



(51) International Patent Classification:

A61B 1/00 (2006.01) A61B 17/00 (2006.01)
A61B 1/005 (2006.01) A61M 25/09 (2006.01)
A61B 1/008 (2006.01) A61B 17/29 (2006.01)
H01B 11/02 (2006.01) A61B 34/00 (2016.01)
A61B 34/30 (2016.01) A61B 1/31 (2006.01)

(21) International Application Number:

PCT/IB2020/058292

(22) International Filing Date:

06 September 2020 (06.09.2020)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/897,293 07 September 2019 (07.09.2019) US

(71) Applicant: MEMIC INNOVATIVE SURGERY LTD.

[IL/IL]; 6 Yonatan Netanyahu Street, 6037604 Or-Yehuda (IL).

(72) Inventors: COHEN, Dvir. LEVINSON, Yaron. NETA, Yiftah.

(74) Agent: VAN DYKE, Marc; 150 Menachem Begin Road, Phd Patent Ltd., WE Tower - Level 9, 6492105 Tel Aviv (IL).

(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, IT, 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, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, 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))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))
- in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE

(54) Title: CABLE AND WIRE ROUTING IN A MECHANICAL ARM OF A SURGICAL APPARATUS

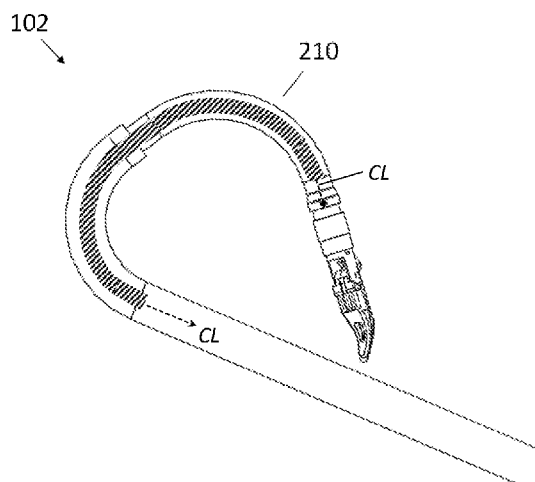


FIG. 4

(57) Abstract: An apparatus for performing electrosurgical operations using an electrosurgical power generator comprises an articulated mechanical arm, an electrosurgical grasper connected to the mechanical arm at a distal end thereof, a flexible sleeve at least partly disposed in a bendable portion of the arm, an outer surface of the sleeve comprising a plurality of surface features that define a helical wire-path around a central longitudinal axis of the sleeve, an actuation-cable passing through an inner conduit of the sleeve and mechanically coupled to the grasper to open and shut the grasper, and an electrically conductive wire for providing electrical connectivity from the power generator to the grasper, the wire being disposed on the outside of the sleeve and engaged with one or more of the surface features so as to follow therethrough the helical wire-path.



CABLE AND WIRE ROUTING IN A MECHANICAL ARM OF A SURGICAL APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

- 5 This patent application claims the benefit of U.S. Provisional Patent Application No. 62/897,293 filed on September 7, 2019, which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

- 10 The present invention relates to surgical and electrosurgical apparatuses used for gripping, coagulating The present invention relates to surgical and electrosurgical apparatuses used for gripping, coagulating, sealing, manipulating and/or cutting tissue. More particularly, it relates to electrosurgical apparatuses including mechanical arms, and devices for routing, in paths within and through such arms, mechanical cables and electrical wires needed for the operation of such apparatuses and arms. In particular, the present
15 invention is suitable for separating and retaining mechanical cables and electrical wires in such paths within bendable sections of mechanical surgical arms.

BACKGROUND

- It is well established that there are benefits of minimally invasive surgery. Instruments for such surgery typically have a surgical end effector located at the distal end
20 of an articulated surgical arm (preferably with minimum diameter) that is inserted through a small opening (e.g., body wall incision, natural orifice) to reach a surgical site. In some instances, surgical instruments can be passed through a cannula and an endoscope can be used to provide images of the surgical site.

- Surgical instruments have been developed that utilize an end effector that integrates
25 the use of tissue fusing and cutting for both convenience and cutting accuracy. In some cases, articulated surgical arms have one or more bending portions which are controlled with mechanical cables whose longitudinal movement affect bending and ultimately control the location of the end effector and change its orientation with reference to the

surgical arm's longitudinal axis. In some case, the surgical arm is capable of retroflected bending relative to the surgical arm longitudinal axis.

The current state of the art is lacking devices and methods that can provide optimal routing of respective mechanical wires and electrical cables through lengths of surgical arms and especially bendable portions thereof, where the electrical wire is separated from the mechanical cable to avoid electrical and/or magnetic interference without stressing the electrical wire when portions of the arm are flexed, and where the electrical wire is neither under too much tension when a corresponding portion of the arm is bent to a small radius of curvature, nor given too much slack that can lead to fouling and misrouting. Such devices and methods would optimally retain the electric wires in surgical arms in safe and efficient routings therein.

