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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
30 January 2020 (30.01.2020)

WIPO | PCT

(10) International Publication Number
WO 2020/023046 A1

(51) International Patent Classification:
*A61M 39/06* (2006.01)

(21) International Application Number:
PCT/US2018/043992

(22) International Filing Date:
27 July 2018 (27.07.2018)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant: **VITALCHAINS CORPORATION** [US/US]; 2710 Sandhill Road, Menlo Park, CA 94025 (US).

(72) Inventors: **LIN, Tzu-Chih**; 2F, 12, Shengyi Rd. Sec. 2, Chupei City, Hsinchu County, 302 (TW). **WANG, Ke-Wen**; 2F, 12 Shengyi Rd. Sec. 2, Chupei City, Hsinchu County, 302 (TW).

(74) Agent: **WANG, Chieh-Mei**; ScienBiziP, P.C., 550 South Hope Street, Suite 2825, Los Angeles, CA 90071 (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, JO, 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))*

(54) Title: SURGICAL ACCESS PORT AND TROCAR DEVICE THEREOF

(57) Abstract: The present disclosure provides a surgical access port. The surgical access port includes a trocar seal configured to engage a surgical instrument. The trocar seal includes a seal holder, a first seal roller, and a second seal roller. The seal holder has a trocar hole configured to be inserted with the surgical instrument. The first seal roller and the second seal roller are symmetrically and rotatably disposed on the seal holder. Each of the first seal roller and the second seal roller has a shaft and a roller body. The shaft is disposed on the seal holder. A groove is formed on a cylindrical surface of each of the roller bodies and has a width that changes along a tangential direction of the cylindrical surface.

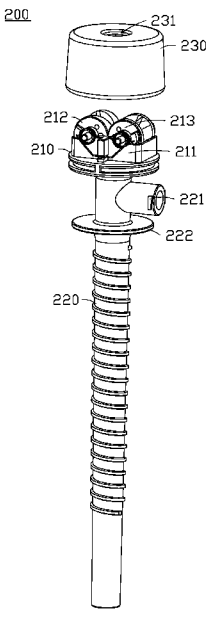


FIG. 2A

WO 2020/023046 A1

# SURGICAL ACCESS PORT AND TROCAR DEVICE THEREOF

## FIELD

**[0001]** The present disclosure generally relates to a surgical access port. More particularly, the present disclosure relates to a surgical access port configured to sealingly engage surgical instruments with various diameters.

## BACKGROUND

**[0002]** Laparoscopic surgery is commonly performed using access ports or trocars, which provide instrument access across an abdominal wall and into a gas pressurized abdominal cavity. Trocar seals within the trocars allow instrument changes with minimal loss in gas pressure. Such trocar seals should be very durable even when challenged by the insertion of sharp-pointed instruments (such as trocar blades). They should be capable of accommodating a wide range of inserted instruments without leakage. FIG. 1A is a perspective view of various types of a conventional trocar seal. FIG. 1B is a top view of the trocar seal of FIG. 1A when inserted by a surgical instrument. The conventional trocar seal 100 is usually made by a silicone compression molding process. The conventional trocar seal 100 has a funnel structure with a closable bottom. The closable bottom can be linear-shaped, cross-shaped, S-shaped, or polygonal. As shown in FIG. 1B, when the surgical

instrument S1 is inserted in the trocar seal 100, the closable bottom of the trocar seal 100 cannot sealingly engage the surgical instrument S1, and hence a gap 101 is usually formed in the trocar seal 100 and causes leakage. In addition to having leakage issues, the conventional trocar seal is hygroscopic and may suffer from mildew if it is not well preserved. The closable bottom of the conventional trocar has a risk of deformation if it is inserted with the surgical instrument for an extended period of time. Also, the conventional trocar seal is not durable to instruments having a wide range of diameter. Furthermore, the compression molding process of the conventional trocar seal has high cost and long manufacturing time.

**[0003]** Accordingly, there remains a need to extend the accommodating range and sealing capability of trocar seals and overcome the above problems.

## SUMMARY OF THE INVENTION

**[0004]** In view of above, an object of the present disclosure is to provide a surgical access port and trocar device thereof. The surgical access port of the present disclosure can sealingly engage surgical instruments with various diameters to prevent air leakage.

**[0005]** To achieve the above object, an embodiment of the present disclosure provides a surgical access port. The surgical access port comprises a trocar seal configured to engage a surgical instrument. The trocar seal comprises a seal holder, a first seal roller, and a second seal roller. The seal holder has a trocar hole configured to be inserted with the surgical

instrument. The first seal roller and the second seal roller are symmetrically and rotatably disposed on the seal holder. Each of the first seal roller and the second seal roller has a shaft and a roller body. The shaft is disposed on the seal holder. A groove is formed on a cylindrical surface of each of the roller bodies and has a width that changes along a tangential direction of the cylindrical surface. When the trocar seal is at a sealed state, the first seal roller and the second seal roller seal over the trocar hole. When the first seal roller and the second seal roller rotate towards each other, the trocar seal changes from the sealed state to an open state, and a through hole is formed above the trocar hole by the grooves of the first seal roller and the second seal roller. A diameter of the through hole changes as the first seal roller and the second seal roller rotate.

**[0006]** To achieve the above object, another embodiment of the present disclosure provides a trocar device comprising a trocar blade, a trocar seal, and a trocar cannula. The trocar seal is configured to engage a surgical instrument. The trocar seal comprises a seal holder, a first seal roller, and a second seal roller. The seal holder has a trocar hole configured to be inserted with the surgical instrument. The first seal roller and the second seal roller are symmetrically and rotatably disposed on the seal holder. Each of the first seal roller and the second seal roller has a shaft and a roller body. The shaft is disposed on the seal holder. A groove is formed on a cylindrical surface of each of the roller bodies and has a width that changes along a tangential direction of the cylindrical surface. When the trocar

seal is at a sealed state, the first seal roller and the second seal roller seal over the trocar hole. When the first seal roller and the second seal roller rotate towards each other, the trocar seal changes from the sealed state to an open state, and a through hole is formed above the trocar hole by the grooves of the first seal roller and the second seal roller. A diameter of the through hole changes as the first seal roller and the second seal roller rotate. The trocar cannula is connected to the trocar hole of the seal holder and configured to allow the trocar blade to be inserted into the trocar cannula through the trocar hole.

**[0007]** To achieve the above object, yet another embodiment of the present disclosure provides a trocar device comprising a trocar seal and a trocar cannula. The trocar seal is configured to engage a surgical instrument. The trocar seal comprises a seal holder, a first seal roller, and a second seal roller. The seal holder has a trocar hole configured to be inserted with the surgical instrument. The first seal roller and the second seal roller are symmetrically and rotatably disposed on the seal holder. Each of the first seal roller and the second seal roller has a shaft and a roller body. The shaft is disposed on the seal holder. A groove is formed on a cylindrical surface of each of the roller bodies and has a width that changes along a tangential direction of the cylindrical surface. When the trocar seal is at a sealed state, the first seal roller and the second seal roller seal over the trocar hole. When the first seal roller and the second seal roller rotate towards each other, the trocar seal changes from the sealed state to an open state, and a through hole is formed above the trocar hole by

the grooves of the first seal roller and the second seal roller. A diameter of the through hole changes as the first seal roller and the second seal roller rotate. The trocar cannula is connected to the trocar hole of the seal holder and configured to allow the surgical instrument to be inserted into the trocar cannula through the trocar hole. The trocar cannula comprises two ends. A blade structure is formed at one end of the trocar cannula. The other end of the trocar cannula is connected to the trocar hole of the seal holder.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0008]** Implementations of the present disclosure will now be described, by way of example only, with reference to the attached figures.

**[0009]** FIG. 1A is a perspective view of various types of a conventional trocar seal according to the prior art.

**[0010]** FIG. 1B is a top view of the conventional trocar seal of FIG. 1A when inserted with a surgical instrument according to the prior art.

**[0011]** FIG. 2A is a perspective view of a surgical access port according to a first embodiment of the present disclosure when a top cover of the surgical access port is disassembled.

**[0012]** FIG. 2B is a perspective view of the surgical access port of FIG. 2A when the top cover of the surgical access port is assembled.

**[0013]** FIG. 3A is a partially enlarged perspective view of a trocar seal of the surgical access port of FIG. 2A.

**[0014]** FIG. 3B is a top view of the trocar seal of FIG. 3A at a sealed state.

**[0015]** FIG. 3C is a top view of the trocar seal of FIG. 3A at an open state.

**[0016]** FIG. 4A is a perspective view of a seal holder of the trocar seal of FIG. 3A.

**[0017]** FIG. 4B is a top view of the seal holder of FIG. 4A.

**[0018]** FIG. 5A is a perspective view of the trocar seal of FIG. 3A and a trocar blade.

**[0019]** FIG. 5B is a cross-sectional view of the trocar seal and the trocar blade of FIG. 5A along a plane I-I.

**[0020]** FIGs. 5C and 5D are cross-sectional views of the trocar seal and the trocar blade of FIG. 5A along the plane I-I when the trocar blade is inserted in the trocar seal.

**[0021]** FIGs. 6A to 6C are cross-sectional views of the trocar seal of FIG. 5A along a plane II-II at the sealed state and the open state.

**[0022]** FIG. 7A is a perspective view of a trocar device according to a second embodiment of the present disclosure.

**[0023]** FIG. 7B is an exploded view of the trocar device of FIG. 7A.

**[0024]** FIG. 8 is a perspective view of a trocar device according to a third embodiment of the present disclosure.

## DETAILED DESCRIPTION

**[0025]** The present disclosure will now be described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments of the disclosure are shown. This disclosure may, however, be embodied in many different forms and should not be construed as limited to the exemplary embodiments set forth herein. Rather, these exemplary embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the disclosure to those skilled in the art. Like reference numerals refer to like elements throughout.

**[0026]** The terminology used herein is for the purpose of describing particular exemplary embodiments only and is not intended to be limiting of the disclosure. As used herein, the singular forms “a”, “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises” and/or “comprising,” or “includes” and/or “including” or “has” and/or “having” when used herein, specify the presence of stated features, regions, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, regions, integers, steps, operations, elements, components, and/or groups thereof.

