an abrasive outlet extending from the outlet end and defining an abrasive outlet axis that is substantially through the center of the abrasive outlet, and

a water outlet extending from the outlet end and defining a water outlet axis that is substantially through the center of the water outlet,

wherein the water outlet axis and the abrasive outlet axis form an angle between about eighteen degrees to about thirty degrees; and

a pressurization unit fluidically coupled with the applicator, the pressurization unit comprising:

a reservoir operable to house an abrasive, and

a funnel coupled to the reservoir and operable to receive the abrasive from the reservoir, wherein the funnel further comprises an air inlet and an abrasive discharge nozzle through which an abrasive stream is expelled towards the applicator.

17. The system as recited in claim 16, wherein the applicator further comprises an abrasive inlet extending from the inlet end of the applicator body. 18. The system as recited in claim 17, wherein the abrasive inlet is an abrasive inlet tube that is substantially cylindrical.

19. The system as recited in claim 17, wherein the abrasive inlet is threaded to the inlet end of the applicator body.

20. The system as recited in claim 17, wherein the applicator further comprises an abrasive passage formed within the applicator body and configured to couple the abrasive inlet to the abrasive outlet.

21. The system as recited in claim 17, wherein the applicator further comprises an abrasive tube located within the applicator body and configured to couple the abrasive inlet to the abrasive outlet.

22. The system as recited in claim 16, wherein the applicator further comprises a water inlet extending from the inlet end of the applicator body.

23. The system as recited in claim 22, wherein the water inlet is a water inlet tube that is substantially cylindrical.

24. The system as recited in claim 22, wherein the water inlet is threaded into the inlet end of the applicator body.

25. The system as recited in claim 22, wherein the applicator further comprises a water passage formed within the applicator body and configured to couple the water inlet to the water outlet.

26. The system as recited in claim 22, wherein the applicator further comprises a water tube located within the applicator body and configured to couple the water inlet to the water outlet.

27. The system as recited in claim 16, wherein the abrasive is aluminum oxide.

28. The system as recited in any of the preceding claims, wherein the water outlet axis and the abrasive outlet axis form an angle between about nineteen degrees to about twenty-six degrees.

29. The system as recited in any one of claims 16-27, wherein the water outlet axis and the abrasive outlet axis forms an angle of about twenty-two degrees.