SUMMARY

According to embodiments disclosed herein, an apparatus for performing electrosurgical operations using an electrosurgical power generator comprises: (a) an articulated mechanical arm; (b) an electrosurgical grasper comprising a plurality of jaws and connected to the mechanical arm at a distal end thereof; (c) a flexible sleeve at least partly disposed in a bendable portion of the arm, an outer surface of the sleeve comprising a plurality of surface features that define a helical wire-path around a central longitudinal axis of the sleeve; (d) an actuation-cable passing through an inner conduit of the sleeve and mechanically coupled to the grasper to effect a movement of at least one jaw; and (e) an electrically conductive wire for providing electrical connectivity from the power generator to the grasper, the wire being disposed on the outside of the sleeve and engaged with one or more of the surface features so as to follow therethrough the helical wire-path.

In some embodiments, the plurality of surface features can comprise non-continuous protrusions, the helical wire-path passing therebetween.

In some embodiments, it can be that the plurality of surface features comprises alternating parallel longitudinal ribs and troughs, the ribs and troughs being helically aligned around the central longitudinal axis of the sleeve for at least a lengthwise portion

of the sleeve, the helical wire-path passing within one of the troughs. In some such embodiments,

the plurality of surface features can comprise at least 3 ribs and at least 3 troughs. In some such embodiments, it can be that for a first lengthwise portion of the sleeve, the parallel
5 ribs and troughs are parallel to the central longitudinal axis, and for a second lengthwise portion of the cable-sleeve the parallel ribs wind helically around the central axis.

In some embodiments, a helical pitch of the helical wire-path can have variability of less than $\pm 50\%$ along the length of the helical wire-path. In some embodiments, a helical pitch of the helical wire-path is either constant or has a variability of less than $\pm 10\%$ along
10 the length of the helical wire-path.

In some embodiments, a helical pitch of the helical wire-path can be at least $1/3$ of the length of a central-axis path of a corresponding portion of the sleeve. In some embodiments, a helical pitch of the helical wire-path is at least $1/2$ of the length of a central-axis path of a corresponding portion of the sleeve. In some embodiments, a helical pitch of
15 the helical wire-path is at most equal to 1.5 times the length of a central-axis path of a corresponding portion of the sleeve, or 1.25 times the length, or the length itself.

In some embodiments, a ratio between a helical pitch and a helical amplitude of the helical wire-path can be at least 10, or at least 20, or at least 50.

In some embodiments, the bendable portion of the arm can comprise a plurality of
20 bendable segments. In some embodiments, the bendable portion of the arm can comprise non-contiguous segments.

In some embodiments, it can be that the sleeve is constrained to bend and/or straighten together with the bendable portion of the arm, and the path of the electric wire is maintained as helical relative to the bent and/or straightened path of the central
25 longitudinal axis of the sleeve. In some such embodiments, the path of the electric wire can be maintained as helical relative to the bent and/or straightened path of the central axis of the sleeve, for any bending of the bendable portion of the arm to a radius of curvature greater than twice the diameter of the bendable portion. In some embodiments, the helical path of the electric wire can be maintained as helical relative to the bent and/or straightened

path of the central axis of the sleeve, for any bending of the bendable portion of the arm to a radius of curvature greater than 1.5 times the diameter of the bendable portion.

In some embodiments, it can be that the bending and/or straightening of the sleeve assembly does not substantially increase tension in the wire.

5 In some embodiments, the inner conduit can have a circular cross-section. In some such embodiments, an inner diameter of the inner conduit can be at least 0.5 mm and at most 2.0 mm.

10 In some embodiments in which the surface features comprise helical ribs, a maximum helical amplitude of the ribs on the outer surface of the sleeve can be at least 1.0 mm and at most 2.0 mm. In some such embodiments, a maximum helical amplitude of the ribs on the outer surface of the sleeve can be at least 1.25 mm and at most 1.5 mm.

In some embodiments, the surface features can be formed integrally with the sleeve.

In some embodiments, the sleeve can comprise a thermoplastic elastomer that includes a rigid polyamide and a flexible polyether.

15 In some embodiments, the electrosurgical grasper can provide at least a bipolar electrosurgery mode when electrically connected to the electrosurgical power generator.

20 In some embodiments, the actuation-cable can be mechanically coupled to the grasper such that rotation of the actuation-cable about its central axis controls the movement of at the least one jaw. In some embodiments, the actuation-cable can be mechanically coupled to the grasper such that longitudinal motion of the actuation-cable within the arm controls the movement of at the least one jaw.

In some embodiments, the surgical apparatus can additionally comprise the electrosurgical power generator, and an electrically conductive wire can provide electrical connectivity from the power generator to the grasper.