**[0027]** It will be understood that the term "and/or" includes any and all combinations of one or more of the associated listed items. It will also be understood that, although the terms first, second, third etc. may be used herein to describe various elements, components, regions,

parts and/or sections, these elements, components, regions, parts and/or sections should not be limited by these terms. These terms are only used to distinguish one element, component, region, part or section from another element, component, region, layer or section. Thus, a first element, component, region, part or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the present disclosure.

**[0028]** Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this disclosure belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and the present disclosure, and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

**[0029]** The description will be made as to the exemplary embodiments of the present disclosure in conjunction with the accompanying drawings in FIGs. 2A to 8. Reference will be made to the drawing figures to describe the present disclosure in detail, wherein depicted elements are not necessarily shown to scale and wherein like or similar elements are designated by same or similar reference numeral through the several views and same or similar terminology.

**[0030]** The present disclosure will be further described hereafter in combination with

accompanying drawings.

**[0031]** Referring to FIGs. 2A and 2B, perspective views of a surgical access port according to a first embodiment of the present disclosure are illustrated. As shown in FIGs. 2A and 2B, the surgical access port 200 includes a trocar seal 210, a trocar cannula 220, and a top cover 230. The trocar seal 210 is made by a thermoplastic rubber (TPR) injection process. Compared to silicone, TPR is resistant to mildew and deformation. The trocar seal 210 is configured to engage a surgical instrument (such as a trocar blade or a trocar endoscope). The trocar cannula 220 is connected to the trocar seal 210. The top cover 230 is configured to house the trocar seal 210. The top cover 230 has a cover hole 231 to allow the surgical instrument to be inserted into the trocar seal 210. In FIG. 2A, the top cover 230 is disassembled from the trocar seal 210. In FIG. 2B, the top cover 230 is assembled with the trocar seal 210.

**[0032]** Referring to FIGs. 3A, 3B, and 3C, a partially enlarged perspective view and top views of the trocar seal 210 of the surgical access port 200 of FIG. 2A are illustrated. As shown in FIGs. 3A and 3B, the trocar seal 210 includes a seal holder 211, a first seal roller 212, and a second seal roller 213. Referring to FIGs. 4A and 4B, a perspective view and a top view of the seal holder 211 of FIG. 3A are illustrated. As shown in FIG. 4B, the seal holder 211 has a trocar hole 211f configured to be inserted with the surgical instrument. As shown in FIGs. 3A, 3B, and 3C, the first seal roller 212 and the second seal roller 213 are

symmetrically and rotatably disposed on the seal holder 211. Each of the first seal roller 212 and the second seal roller 213 has a shaft and a roller body. Respectively, the first seal roller 212 has a shaft 212a and a roller body 212b; and the seal roller 213 has a shaft 213a and a roller body 213b. The shafts 212a and 213b are disposed on the seal holder 211. A groove G1 is formed on a cylindrical surface 212c of the roller body 212b of the first seal roller 212. Similarly, a groove G2 is formed on a cylindrical surface 213c of the roller body 213b of the second seal roller 213. As shown in FIG. 3B, the groove G1 has a width W1 that changes along a tangential direction of the cylindrical surface 212c; and the groove G2 has a width W2 that changes along a tangential direction of the cylindrical surface 213c. Each of the grooves G1, G2 may include a first groove portion and a second groove portion. The first groove portion and the second groove portion may have different curvatures. It is to be notice that the first seal roller 212 and the second seal roller 213 are symmetrically and rotatably disposed on the seal holder 211. The first groove portions of the first seal roller 212 and the second seal roller 213 are symmetrically formed; and similarly the second groove portions of the first seal roller 212 and the second seal roller 213 are symmetrically formed. When the trocar seal 210 is at a sealed state, as shown in FIG. 3B, the first seal roller 212 and the second seal roller 213 seal over the trocar hole 211f. As shown in FIG. 3C, when the first seal roller 212 and the second seal roller 213 rotate towards each other, the trocar seal 210 changes from the sealed state to an open state, and a through hole H2 is formed above the trocar hole 211f by

the grooves G1, G2 of the first seal roller 212 and the second seal roller 213. A diameter D of the through hole H2 changes as the first seal roller 212 and the second seal roller 213 rotate. To be specifically, the through hole H2 is formed between the first seal roller 212 and the second seal roller 213. The diameter D of the through hole H2 is changeable upon the rotation of the first seal roller 212 and the seal roller 213.

**[0033]** As shown in FIGs. 3A to 3C, each of the grooves G1, G2 are respectively formed partially around the cylindrical surface 212c, 213c of the roller bodies 212b, 213b. When the first seal roller 212 and the second seal roller 213 rotate towards each other for a predetermined angle, the diameter D of the through hole H2 reaches a maximum value. In a preferred exemplary embodiment, the diameter D of the through hole H2 increases linearly as the trocar seal 210 transitions from the sealed state to the open state. In another preferred exemplary embodiment, the diameter D of the through hole H2 increases non-linearly as the trocar seal 210 transitions from the sealed state to the open state.

**[0034]** As shown in FIG. 3C, the trocar cannula 220 is connected to the trocar hole 211f of the seal holder 211 and configured to allow the surgical instrument to be inserted into the trocar cannula 220 through the trocar hole 211f. When the trocar seal 210 is at the open state, the surgical instrument is inserted into the trocar cannula 220 through the through hole H2 and the trocar hole 211f. As shown in FIG. 2B, the trocar cannula 220 includes a trocar tub 221 configured to allow pressurized air to be injected into the trocar cannula 220. The trocar

cannula 220 further includes a stop plate 222 formed around an outer surface of the trocar cannula 220. When the trocar cannula 220 is inserted into a body cavity of a patient, the stop plate 222 is disposed between the trocar tub 221 and the patient's skin to prevent the trocar tub 221 from entering the body cavity.

**[0035]** As shown in FIGs. 3A to 4B, the seal holder 211 includes a holder plate 211a and a shaft supports 211b disposed on the holder plate 211a. The trocar hole 211f is formed on the holder plate 211a. The shafts 212a, 213a of the first seal roller 212 and the second seal roller 213 are supported by the shaft support 211b. The trocar seal 210 further includes at least one spring connected to the first seal roller 212 and the second seal roller 213. In this embodiment, the trocar seal 210 includes two springs 214a, 214b connected to the first seal roller 212 and the second seal roller 213. When the surgical instrument is removed from the trocar seal 210, each of the springs 214a, 214b provides a resilience force to rotate the first seal roller 212 and the second seal roller 213, therefore returning the trocar seal 210 back to the sealed state. Each of the springs 214a, 214b includes two coils and two ends. The two coils of each of the springs 214a, 214b respectively coil around the shafts 212a, 213a of the first seal roller 212 and the second seal roller 213. The two ends of each of the springs 214a, 214b are respectively fixed on the roller bodies 212b, 213b of the first seal roller 212 and the second seal roller 213. The seal holder 211 has at least one pin structure disposed on the shaft support 211b. In this embodiment, the seal holder has two pin structures 211d, 211e

disposed on the shaft support 211b. The spring 214a is fixed on the shaft support 211b by the pin structure 211d. Similarly, the spring 214b is fixed on the shaft support 211b by the pin structure 211e.

**[0036]** Referring to FIGs. 5A to 6C, a perspective view and cross-sectional views of the trocar seal of FIG. 3A when inserted with a trocar blade are illustrated. FIG. 5A is a perspective view of the trocar seal 210 of FIG. 3A and a trocar blade S2. In FIG. 5A, the surgical instrument described hereinabove is illustrated by the trocar blade S2. FIG. 5B is a cross-sectional view of the trocar seal 210 and the trocar blade S2 of FIG. 5A along a plane I-I. FIGs. 5C and 5D are cross-sectional views of the trocar seal 210 and the trocar blade S2 of FIG. 5A along the plane I-I when the trocar blade S2 is inserted in the trocar seal 210. FIGs. 6A to 6C are cross-sectional views of the trocar seal 210 of FIG. 5A along a plane II-II at the sealed state and the open state. Before inserting the trocar blade S2, the trocar seal 210 is at the sealed state, as shown in FIGs. 5A, 5B and 6A. As the trocar blade S2 are pushed into the trocar seal 210 between the first seal roller 212 and the second seal roller 213, the first seal roller 212 and the second roller 213 rotate towards each other by a friction force generated among the trocar blade S2, the first seal roller 212, and the second seal roller 213. Therefore, the through hole H2 is formed by the grooves G1, G2. More specifically, the first seal roller 212 rotates clockwise and second seal roller 213 rotates counter-clockwise so that the first groove portions of both of the grooves G1, G2 face each other, as shown in FIG. 5C. As the

trocar blade S2 keeps being inserted into the trocar seal 210, the first seal roller 212 keeps rotating clockwise, and the second seal roller 213 keeps rotating counter-clockwise. The second groove portions of both of grooves G1, G2 face each other as shown in FIG. 5D. The diameter of the through hole H2 changes with a width of a part of the trocar blade S2 that is in contact with the first seal roller 212 and the second seal roller 213.

**[0037]** When the trocar blade S2 is inserted into the through hole H2 between the first seal roller 212 and the second seal roller 213, the diameter of the through hole H2 changes with the width of the part of the trocar blade S2 that is in contact with the first seal roller 212 and the second seal roller 213. As shown as FIG. 5C, when a tip portion of the trocar blade S2 is inserted into the through hole H2 between the first seal roller 212 and the second seal roller 213, the diameter of the through hole H2 equals to a width of the tip portion of the trocar blade S2. As shown as FIG. 5D, when a middle portion of the trocar blade S2 is further inserted into the first seal roller 212 and the second seal roller 213, the diameter of the through hole H2 equals to a width of the middle portion of the trocar blade S2. It should be noted that the width of the middle portion of the trocar blade S2 is bigger than the width of the tip portion of the trocar blade S2. Therefore, the diameter of the through hole H2 of FIG. 5D is greater than that of FIG. 5C. The first seal roller 212 and the second seal roller 213 are made of rubbers or other soft materials in order to consistently comply with an outer shape of trocar blade S2 when the trocar blade S2 is inserted into the through hole H2 between the first seal

roller 212 and the second seal roller 213.