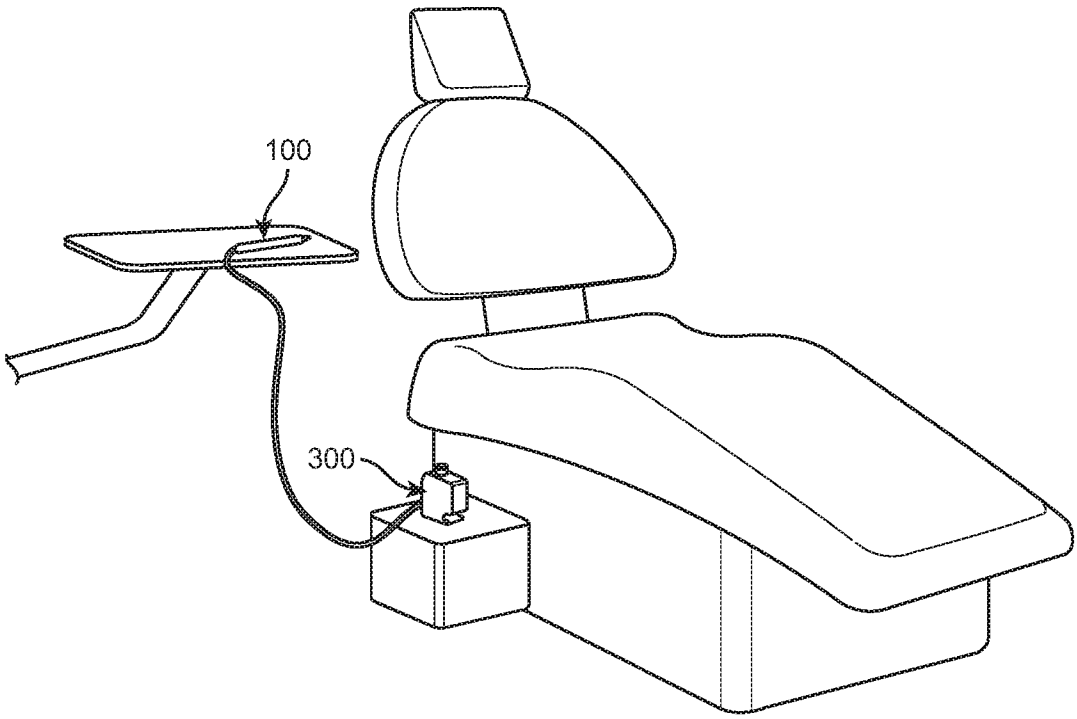

FIG. 1

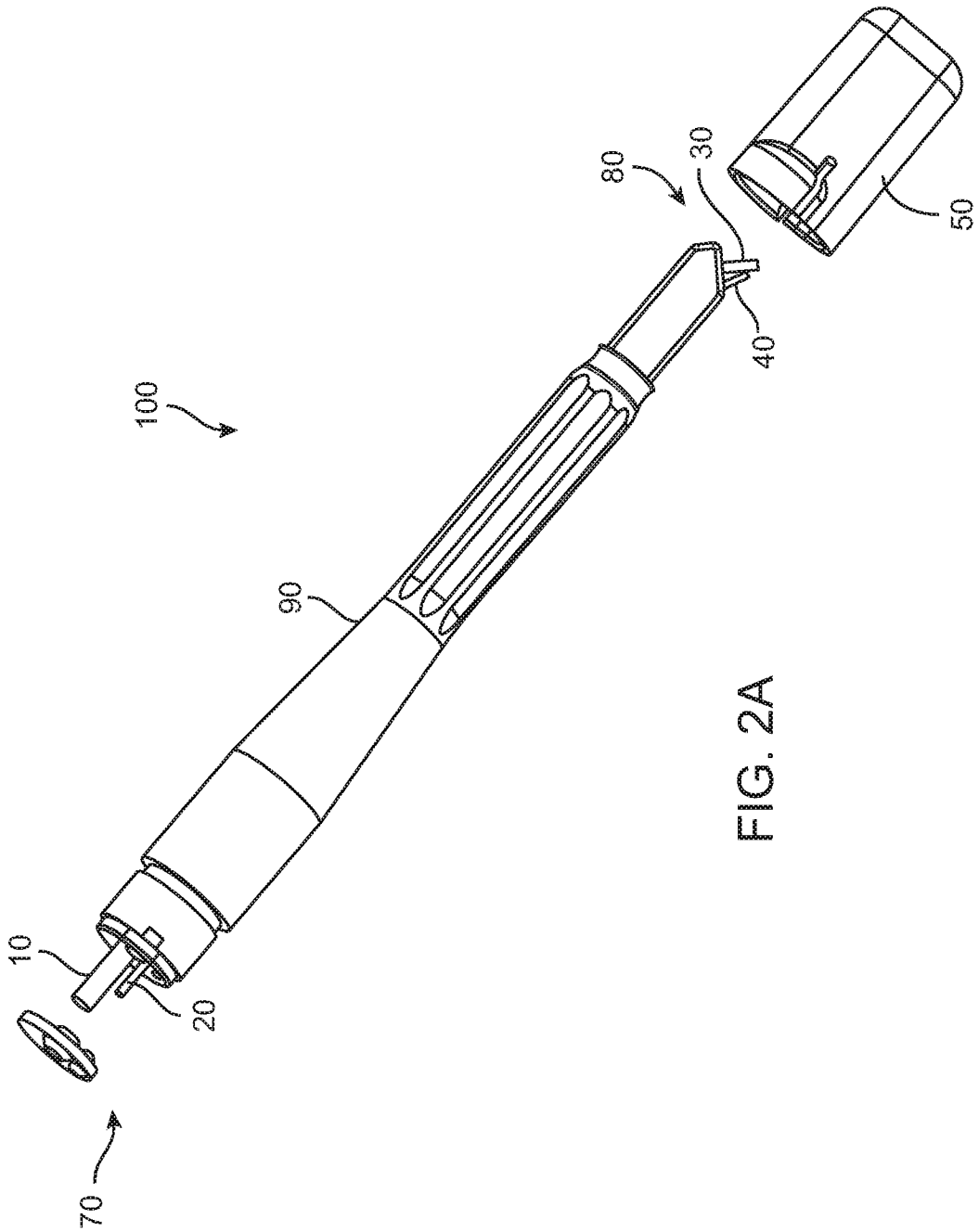