25 According to embodiments disclosed herein, a surgical apparatus for use with a source of electrical power comprises: a. an articulated mechanical arm; b. a tool connected to the mechanical arm at a distal end thereof, the tool being electrically powered or having at least one electrically-powered auxiliary device mounted thereto; c. a flexible

sleeve at least partly disposed in a bendable portion of the arm, an outer surface of the sleeve comprising a plurality of surface features that define a helical wire-path around a central longitudinal axis of the sleeve; and d. an electrically conductive wire for providing electrical connectivity from the electrical power source to the tool or to the mounted auxiliary device, the wire being disposed on the outside of the sleeve and engaged with one or more of the surface features so as to follow therethrough the helical wire-path.

In some embodiments, the tool is a surgical tool.

In some embodiments, the surgical tool is selected from the group consisting of a grasper, forceps, scissors, a clamp, a hook and a laser.

10 In some embodiments, the tool and/or the auxiliary device is a camera -- i.e. the electrically conductive wire being for providing electrical connectivity from the electrical power source to the camera.

In some embodiments, the tool and/or the auxiliary device is a data-acquisition tool- the electrically conductive wire for providing electrical connectivity from the electrical power source to the data-acquisition tool.

15 In some embodiments, the data-acquisition tool is or comprises at least one of an electrically-powered thermometer, a camera, and an electrically-powered microphone.

In some embodiments, the tool and/or the auxiliary device comprises an electrically-powered illumination source (for example, a light-emitting-diode (LED)) -i.e. the electrically conductive wire for providing electrical connectivity from the electrical power source to the illumination source.

20 In some embodiments, the tool has at least one internal degree of freedom.

In some embodiments, additionally comprising an actuation-cable passing through an inner conduit of the sleeve and mechanically coupled to the tool so as to: (i) modify an internal configuration of the tool with respect to one or more of the degrees of freedom; and/or (ii) mechanically operate or actuate the tool.

25 In some embodiments, the plurality of surface features comprises non-continuous protrusions, the helical wire-path passing therebetween.

In some embodiments, the plurality of surface features comprises alternating parallel longitudinal ribs and troughs, the ribs and troughs being helically aligned around the central longitudinal axis of the sleeve for at least a lengthwise portion of the sleeve, the helical wire-path passing within one of the troughs.

- 5 In some embodiments, the plurality of surface features comprises at least 3 ribs and at least 3 troughs.

In some embodiments, for a first lengthwise portion of the sleeve, the parallel ribs and troughs are parallel to the central longitudinal axis, and for a second lengthwise portion of the cable-sleeve the parallel ribs wind helically around the central axis.

- 10 In some embodiments, a helical pitch of the helical wire-path has a variability of less than $\pm 50\%$ along the length of the helical wire-path.

In some embodiments, a helical pitch of the helical wire-path is either constant or has a variability of less than $\pm 10\%$ along the length of the helical wire-path.

- 15 In some embodiments, a helical pitch of the helical wire-path is at least $1/3$ of the length of a central-axis path of a corresponding portion of the sleeve.

In some embodiments, a helical pitch of the helical wire-path is at least $1/2$ of the length of a central-axis path of a corresponding portion of the sleeve.

- 20 In some embodiments, a helical pitch of the helical wire-path is at most equal to 1.5 times the length of a central-axis path of a corresponding portion of the sleeve, or 1.25 times the length, or the length itself.

In some embodiments, a ratio between a helical pitch and a helical amplitude of the helical wire-path is at least 10, or at least 20, or at least 50.

In some embodiments, the bendable portion of the arm comprises a plurality of bendable segments.

- 25 In some embodiments, the bendable portion of the arm comprises non-contiguous segments.

In some embodiments, the sleeve is constrained to bend and/or straighten together with the bendable portion of the arm, and the path of the electric wire is maintained as helical relative to the bent and/or straightened path of the central longitudinal axis of the sleeve.

- 5 In some embodiments, the path of the electric wire is maintained as helical relative to the bent and/or straightened path of the central axis of the sleeve, for any bending of the bendable portion of the arm to a radius of curvature greater than twice the diameter of the bendable portion.

- 10 In some embodiments, the helical path of the electric wire is maintained as helical relative to the bent and/or straightened path of the central axis of the sleeve, for any bending of the bendable portion of the arm to a radius of curvature greater than 1.5 times the diameter of the bendable portion.

In some embodiments, the bending and/or straightening of the sleeve assembly does not substantially increase tension in the wire.

- 15 In some embodiments, the inner conduit has a circular cross-section.

In some embodiments, an inner diameter of the inner conduit is at least 0.5 mm and at most 2.0 mm.

In some embodiments, a maximum helical amplitude of the ribs on the outer surface of the sleeve is at least 1.0 mm and at most 2.0 mm.

- 20 In some embodiments, a maximum helical amplitude of the ribs on the outer surface of the sleeve is at least 1.25 mm and at most 1.5 mm.