**[0038]** When the trocar blade S2 is fully inserted into the trocar seal 210, the first seal roller 212 and the second seal roller 213 stop rotating towards each other. During the insertion process of the trocar blade S2, the trocar seal 210 is sealingly engaged with the trocar blade S2 to prevent air leakage. When the trocar blade S2 is pulled out from the trocar seal 210, the springs 214a, 214b provide the resilience force to cause the first seal roller 212 and the second seal roller 213 to rotate against each other therefore returning the trocar seal 210 back to the sealed state. To be more specifically, the springs 214a, 214b provide the resilience force to cause the first seal roller 212 to rotate counter-clockwise and the second seal roller 213 to rotate clockwise, therefore returning the trocar seal 210 back to the sealed state. In FIG. 6A, the trocar seal 210 is at the sealed state. At the open state, as the first seal roller 212 and the second seal roller 213 rotate towards each other, and the diameter D of the through hole H2 increases, as shown in FIGs. 6B to 6C. In a preferred exemplary embodiment, when the first seal roller 212 and the second seal roller 213 rotate toward each other for the predetermined angle (such as 180 degree or 270 degree), the diameter D of the through hole H2 reaches the maximum value. Therefore, the through hole H2 can sealingly match with surgical instruments having various diameters to prevent air leakage.

**[0039]** In a second embodiment, the present disclosure provides a trocar device 300 as shown in FIGs. 7A and 7B. The trocar device 300 of the second embodiment includes a

trocar blade S3, a trocar seal 310, and a trocar cannula 320. The trocar device 300 further includes a top cover 330 configured to house the trocar seal 310. The trocar seal 310, the trocar cannula 320, and the top cover 330 can respectively be referred to the trocar seal 210, the trocar cannula 220, and the top cover 230 of the surgical access port 200 of the first embodiment. The trocar blade S3 can be referred to the trocar blade S2 of the first embodiment. The elements of the trocar device 300 and their connection are similar to those of the first embodiment; no further description is to be repeated herein.

**[0040]** In a third embodiment, the present disclosure also provides a trocar device 400 as shown in FIG. 8. The trocar device 400 of the fourth embodiment includes a trocar seal 410 and a trocar cannula 420. The trocar seal 410 is configured to engage a surgical instrument (such as a trocar endoscope). The trocar device 400 may further include a top cover 430 configured to house the trocar seal 410. The trocar seal 410 and the top cover 430 can respectively be referred to the trocar seal 210 and the top cover 230 of the first embodiment; no further description is to be repeated herein. The trocar seal 410 includes a seal holder having a trocar hole configured to be inserted with the surgical instrument. The trocar cannula 420 is connected to the trocar hole of the seal holder and configured to allow the surgical instrument to be inserted into the trocar cannula 420 through the trocar hole. When the surgical instrument is inserted in the trocar device 400, the surgical instrument is inserted through the top cover 430 and the trocar seal 410, and disposed in the trocar cannula 420.

The trocar cannula 420 has two ends. In the third embodiment, a blade structure 423 is formed at one end of the trocar cannula 420. The other end of the trocar cannula 420 is connected to the trocar hole of the seal holder.

**[0041]** As described above, the surgical access port and the trocar device of the various embodiments of the present disclosure can sealingly engage surgical instruments with various diameters. Also, the trocar seal of the surgical access port is made by a TPR injection process to prevent mildew and deformation. Furthermore, the trocar seal uses springs to provide a resilience force to allow sealing engagement between the trocar seal and the surgical instruments to prevent air leakage during insertion and operation of surgical instruments.

**[0042]** The embodiments shown and described above are only examples. Many details are often found in the art such as the other features of a surgical access port and trocar device thereof. Therefore, many such details are neither shown nor described. Even though numerous characteristics and advantages of the present technology have been set forth in the foregoing description, together with details of the structure and function of the present disclosure, the disclosure is illustrative only, and changes may be made in the detail, especially in matters of shape, size, and arrangement of the parts within the principles of the present disclosure, up to and including the full extent established by the broad general meaning of the terms used in the claims. It will therefore be appreciated that the embodiments described above may be modified within the scope of the claims.

What is claimed is:

1. A surgical access port comprising:

a trocar seal configured to engage a surgical instrument, comprising:

a seal holder having a trocar hole configured to be inserted with the surgical instrument; and

a first seal roller and a second seal roller symmetrically and rotatably disposed on the seal holder,

wherein each of the first seal roller and the second seal roller has a shaft and a roller body, the shaft is disposed on the seal holder, a groove is formed on a cylindrical surface of each of the roller bodies and has a width that changes along a tangential direction of the cylindrical surface.

2. The surgical access port of claim 1, wherein when the trocar seal is at a sealed state, the first seal roller and the second seal roller seal over the trocar hole, when the first seal roller and the second seal roller rotate towards each other, the trocar seal changes from the sealed state to an open state and a through hole is formed above the trocar hole by the grooves of the first seal roller and the second seal roller, and a diameter of the through hole changes as the first seal roller and the second seal roller rotate.

3. The surgical access port of claim 1, wherein each of the grooves is respectively formed partially around the cylindrical surface of each of the roller bodies.

4. The surgical access port of claim 2, wherein when the first seal roller and the second seal roller rotates towards each other for a predetermined angle, the diameter of the through hole reaches a maximum value.

5. The surgical access port of claim 4, wherein when the first seal roll and the second seal roller rotate towards each other, the diameter of the through hole increases.

6. The surgical access port of claim 5, wherein the diameter of the through hole increases linearly as the first seal roller and the second seal roller rotate towards each other.

7. The surgical access port of claim 5, wherein the diameter of the through hole increases non-linearly as the first seal roller and the second seal roller rotate towards each other.

8. The surgical access port of claim 1, further comprising a trocar cannula connected to the trocar hole of the seal holder.

9. The surgical access port of claim 8, wherein the trocar cannula comprises a trocar tub configured to allow air to be injected into the trocar cannula.

10. The surgical access port of claim 8, wherein the trocar cannula further comprises a stop plate formed around an outer surface of the trocar cannula.

11. The surgical access port of claim 1, further comprising a top cover configured to house the trocar seal.

12. The surgical access port of claim 2, wherein the seal holder comprises a holder plate and a shaft support disposed on the holder plate, the trocar hole is formed on the holder plate, and

the shafts of the first seal roller and the second seal roller are supported by the shaft support.

13. The surgical access port of claim 12, wherein the trocar seal further comprises at least one spring connected to the first seal roller and the second seal roller, and when the surgical instrument is removed from the trocar seal, the spring provides a resilience force to rotate the first seal roller and the second seal roller so that the trocar seal returns to the sealed state.

14. The surgical access port of claim 13, wherein the spring comprises two coils and two ends, the two coils of the spring respectively coil around the shafts of the first seal roller and the second seal roller, and two ends of the spring are respectively fixed on the roller bodies of the first seal roller and the second seal roller.

15. The surgical access port of claim 14, wherein the seal holder has at least one pin structure disposed on the shaft support, and the at least one spring is fixed on the shaft support by the at least one pin structure.

16. A trocar device comprising:

a trocar blade;

a trocar seal configured to engage the trocar blade, comprising:

a seal holder having a trocar hole configured to be inserted with the trocar blade; and

a first seal roller and a second seal roller symmetrically and rotatably disposed on the seal holder,

wherein each of the first seal roller and the second seal roller has a shaft and a roller body, the shaft is disposed on the seal holder, a groove is formed on a cylindrical surface of each of the roller bodies and has a width that changes along a tangential direction of the cylindrical surface; and

a trocar cannula connected to the trocar hole of the seal holder and configured to allow the trocar blade to be inserted into the trocar cannula through the trocar hole.

17. The trocar device of claim 16, wherein when the trocar seal is at a sealed state, the first roller and the second seal roller seal over the trocar hole, when the first seal roller and the second seal roller rotate towards each other, the trocar seal changes from the sealed state to an open state and a through hole is formed above the trocar hole by the grooves of the first seal roller and the second seal roller, and a diameter of the through hole changes as the first seal roller and the second seal roller rotate.

18. A trocar device comprising:

a trocar seal configured to engage a surgical instrument, comprising:

a seal holder having a trocar hole configured to be inserted with the surgical instrument; and

a first seal roller and a second seal roller symmetrically and rotatably disposed on the seal holder,

wherein each of the first seal roller and the second seal roller has a shaft and a

roller body, the shaft is disposed on the seal holder, a groove is formed on a cylindrical surface of each of the roller bodies and has a width that changes along a tangential direction of the cylindrical surface; and

a trocar cannula connected to the trocar hole of the seal holder and configured to allow the surgical instrument to be inserted into the trocar cannula through the trocar hole, the trocar cannula comprising two ends, wherein a blade structure is formed at one end of the trocar cannula, and the other end of the trocar cannula is connected to the trocar hole of the seal holder.

19. The trocar device of claim 18, wherein when the trocar seal is at a sealed state, the first roller and the second seal roller seal over the trocar hole, when the first seal roller and the second seal roller rotate towards each other, the trocar seal changes from the sealed state to an open state and a through hole is formed on the trocar hole by the grooves of the first seal roller and the second seal roller, and a diameter of the through hole changes as the first seal roller and the second seal roller rotate.

20. The trocar device of claim 18, wherein each of the grooves is respectively formed partially around the cylindrical surface of each of the roller bodies.