FIG. 2A

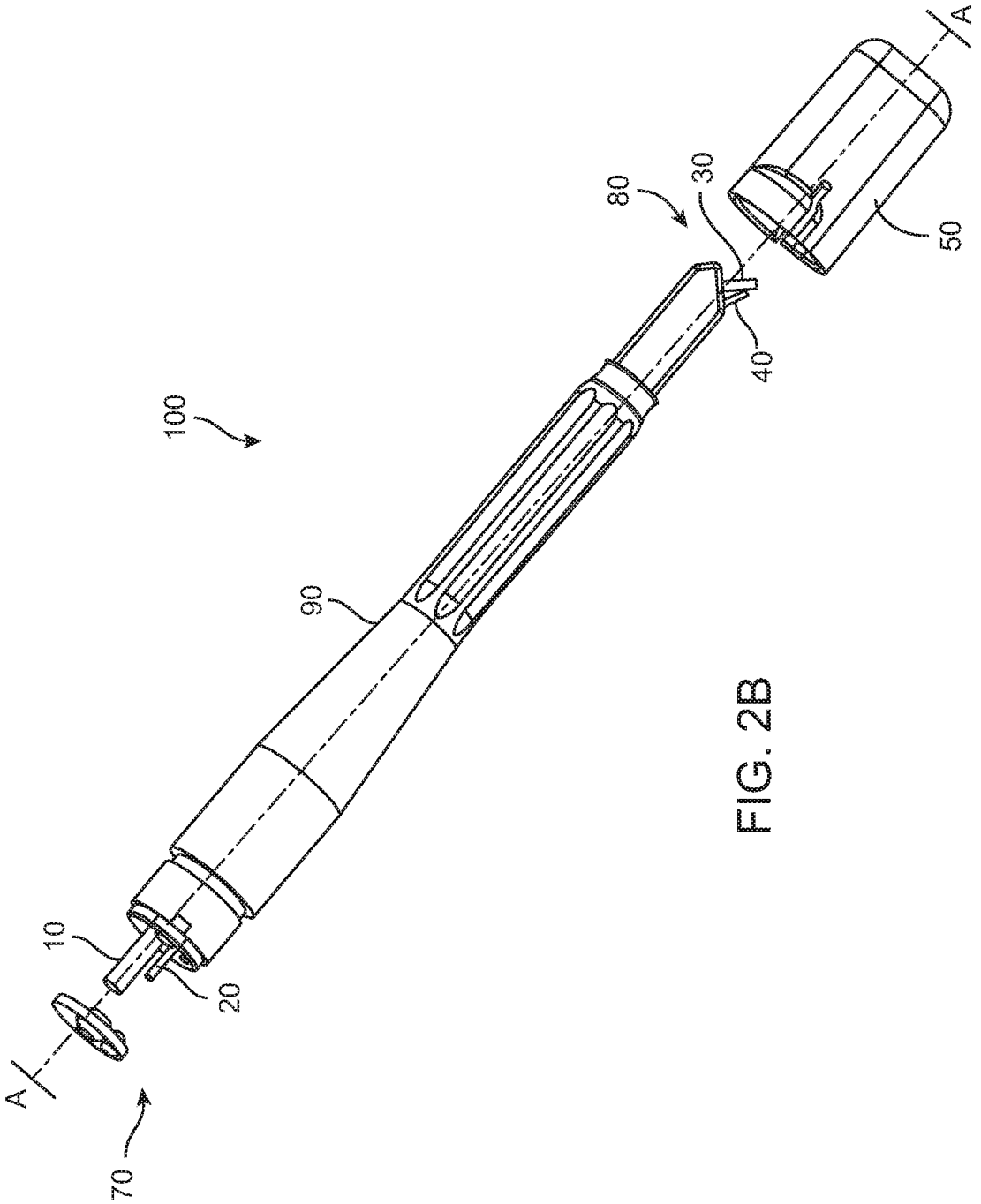

FIG. 2B