In some embodiments, the surface features are formed integrally with the sleeve.

In some embodiments, the sleeve comprises a thermoplastic elastomer that includes a rigid polyamide and a flexible polyether.

- 25 A teleoperated robotic surgical system comprising: any apparatus disclosed herein; a patient side console configured to interface with the surgical tool to actuate the surgical tool to perform one or more surgical procedures; and a surgeon side console comprising

one or more input devices configured to be manipulated by a surgeon and to transmit signals to control the surgical tool at the patient side console.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described further, by way of example, with reference to the accompanying drawings, in which the dimensions of components and features shown in the figures are chosen for convenience and clarity of presentation and not necessarily to scale. Also, in some drawings the relative sizes of objects, and the relative distances between objects, may be exaggeratedly large or small for the sake of convenience and clarity of presentation. In the drawings:

Fig. 1 shows a simplified schematic of a surgical system according to embodiments of the present invention.

Fig. 2A shows a surgical arm unit according to embodiments of the present invention.

Fig. 2B shows a mechanical arm having a bendable portion comprising stacked links and end effector tooling, according to embodiments of the present invention.

Fig. 2C shows a result of bending the bendable portion of a mechanical arm, according to embodiments of the present invention.

Fig. 2D shows a schematic illustrating a central axis of a mechanical arm, a diameter of a section of mechanical arm, and a radius of curvature for a bendable portion of a mechanical arm as used in this disclosure.

Fig. 3 is a longitudinal cross-sectional projection of part of a mechanical arm, showing a cable- and wire-routing sleeve according to embodiments of the present invention.

Fig. 4 schematically shows the bent mechanical arm of Fig. 2C with an overlay of a similarly bent cable sleeve according to embodiments of the present invention.

Figs. 5A and 5B schematically show a sleeve and its partial magnification having helical ribs and troughs as surface features, according to embodiments of the present invention,

Fig. 6 shows a sleeve having protrusions as surface features, according to
5 embodiments of the present invention.

Fig. 7 shows the sleeve of Fig. 5A with a wire in a helical wire-path, according to embodiments of the present invention.

Fig. 8A is a two-dimensional projection of the wire of Fig. 7.

Figs. 8B and 8C are respective two-dimensional projections of wires having
10 different helical pitches.

Fig. 9 shows a schematic illustrating helical pitch and helical amplitude as used in this disclosure.

Fig. 10 shows an embodiment of a sleeve having straight ribs and troughs on the outer surface of a first portion of the length of the sleeve, and helical ribs and troughs on
15 the outer surface of a second portion thereof, according to embodiments of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

According to embodiments, a mechanical surgical arm can house a 'mechanical' or
20 'actuation' cable for actuating and controlling the movements of a surgical tool located at the distal end of the arm. An example of a surgical tool is a multi-jaw grasper used in electrosurgery. The grasper preferably provides at least a bipolar electrosurgery mode typically used to fuse tissue (e.g. blood vessels) or for general coagulation of tissue bundles, cold cutting, tissue dissection, and tissue manipulation/retraction. A grasper can also
25 provide a monopolar electrosurgery mode.

The 'distal' end of the arm is defined herein as the end to which the surgical tool is connected, i.e., the end which in normal surgical operation is furthest from an operator or

user of a surgical apparatus comprising the arm. The term ‘mechanical’ is used herein to denote that the cable is generally not used for conducting electricity, and generally does not carry data, although in some embodiments the ‘mechanical’ cable can be used for carrying data and/or as a ground return to complete an electric circuit.

5 A mechanical or actuation wire can run the entire length of the arm or a portion thereof, and can be connected, directly or indirectly, at or near a proximal end of the arm to one or more mechanical and/or electronic control elements, such as a gearing or an actuator. The surgical tool may be controlled, directly or indirectly, by longitudinal force applied by the actuation cable (i.e., producing back-and-forth movements), or by rotation
10 torque applied via the cable, depending upon the mechanical arrangements of the arm and/or the tool. It can be desirable to route the actuation cable through a longitudinal conduit, such as a tube or sleeve, deployed around a central axis of the arm so as to maintain a straightforward routing path thereby allowing maximum control of movement.

 A mechanical surgical arm can additionally house an electric wire that – in an
15 operating state of the surgical apparatus – conducts electricity from a power source such as (but not limited to) an electrosurgical generator to the same surgical tool controlled by the actuation cable. The wire can be single or double wire (or even triplex wire). If a single wire is used then an electric circuit can be completed by using another return path, e.g., a metallic arm housing or the actuation cable. It can be desirable to physically separate the
20 path of the electric wire from that of the actuation cable to avoid, inter alia, potential tangling that could interfere with the functionality of the actuation cable and/or endanger the physical integrity of the less-robust electric wire. The electric wire is preferably both physically separated and electrically insulated from the actuation cable, which is preferably coaxial with the central axis of the arm for maximum function. Thus, the electric wire, if it
25 were to follow a straight path through the arm, would necessarily be off-center. Retaining the wire in an off-center routing path can require a complicated mechanical scheme and, in some cases, may put excess strains, stresses and/or shear forces, even resulting in tearing, on the portion of the wire that passes through a bendable portion of the arm especially when the arm is placed in repeated retroflected position.