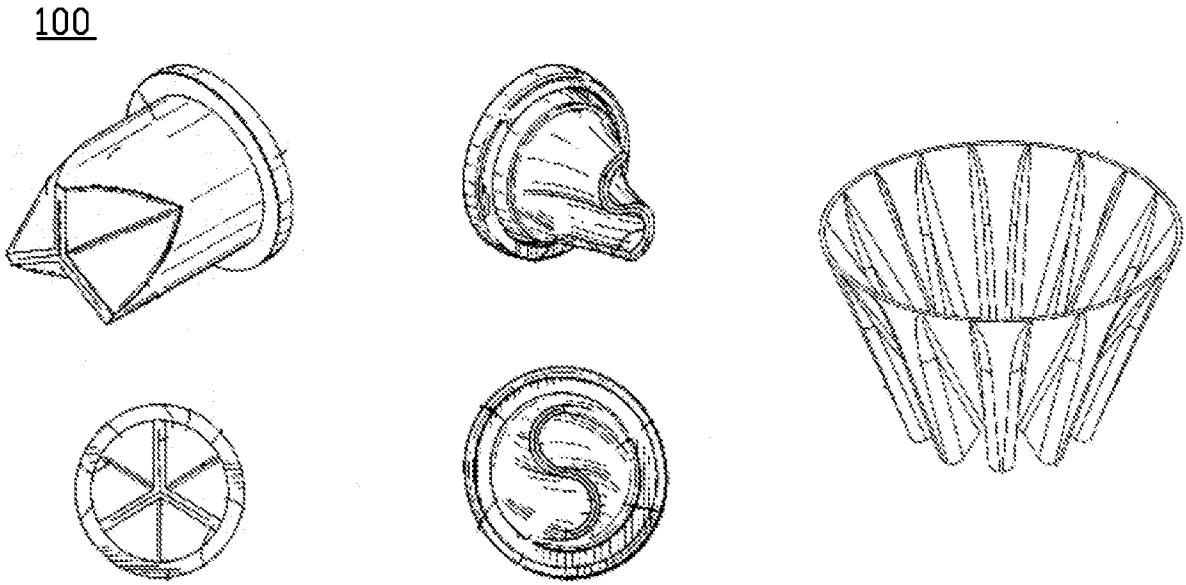


FIG. 1A(Prior Art)

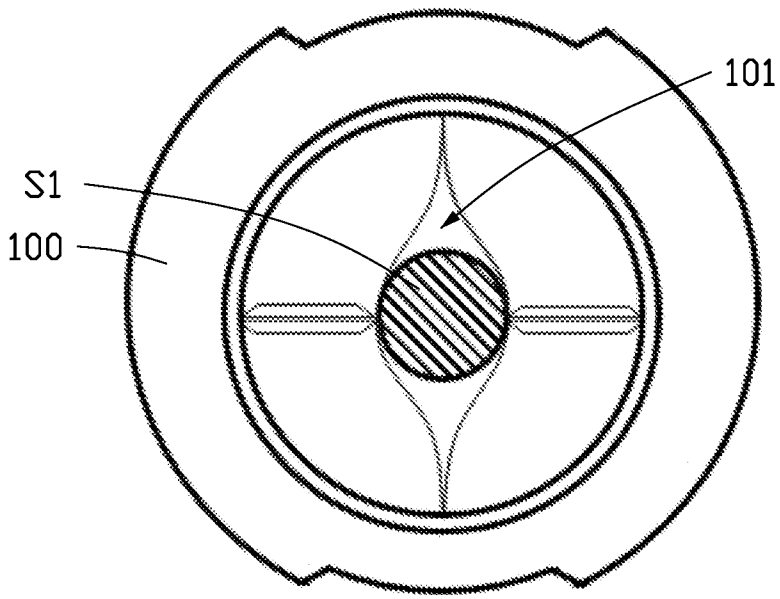


FIG. 1B(Prior Art)

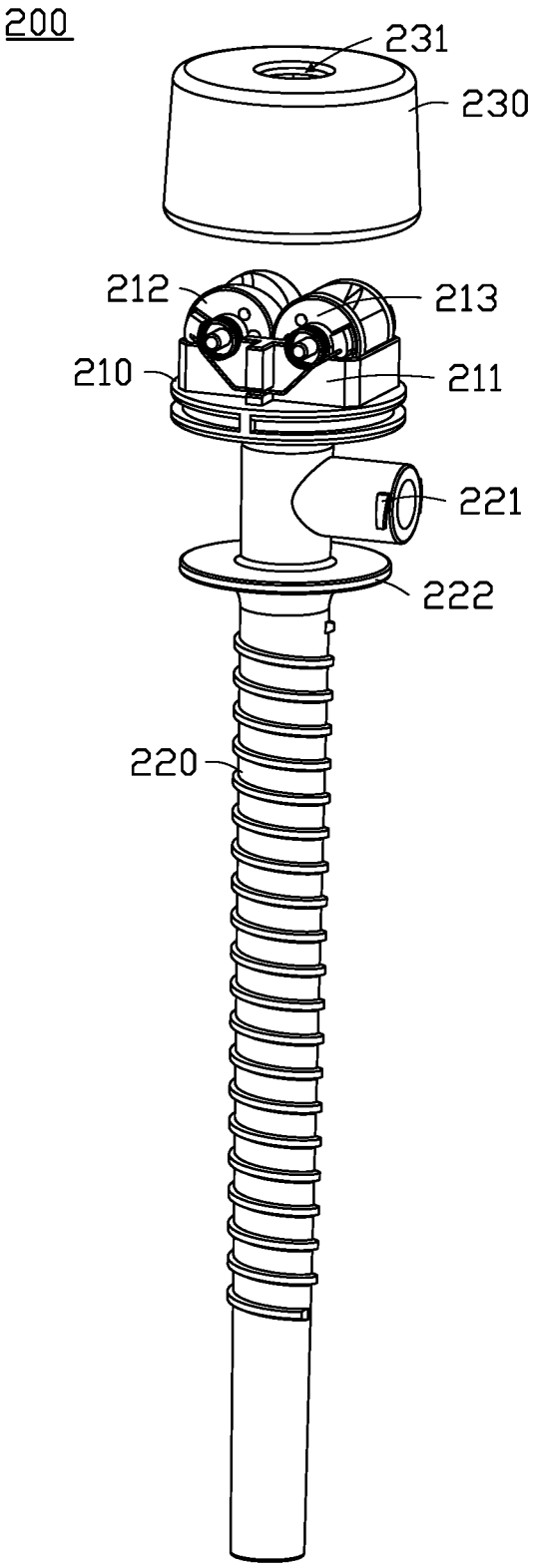


FIG. 2A

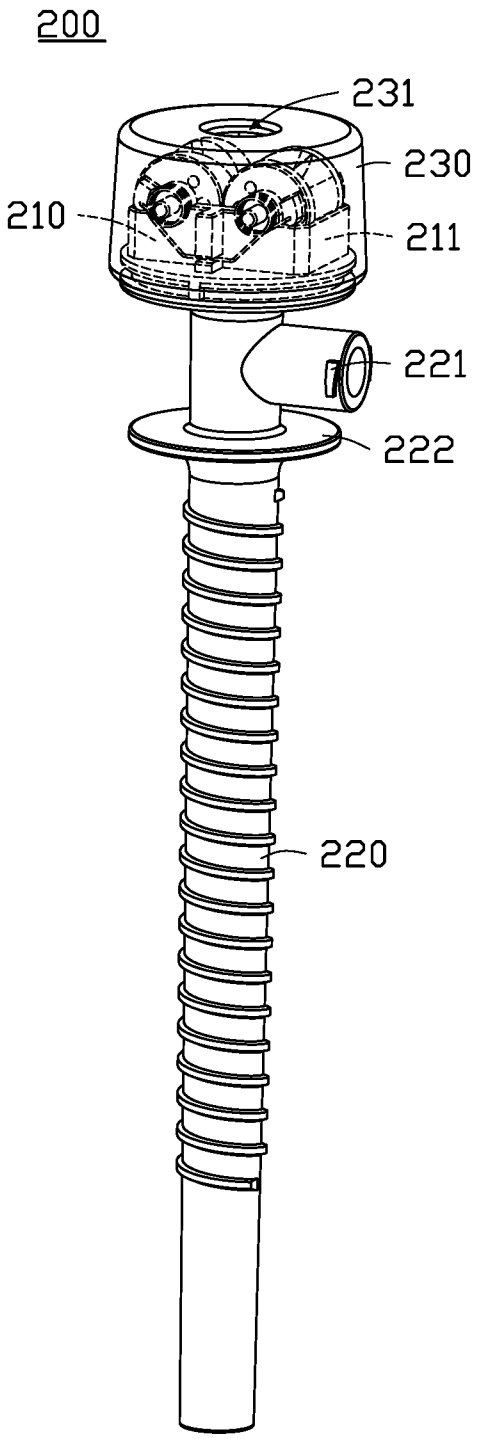


FIG. 2B

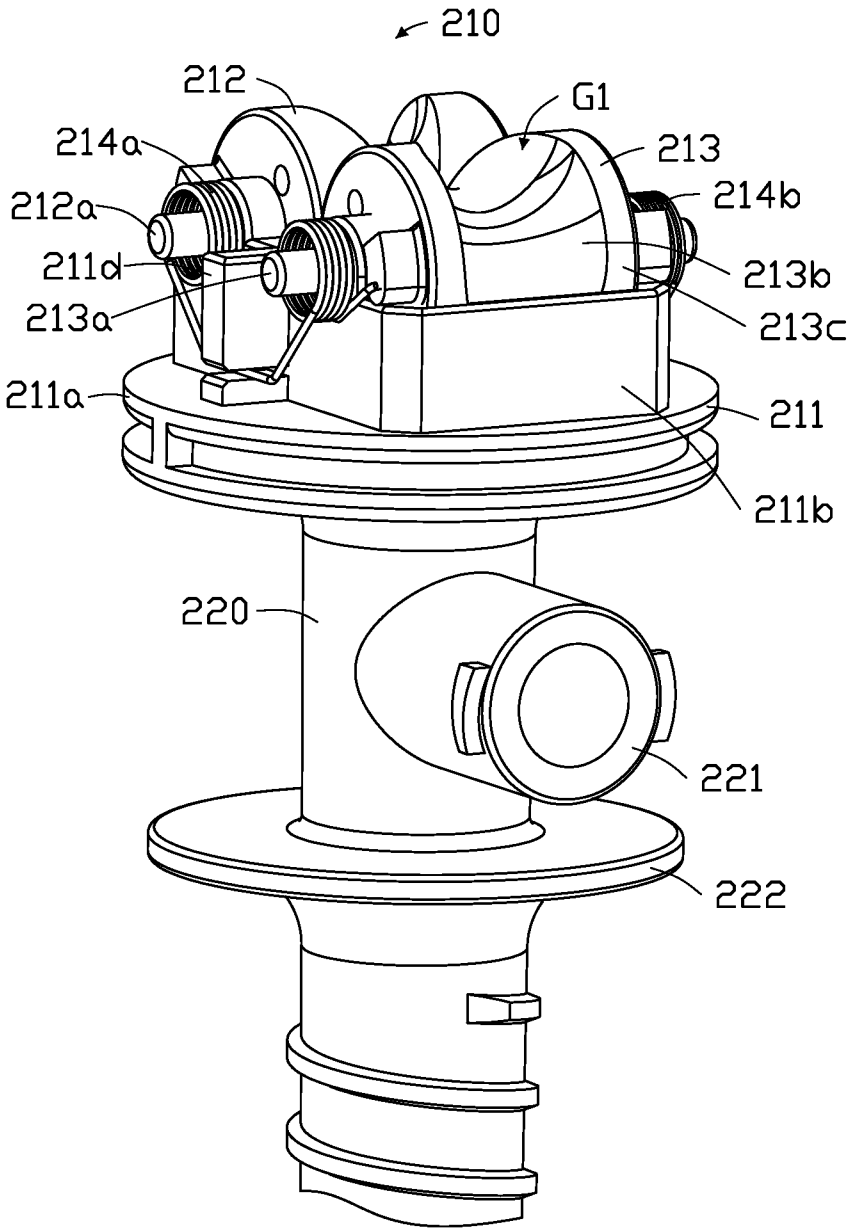
210
212
G1
214a
213
212a
214b
211d
213b
213a
213c
211a
211
211b
220
221
222