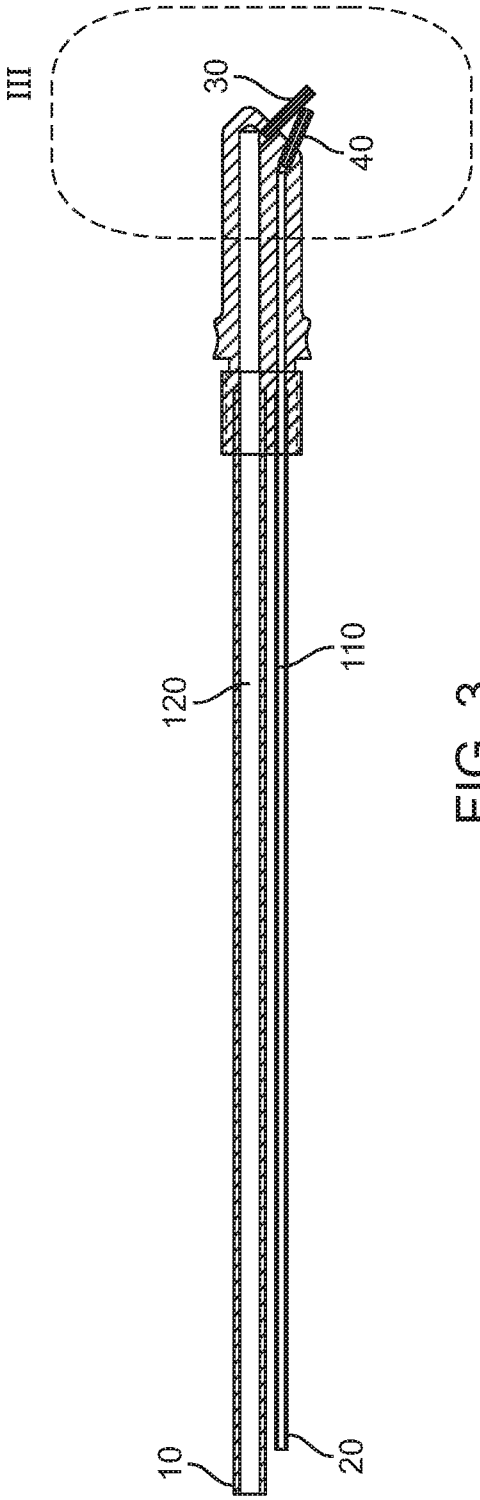

FIG. 3

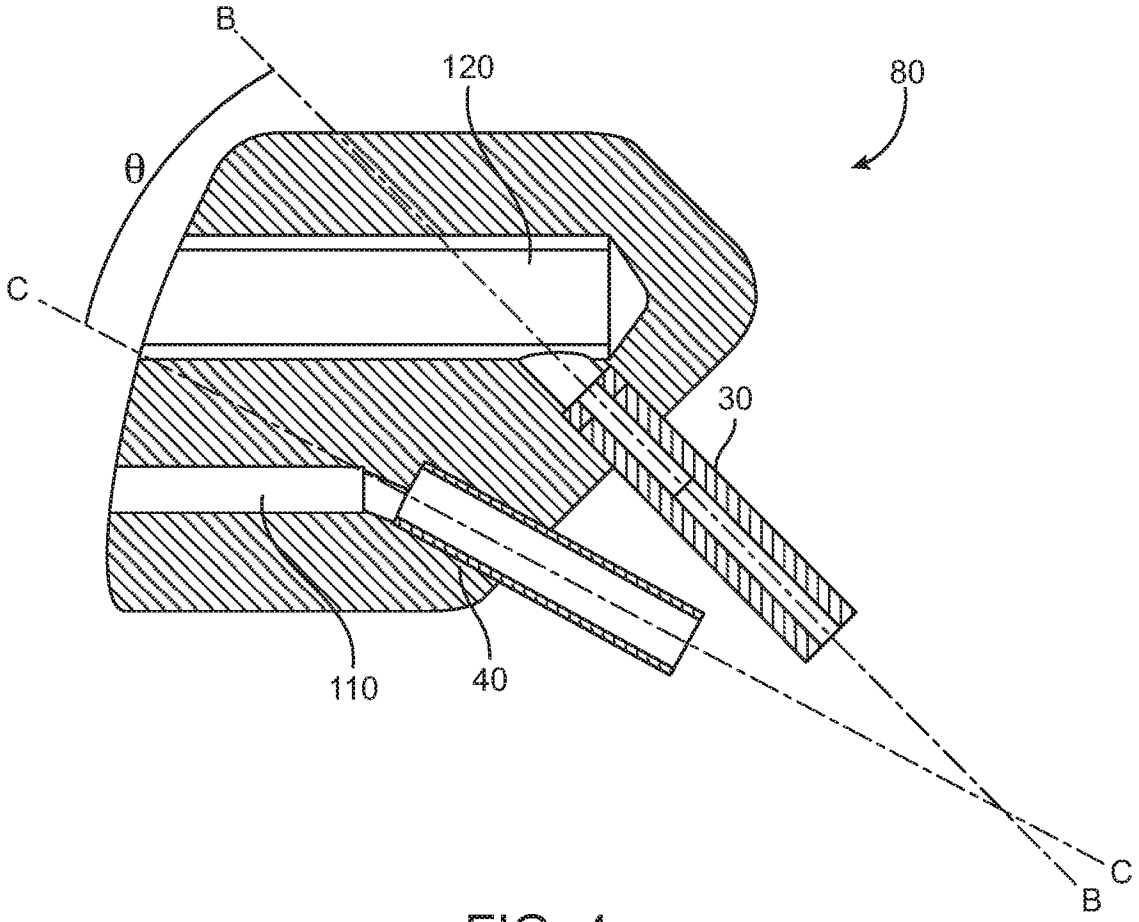

FIG. 4