Therefore, it can be desirable to wrap the electric wire around the sleeve or tube through which the actuation cable passes, and, according to embodiments disclosed herein, use surface features provided of the outside surface of the sleeve to create a stable wire-path around the outside surface. A helical wire-path around the outside surface of the sleeve can be desirable since a central axis of the helix can be made to be coaxial with the central axis of the sleeve through which the actuation cable passes in the center of the arm. As will be discussed hereinbelow, the central axes of the sleeve and of the arm remain coaxial with each other, or at least parallel to each other if not coaxial, with the bending and straightening of the bendable portion of the arm; although seemingly distorted by the bending, the helical wire-path remains helical with respect to the path of the central axis of the sleeve. The bending of the bendable portion of the arm can include 'extreme' bending such as retroflex configurations and S-shaped curves, and the sleeve remains coaxial with (or parallel to) the arm in any such usage. Creating a stable helical wire-path centered around the central axis of the arm can have the advantage of reducing tension in the wire when the wire-path is bent along with the bendable portion of the arm, and/or reducing the amount of slack provided in the wire when assembled. A wire can slide longitudinally within its helical wire-path so that 'excess' wire in the 'inside' of a curve or bend can slide towards the 'outside' of the curve or bend where the wire would otherwise be under greater tension, or even become stretched or broken. This sliding helical movement of the electric wire within its helical wire-path is preferably unimpeded, or at least sufficiently unimpeded so that the bending and/or straightening of the sleeve assembly does not substantially increase tension in the wire. As a counter-example, if the wire were to be wrapped or tied around a surface feature of the outside surface of the sleeve, this sliding would most likely be overly impeded and tension could substantially increase in a portion of the wire, such as a portion that in an operating state is located on the 'outside' of a curve or bend.

Fig. 1 shows a schematic illustration of a typical prior-art surgical system **100** according to embodiments. The system **100** includes two surgical mechanical arms **102**. In other embodiments, a single surgical arm is provided. Surgical mechanical arms **102** are preferably sized and/or shaped for insertion into a human body or patient **106**. Each of the surgical mechanical arms **102** is actuated by a respective motor unit **108**. The surgical arms

102 and/or motor units **108** are supported in this example by attachment to a patient support **116**, e.g., a bed but may also be supported by a patient side cart.

Power to the arms **102** and the motor units **108** is supplied by an electrosurgical generator **112**. As known in the art of electrosurgery, an electrosurgical generator supplies
5 high-frequency (e.g. radio frequency) alternating polarity, electric current. An electrosurgical generator **112** can be configured to supply different frequencies and/or power levels, for example, suitable for cutting and/or coagulating and/or sealing and/or desiccating and/or fulgurating tissue. An example of a suitable, commercially available electrosurgical generator **112** is a Covidien Force FX ESU Electrosurgical Generator.
10 Power is supplied to the motor units **108** via cable/s **114** which are configured to transfer radio frequency electrosurgical power.

Movement and/or electrosurgical charging of the surgical arms **102** is/are controlled at a control console **118**. Control console **118** includes a plurality of user interfaces including one or more of: input devices, e.g., input device arms **120** where the
15 control console is configured to generate control signals based upon movement of the input device arms **120**; touch-screen display **128** configured to receive user input and/or display imaging of a surgical zone, for example, to display images collected by a camera inserted into patient **106** using one of surgical arms **102**; and one or more additional user interfaces **130** (e.g. button, switch, etc.).

20 Control console **118** includes a processor (not shown) configured to receive signals from a user input/s and to send control signals to motor units **108** and/or electrosurgical generator **112**. Foot pedal **126** and/or electrosurgical generator **112** include/s a processor (not shown) configured to receive control signals (e.g. generated by a user pressing on a portion/s of the foot pedal **126**) to vary electrical power supplied to motor units **108** based
25 on the control signals. Foot pedal control signals do not necessarily pass through a control unit processor.

The movement of input device arms **120** controls movement of a respective surgical device arm **102**. A user **124** can position and/or move an input arm **120** by grasping an input device arm handle **127**.

It can be desirable that a surgical arm be sized and/or shaped for insertion into a human body. For example, an arm can be sized and/or shaped for insertion through a laparoscopic port and/or for performing laparoscopic surgery. For example, an arm can be sized and/or shaped for insertion through a natural body orifice, e.g. vagina, anus, trachea, esophagus, ear canal.