FIG. 3A

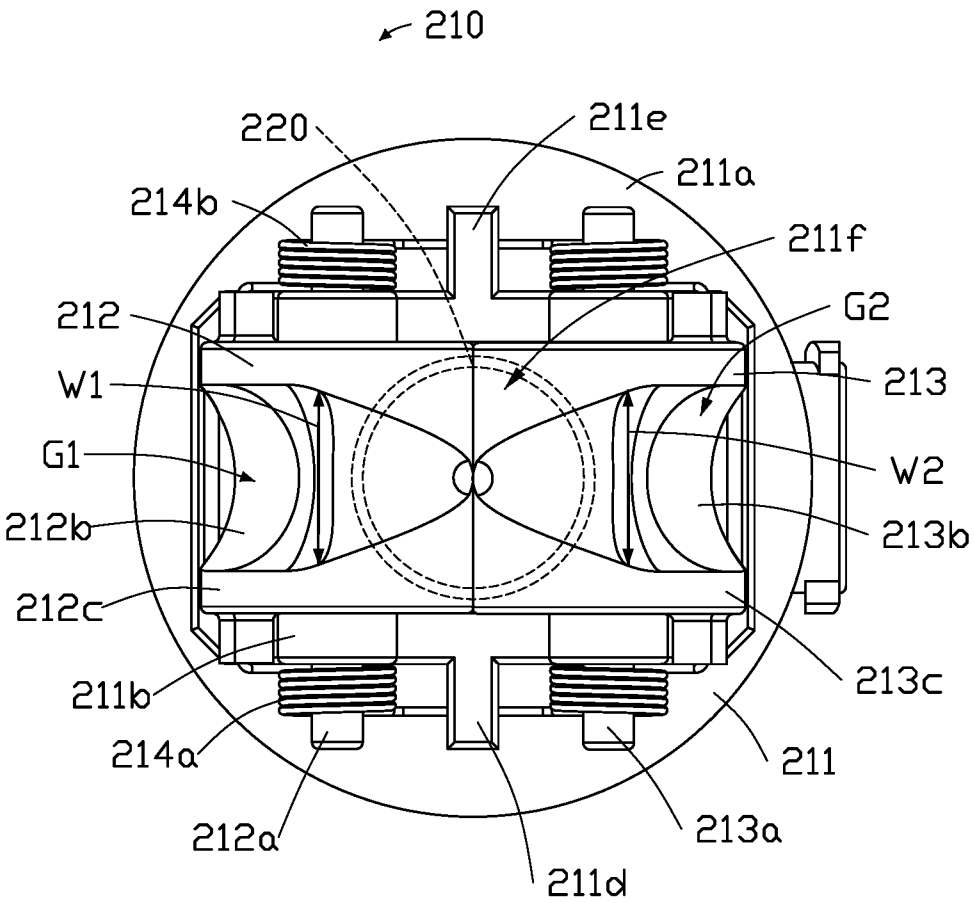
210
220
211e
211a
214b
211f
212
G2
W1
213
G1
W2
212b
213b
212c
213c
211b
211
214a
212a
213a
211d

FIG. 3B

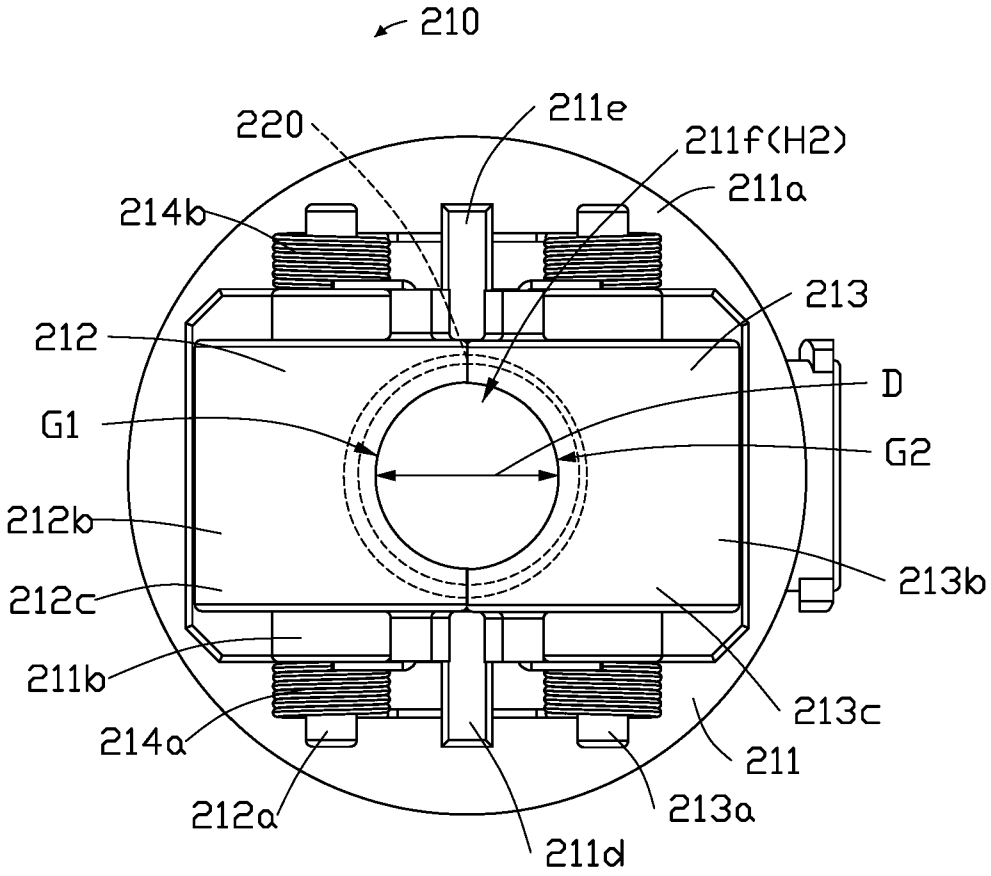
210
220
211e
211f(H2)
211a
214b
213
212
D
G1
G2
212b
213b
212c
211b
213c
214a
211
212a
213a
211d