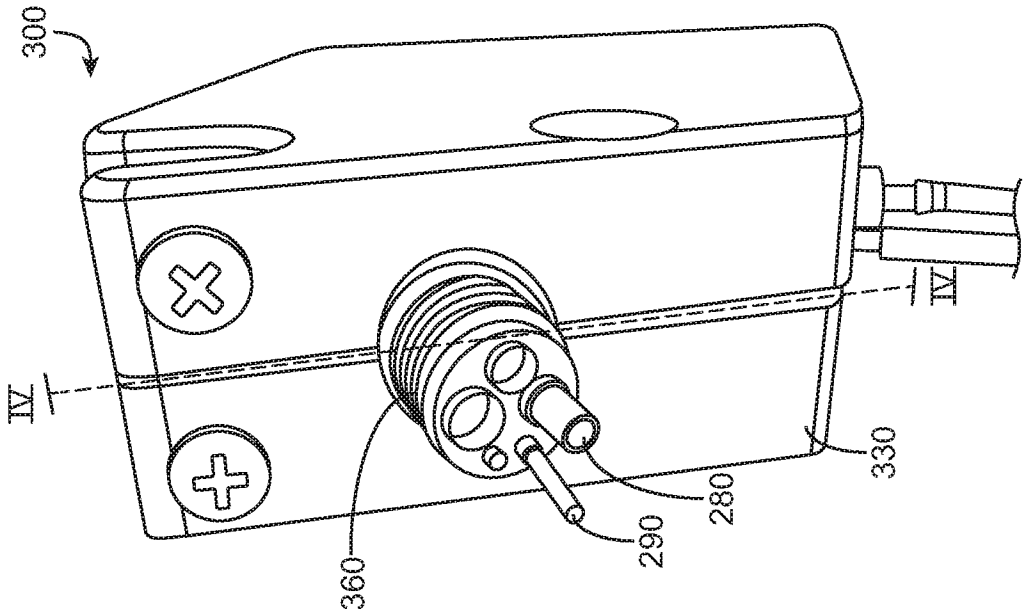
300
IV
IV
360
290
280
330

FIG. 6