Referring now to Fig. 2A, arm unit **204** includes a proximal end where a support unit **223** is attached to an arm **102**, and a distal end where an electrosurgical tool **224** such as the illustrated multi-jaw grasper is attached to the arm **102**. The example of a multi-jaw grasper is intended to be non-limiting, and any appropriate surgical tool may be used. Various non-limiting examples of grasper tool designs are illustrated in the attached figures; any electrically powered surgical tool actuated by an actuation cable can be suitable for use as electrosurgical tools in the disclosed embodiments. A bendable portion **200** of the arm **102** is located along the length of the arm, closer to the distal end. The bendable portion **200** can comprise a series of stacked links **199** that provide external flexibility for the arm **102**; an example of a plurality of stacked links **199** in a bendable portion **200** of an arm **102** is illustrated in Fig. 2B. As shown in Fig. 2B, an arm **102** or one or more segments of a bendable portion **200** can have different diameters while sharing the same central longitudinal axis.

The bendable portion **200** of an arm **102** can comprise non-contiguous segments. In other words, the bendable portion **200** can actually comprise multiple bendable portions with or without non bendable segments interposed therebetween. Fig. 2C illustrates a typical arm **102** bent in multiple locations along the bendable portion **200**. A clockwise 'tour' of Fig. 2C reveals: rigid portion **202** (the most-proximal part of the arm **102** illustrated in Fig. 2C); a bendable segment **208** comprising a first bendable segment within the length of bendable portion **200**; a rigid connecting segment **212**; a bendable segment **220** that comprises a second bendable segment within the length of bendable portion **200**; and a rigid segment **216** to which the surgical tool **224** is connected. Rigid segment **216** may house mechanical arrangements for translating control movements of an actuation cable to the surgical tool **224**.

Any portion or segment in the bendable portion **200** of the arm **102** can be bent to a radius of curvature R , which for the purposes of this disclosure is calculated as the radius of curvature of the central axis, or centerline CL , as illustrated for the sake of clarity in Fig. 2D. Lower limits on the radius of curvature R , in embodiments, can be defined by the size and specific design of the bendable portion and its component links, as well as by the diameter D of the arm **102**. For example, the radius of curvature R can be limited to being at least 3 times the diameter of the arm **102**, or at least twice the diameter of the arm **102**, or at least 1.5 times the diameter of the arm, or at least 1.25 times the diameter of the arm **102**.

The diameter D of a bendable portion **200** (or any segment thereof) of a mechanical surgical arm **102** suitable for electrosurgery ..and especially suitable for minimally invasive surgery can be in the range of 6 to 12 mm, or 7 to 11 mm, or 8 to 10 mm, or 8 to 9 mm. Different segments can be designed to have different D values. The ‘length’ of a link **199**, i.e., when incorporated in a bendable portion **200** that is not bent, can be in the range of 1.5 to 4 mm, or 2.0 to 3.25 mm, or 2.25 to 2.75 mm. Each link **199**, when the corresponding bendable portion **200** (or segment thereof) is maximally flexed or bent, can correspond to an arc of 5° to 15° , or 6° to 13° , or 7° to 11° , or 8° to 10° . The resulting radius of curvature, R , can be in the range of 10 to 20 mm, or 11 to 16 mm, or 12 to 15 mm, or 13 to 14 mm.

Referring now to Fig. 3, which shows a cross-sectional view of the distal portion of an arm **102**. A cable- and wire-routing sleeve **210**, not in cross-section, is shown as being disposed within the bendable portion **200** of an arm **102**.

Use of the term “disposed within” throughout this disclosure and the appended claims should be understood to include, interchangeable, either one of “entirely disposed within” or “partially disposed within”. For example, whilst Fig. 3 shows the entire length of sleeve **210** as being subsumed in the marked length of bendable portion **200**, the sleeve **210** of Fig. 3 would still be “disposed within” the bendable portion **200** even if there were an overlap between the length of the sleeve **210** and the length of the bendable portion **200** such that either one or both ends of the sleeve were to extend from the marked length of the bendable portion **200**. Moreover, the length marked as the bendable portion **200** can include, as discussed in connection with Fig. 2C, one or more rigid sections, e.g., rigid

section **212**. The purpose, function, shape and manufacture of sleeve **210** will be further discussed below. It can be desirable for the sleeve to have a central longitudinal axis that is coaxial with the central longitudinal axis *CL* of the arm **102**, as is shown in Fig. 3.