FIG. 3C

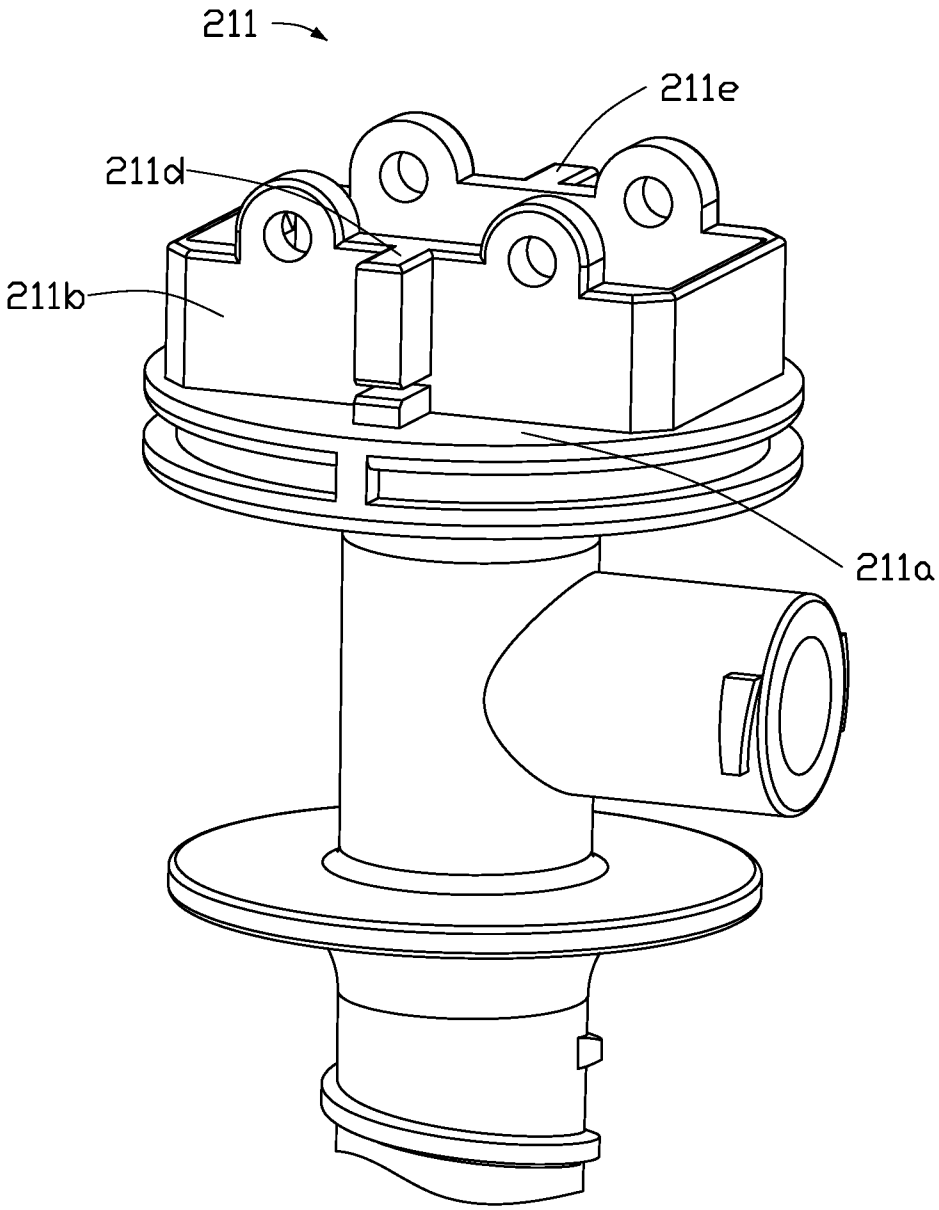


FIG. 4A

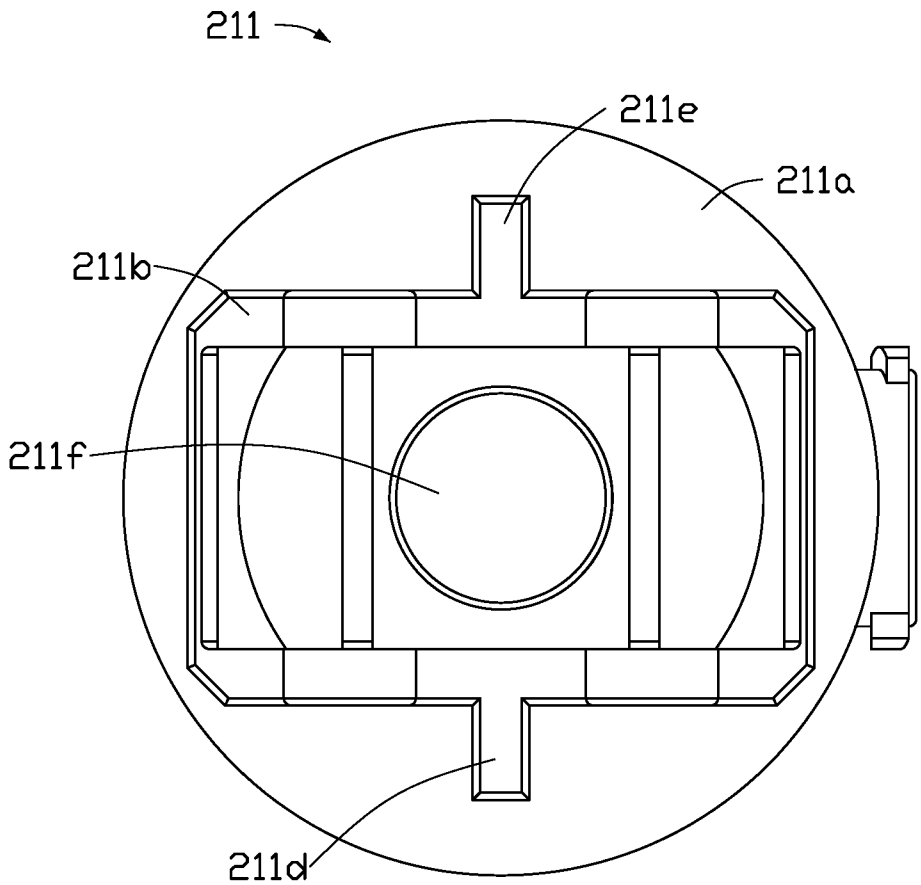


FIG. 4B

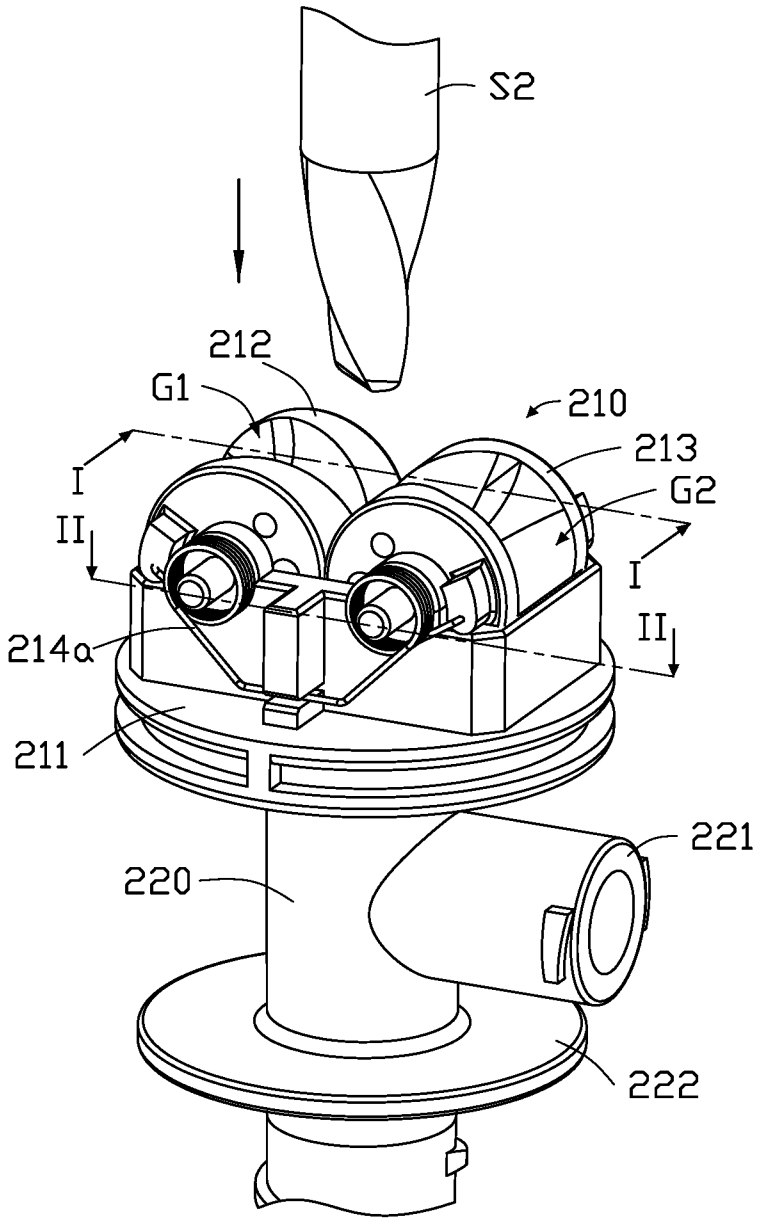


FIG. 5A

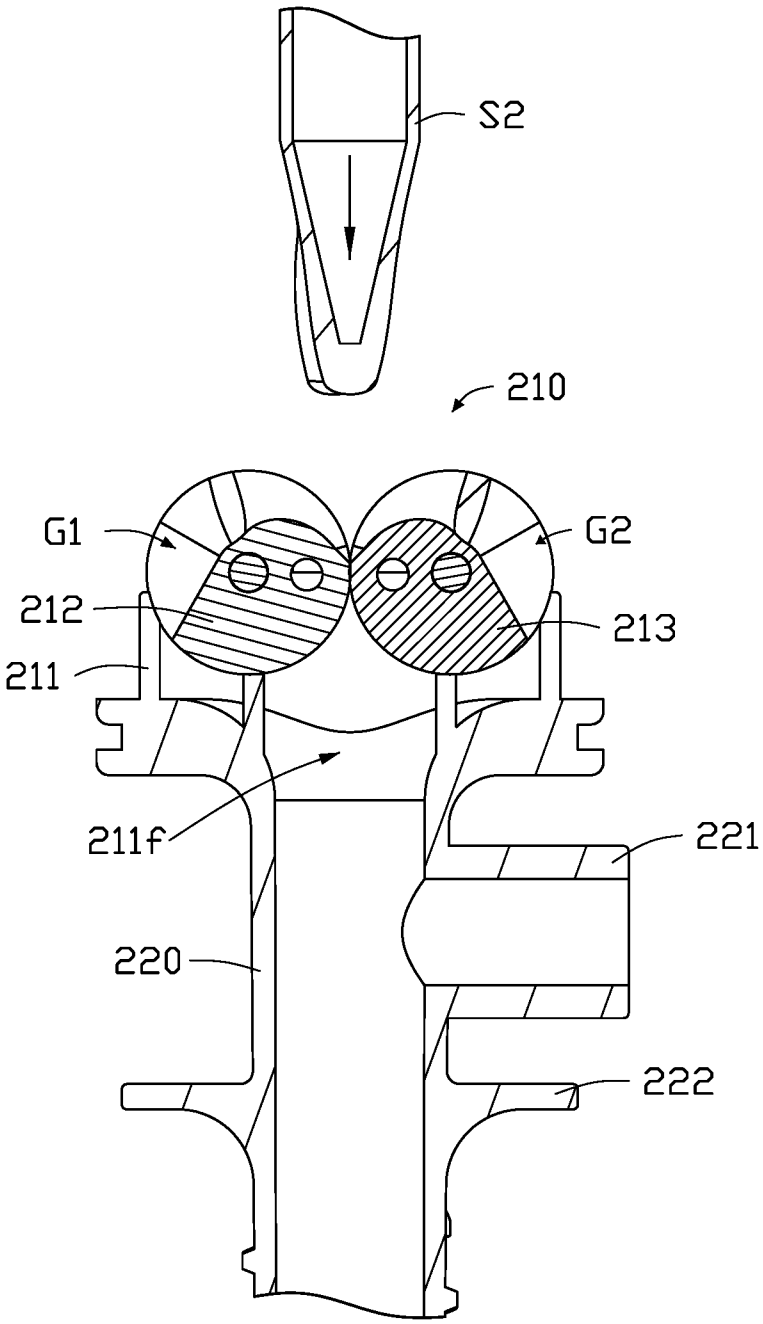


FIG. 5B

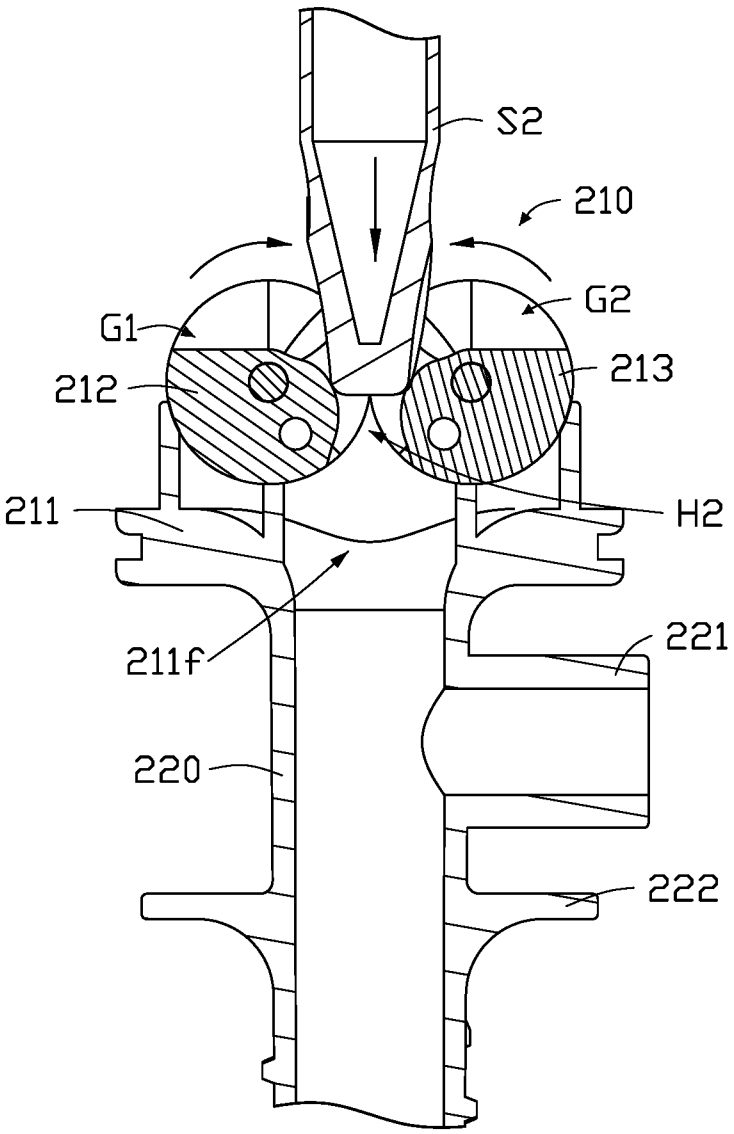


FIG. 5C

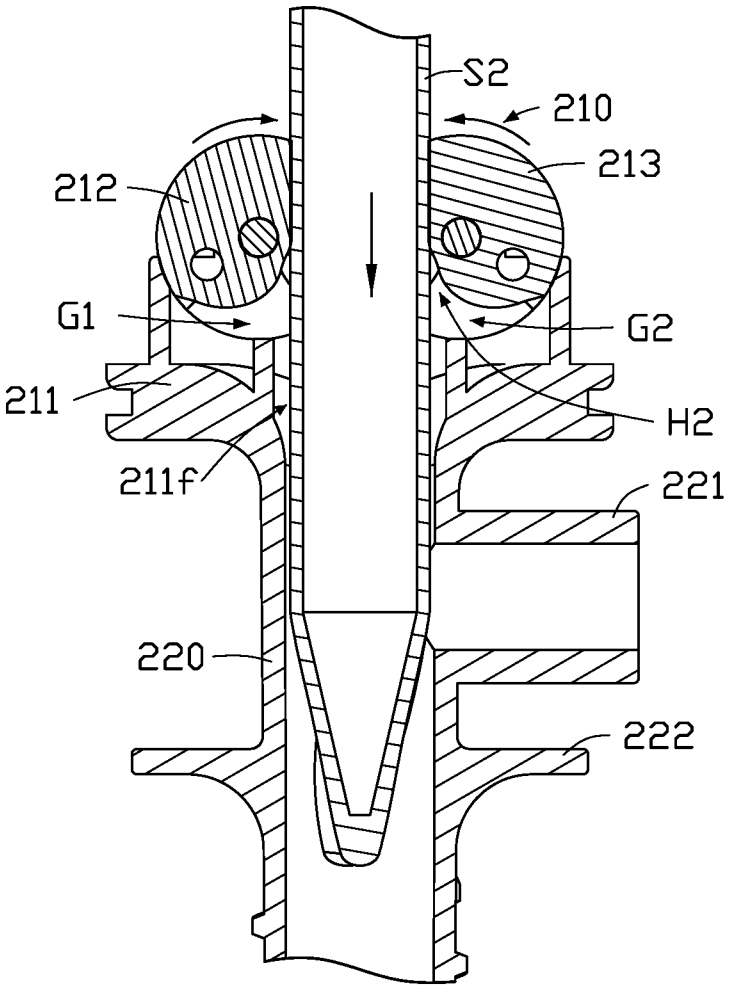


FIG. 5D

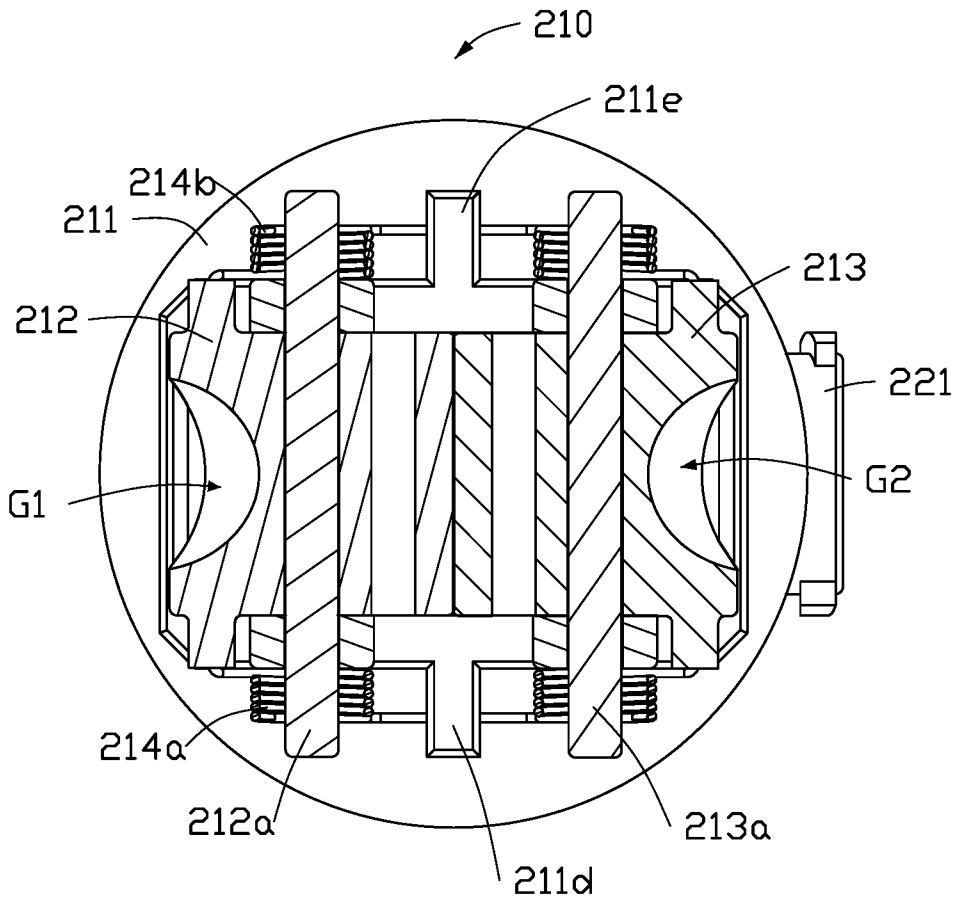


FIG. 6A

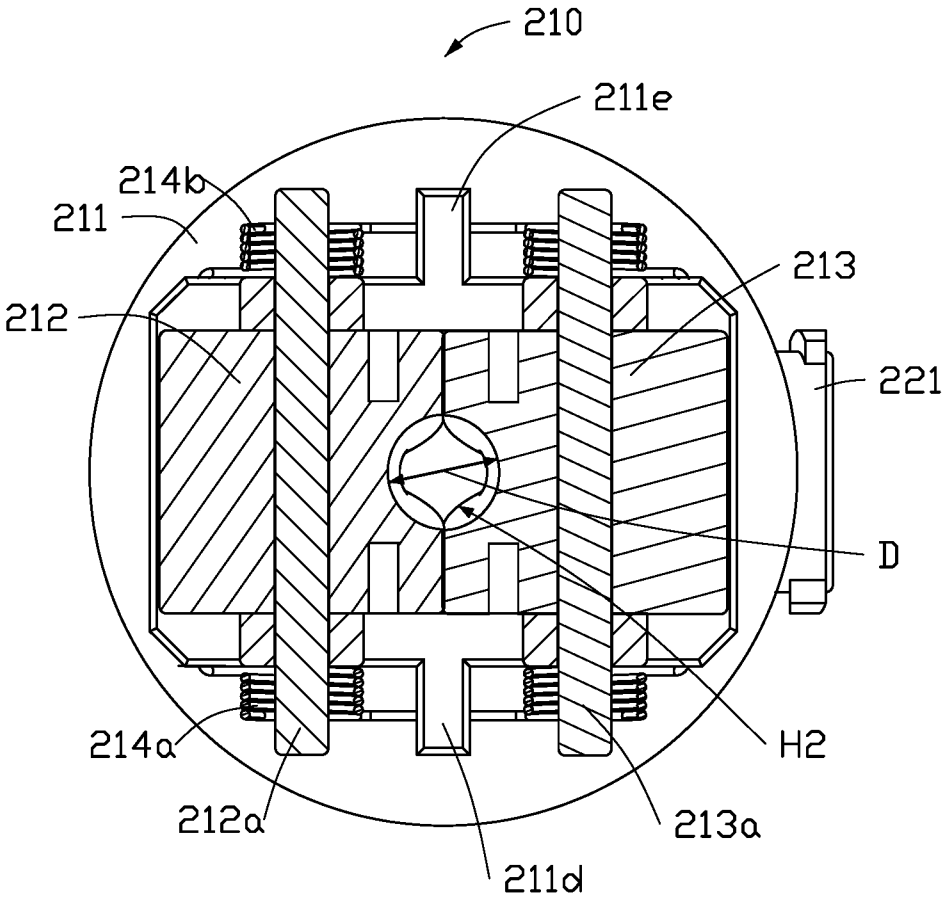


FIG. 6B

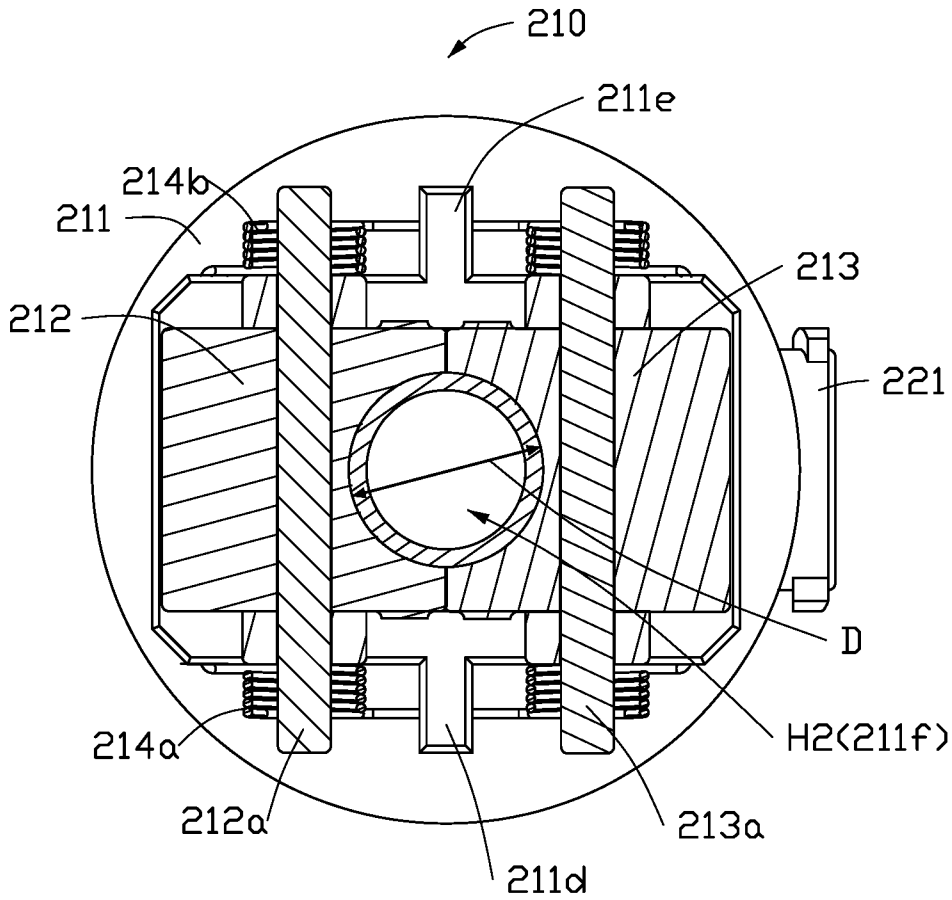


FIG. 6C

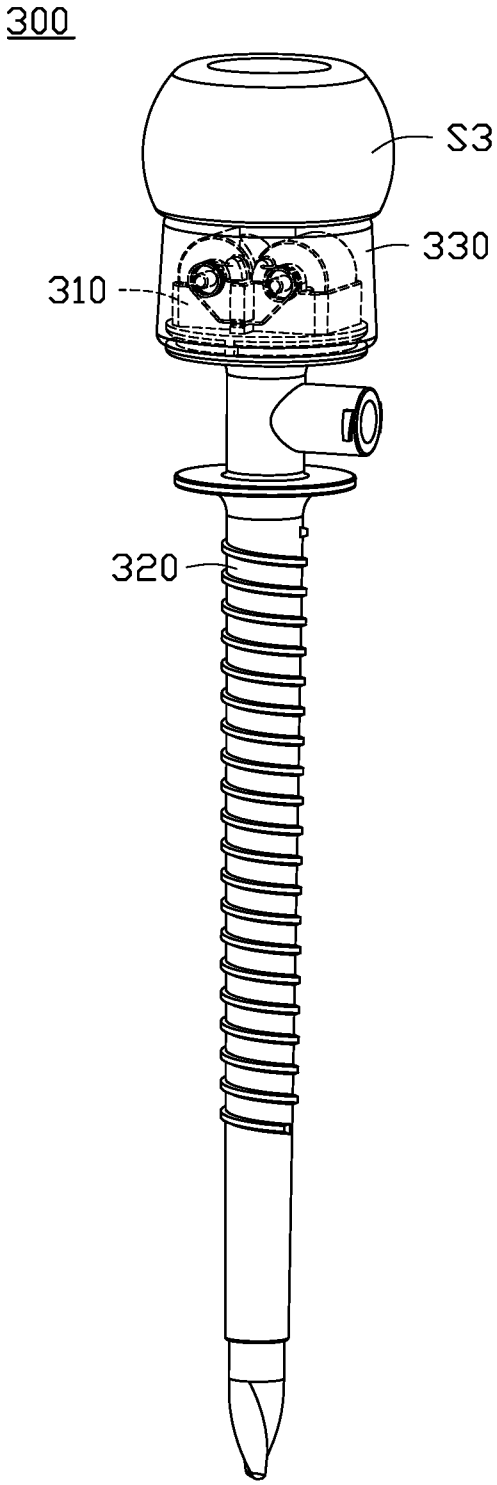


FIG. 7A

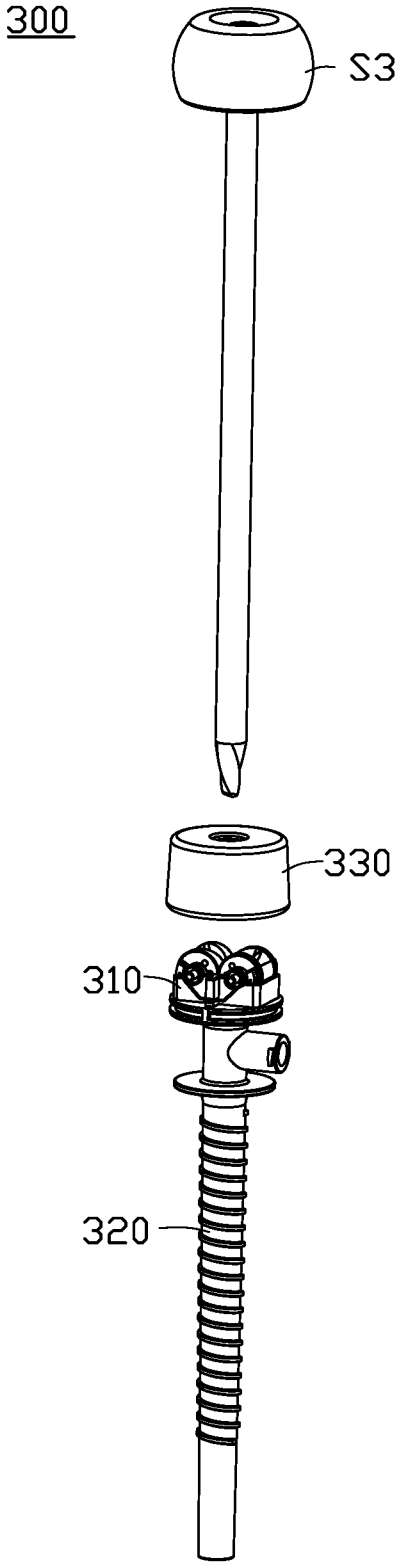


FIG. 7B

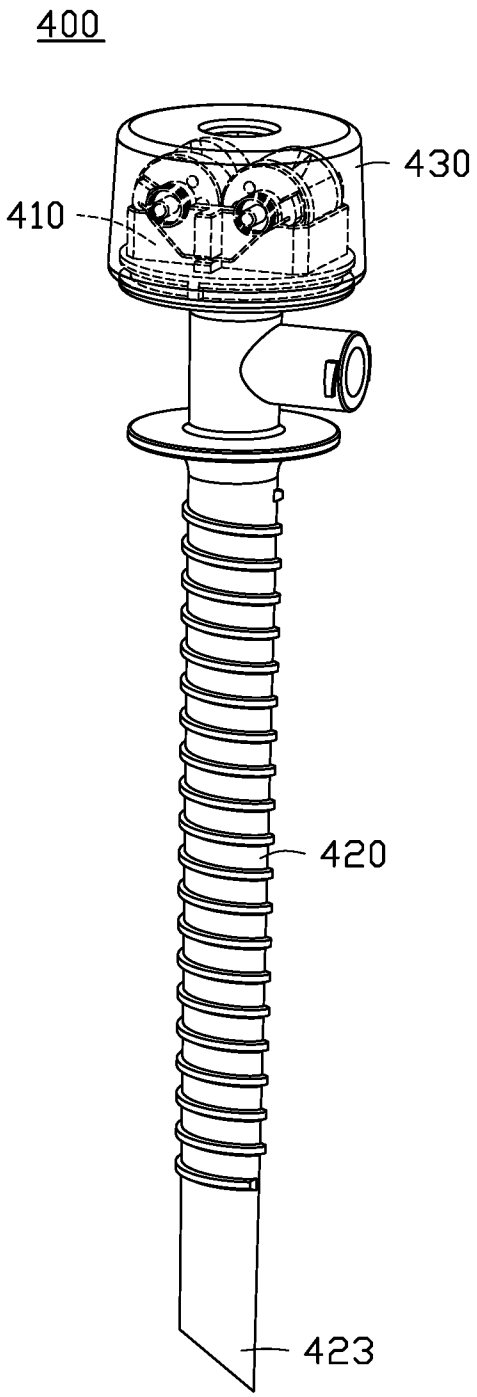


FIG. 8

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 18/43992

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A61M 39/06 (2018.01)