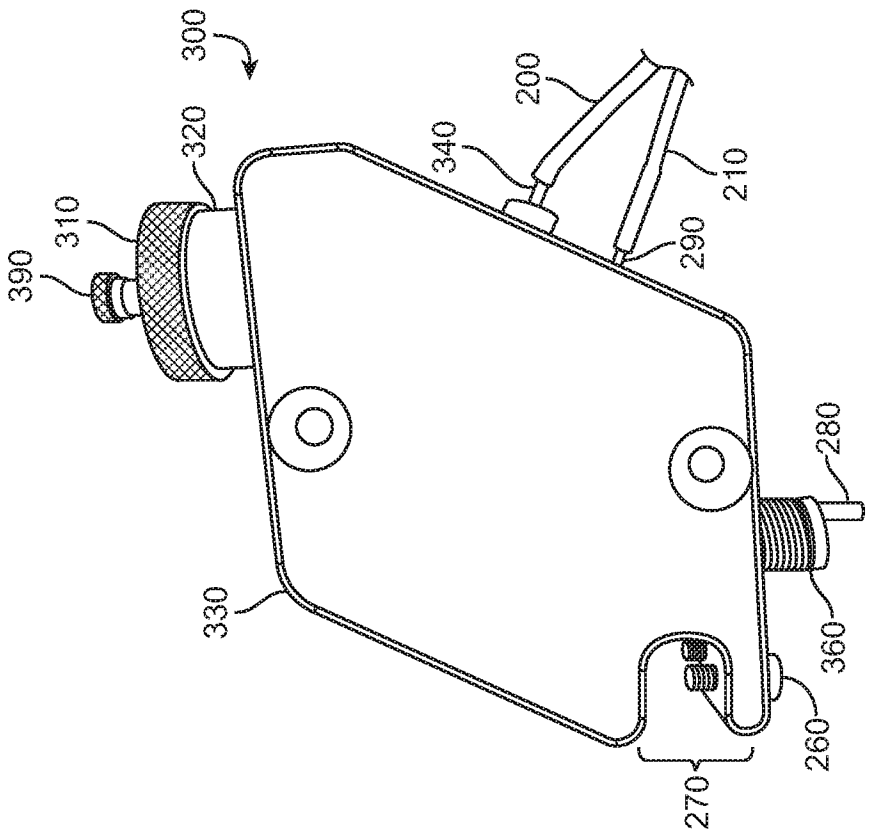
300
320
310
390
340
200
210
290
280
330
360
260
270