Fig. 4 illustrates schematically the effect of the bending of the bendable portion **200** of the arm **102** on the sleeve **210**. The sleeve **210** will obviously bend within the confines of the bent bendable portion **200**. It is desirable, however, that the sleeve **210** be suitably constrained within the arm, and be sufficiently flexible, so that its central axis and the central axis *CL* of the arm remain coaxial (i.e., parallel) throughout the range of bending associated with the ranges of radius of curvature *R* of the bendable portion **200** as described hereinabove. While Fig. 4 appears to show a single sleeve **210** extending the length of the bendable portion **200** of the arm **102**, in some embodiments there can be more than one sleeve **210**; for example, there can be one sleeve for each bendable segment (e.g., segments **208** and **220**) of the bendable portion **200**. A thermoplastic elastomer can be chosen with physical properties that enable repeated bending and straightening as described here. The inventors have found that suitable material for fabricating a sleeve **210** is a thermoplastic elastomer that includes a rigid polyamide and a flexible polyether, an example of which is a PEBAX ® formulation available commercially from Arkema of Colombes Cedex, France. The sleeve can be manufactured using any of the methods known in the art, including, without limitation, molding, extrusion and 3D printing. Additionally or alternatively, a sleeve having helically disposed surface features can be fabricated from an ‘untwisted’ sleeve having surface features that are not already helically disposed.

A sleeve can be deployed within an arm to route a mechanical cable, such as an actuation cable used to transfer or produce movements in a surgical tool connected to the distal end of the arm, and at the same time to route an electrical wire, such as a wire that provides electrical connectivity between a power source and the surgical tool. According to embodiments, a sleeve includes an inner, or central longitudinal conduit through which the mechanical cable passes, and a plurality of surface features on an outer surface of the sleeve through which the electric wire can be routed, where the surface features can be useful for retaining the wire within a path, such as a helical path.

A non-limiting example of a sleeve **210** having an inner conduit **110** and surface features on its outer surface **211** is shown in Figs. 5A and 5B. The inner conduit **110** can have a circular cross-section; this not only facilitates having a regularly helical wire-path on the outer surface of the sleeve **210**, the circular-cross-section is also beneficial in assembly and operation of the mechanical arm **102**. For example, a sleeve **210** comprising a circular-cross-section inner conduit **110** need not be oriented in a specific way during assembly, and the sleeve **210** can be bent, etc. with equal ease (force) in every direction. A different shape could complicate assembly, and/or affect the bending behavior of the sleeve **210**. As shown, in Fig. 5A, actuation cable **240** passes through the inner conduit **110**. The exemplary surface features illustrated in Figs. 5A and 5B include parallel helical ribs **248** alternating with helical troughs **249**. The ribs **248** and troughs **249** are formed so as to wrap helically around a central longitudinal axis CL_{SLEEVE} of the sleeve **210** and run the entire length of the outer surface **211**. In some embodiments, the ribs **248** and troughs **249** run at least 70% or at least 80% or at least 90% of the length of the outer surface **211**. As will be described below, a wire (e.g., a segment of a wire) can be retained in a helical wire-path defined by one of the troughs with the wire being subjected to, at most, a moderate amount of tension. The illustrated examples accompanying this disclosure uniformly show 4 ribs and 4 troughs. However, any reasonable number of ribs and troughs can be implemented as surface features, from a minimum of 3 to as many as 6 or 8 (or even 10) ribs and troughs. If there are too few ribs, i.e., fewer than 3, then the wire may not be retained in a helical path; if there are too many ribs, then there might not be enough room in a trough for the wire, depending on the physical dimensions of the wire. Although not shown in the figures, one or more troughs **249** not occupied by the electric wire can be used as paths for additional cables – mechanical, data, and/or electrical.

Another non-limiting example of a sleeve having an inner conduit **110** and surface features on its outer surface **211** is shown in Fig. 6. In this example, the surface features include a plurality of protrusions **215**. A wire can be retained in a helical wire-path by threading the wire between the appropriate protrusions **215**. In another example (not shown) the protrusions **215** can have mushroom-like ‘caps’ to better retain the wire in a helical wire-path. In yet another example (also not shown), it can be that only those protrusions **215** needed to define a helical wire-path are provided.

The number of wire wrappings, or wrappings per unit of length (i.e., the length of either the wire or the central axis), needs to be limited so as to avoid producing a magnetic field that could interfere with proper operation of the arm and/or of the surgical tool, or even magnetize the actuation cable. The advantages, as described above, of the helical wrapping of the wire within a stable helical wire-path, can be realized with a small number of wrappings. For example, a sleeve with a length of 100 mm may be wrapped with no more than 3 helical revolutions, or no more than 2, or even fewer. Thus, the helical pitch – whether for a single sleeve passing the entire bendable portion of the arm, or for any one sleeve or portion thereof, of multiple sleeves in multiple segments of the bendable portion of the arm – can be at least 1/3 of the length of a central-axis path of a corresponding portion of the sleeve, or at least 1/2 of the length. In some embodiments, at least one full helical revolution of the wire is necessary to allow in-wire-path helical sliding and other advantages including avoiding electrical resonance of employing a helical wire-path, and in other embodiments four-fifths, three-quarters, or even two-thirds of a revolution can be sufficient. In some embodiments, the helical pitch is at most equal to 1.5 times the length of a central-axis path of a corresponding portion of the sleeve, or at most 1.25 times the length, or at most the length itself.