CPC - A61B 17/3462

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
See Search History Document

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<br>--<br>Y<br>--<br>A | US 5,522,831 A (SLEISTER et al.); 4 June 1996 (04.06.1996); entire document, especially Figs. 1-9; col. 5, ln 46-col. 7, ln 12; col. 8, ln 1-44. | 1-11, 16-20<br>----------<br>12-13<br>----------<br>14-15 |
| Y | US 2014/0207070 A1 (ST. JUDE MEDICAL, ATRIAL FIBRILLATION DIVISION, INC); 24 July 2014 (24.07.2014); entire document, especially Fig. 1-8, para. [0021], [0024], [0027], [0028], | 12-13 |
| A | US 5,201,714 A (GENTELIA et al.); 13 April 1993 (13.04.1993); entire document, especially Fig. 2, col. 2, ln 24-48.<br>14-15 | 14-15 |
| A | US 2006/0264998 A1 (JOHNSON et al.); 23 November 2006 (23.11.2006); entire document, especially Fig. 1, 3, para. [0029]-[0030], [0033]-[0036]. | 1-20 |
| A | US 5,300,070 A (GENTELIA et al.); 5 April 1994 (05.04.1994); entire document. | 1-20 |
| A | US 7,727,255 B2 (TAYLOR et al.); 1 June 2010 (01.06.2010); entire document. | 1-20 |

☐ 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 |
|---|---|
| 13 September 2018 | 15 OCT 2018 |
| Name and mailing address of the ISA/US<br>Mail Stop PCT, Attn: ISA/US, Commissioner for Patents<br>P.O. Box 1450, Alexandria, Virginia 22313-1450<br>Facsimile No. 571-273-8300 | Authorized officer:<br>Lee W. Young<br>PCT Helpdesk: 571-272-4300<br>PCT OSP: 571-272-7774 |