FIG. 5

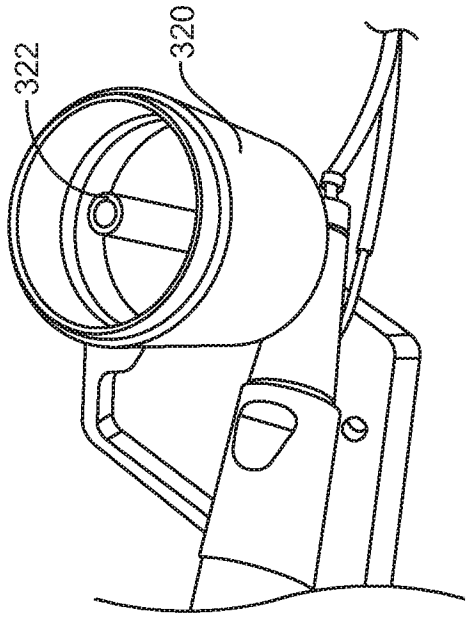

FIG. 8

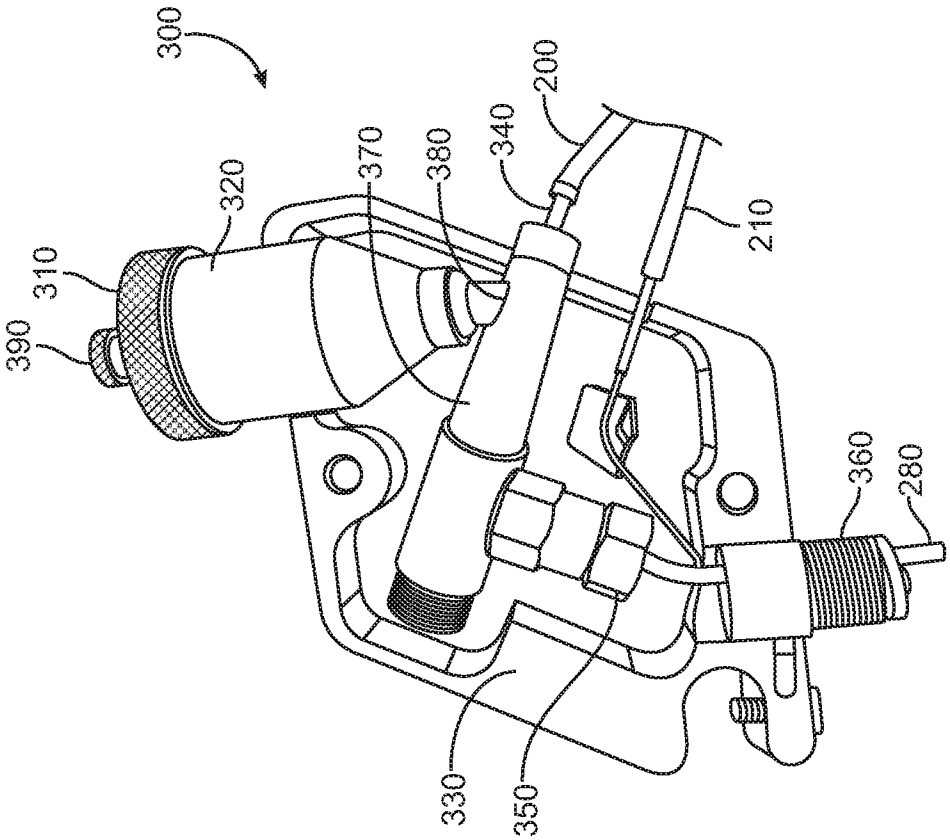

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/021940

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 28
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/021940

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A61C 3/025; A61C 3/02; A61C 17/02; B24C 5/00; B24C 7/00 (2017.01)
CPC - A61C 3/025; A61B 17/545; A61C 17/02; A61C 17/0217; B24C 7/0053 (2017.02)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 433/88; 433/80; 451/90; 451/102 (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2002/0123020 A1 (AUMULLER et al) 05 September 2002 (05.09.2002) entire document	1-27, 29
A	US 6,106,288 A (BRASSIL et al) 22 August 2000 (22.08.2000) entire document	1-27, 29
A	US 6,729,942 B2 (HARRIS) 04 May 2004 (04.05.2004) entire document	1-27, 29

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
02 May 2017	23 MAY 2017
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	Authorized officer Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774