Referring now to Fig. 7, the sleeve **210** of Figs. 5A and 5B is shown with a wire **255** disposed (in corresponding part) in a helical wire-path in one of the troughs **249**. As discussed above, a moderate number of wrappings of a wire is preferable to avoid producing a potentially problematic magnetic field around the actuation cable **240**. In the particular example of Fig. 7, the helical pitch is such that there are fewer than two wrappings of the wire around this particular sleeve. (The usage of the terms helical pitch and helical amplitude as used in this disclosure, and in the appended claims, are illustrated for added clarity in Fig. 9.) The helical pitch employed preferably has at most a moderate amount of variability along the length of the sleeve **210**, for example variability of less than $\pm 50\%$, or less than $\pm 10\%$ or 0% , i.e., remains constant (where ‘constant’ means within a tolerance of $\pm 2\%$).

The actual shape of the wire **255** of Fig. 7 is shown in two-dimensional projection in Fig. 8A. Here it is easier to see that there are approximately (but not quite) two

wrappings of the wire **255** around the sleeve **210**. Since, as shown in Fig. 9, helical pitch *HP* is defined (in this disclosure, as well as in normal scientific usage) as the linear distance between adjacent ‘peaks’ of a helix, it can be said that the helical pitch *HP* of wire **255** in Fig. 8A is slightly more than half the central-axis (*CL*) length of the corresponding sleeve **210**. In other words, if the sleeve **210** of Fig. 7 were 100 mm in length, the corresponding value of *HP* would be more than 50 mm. Examples of wires **255** with alternative helical pitches *HP* are shown (in two-dimensional projection) in Figs. 8B and 8C. The wire **255** in Fig. 8B has a helical pitch equal to about one-third of the length of the sleeve **210**, while the wire **255** in Fig. 8C has a helical pitch roughly equal to the length of the sleeve **210**. It will be obvious to the skilled artisan that the wires **255** of Figs. 8B and 8C would require a sleeve **210** with differently formed ribs **248** and troughs **249** than the sleeve **210** of Figs. 5A, 5B and 7 – or, alternatively, a sleeve **210** with alternative surface features such as, for example, the protrusions **215** of Fig. 6.

Fig. 9 illustrates the terms helical pitch *HP* and helical amplitude *HA* as used herein. *HP*, as mentioned earlier, is the linear distance between successive helical peaks. *HA* is the distance (height) of a helical loop above the central axis *CL* of the helix. A sleeve **210** having ribs **248** and troughs **249** as illustrated, inter alia, in Fig. 7, can have an *HA* value between 1.0 and 2.0 mm, between 1.1 and 1.7 mm, or between 1.25 and 1.5 mm. A ratio between a helical pitch *HP* and helical amplitude *HA* for a helically-ribbed sleeve can be at least 10, at least 20, or at least 50.

Fig. 10 illustrates an embodiment of a sleeve **210** in which the parallel alternating ribs **248** and troughs **249** are ‘straight’, i.e., parallel to a central axis of the sleeve, for a first portion of the sleeve length, and ‘helical’ for a second portion of the sleeve length. Such an embodiment may be particularly suitable for use in mechanical arms when one or both of the ends of the sleeve are not housed in a bendable portion of the arm but, instead, in a rigid section adjacent to the bendable portion.

The present invention has been described using detailed descriptions of embodiments thereof that are provided by way of example and are not intended to limit the scope of the invention. The described embodiments comprise different features, not all of which are required in all embodiments of the invention. Some embodiments of the present

invention utilize only some of the features or possible combinations of the features. Variations of embodiments of the present invention that are described and embodiments of the present invention comprising different combinations of features noted in the described embodiments will occur to persons skilled in the art to which the invention pertains.

5 Any feature or combination of features described in the present document may be combined with any feature or combination of features described in US Patent Application Ser. No. 15/915,237 filed on March 8, 2018 and published as US Patent Publication US20180256246A1; and US Patent Application Ser. No. 15/454,123 filed on Mar. 9, 2017 and published as US Patent Publication US20170258539A1; U.S. patent application Ser.
10 No. 15/501,862 filed on Feb. 6, 2017 and published as US Patent Publication US20170239005A1; all of which are hereby incorporated by reference herein as if fully set forth in their entirety.

15 In the description and claims of the present disclosure, each of the verbs, "comprise", "include" and "have", and conjugates thereof, are used to indicate that the object or objects of the verb are not necessarily a complete listing of members, components, elements or parts of the subject or subjects of the verb. As used herein, the singular form "a", "an" and "the" include plural references unless the context clearly dictates otherwise. For example, the term "a marking" or "at least one marking" may include a plurality of markings.

CLAIMS

1. A surgical apparatus for use with a source of electrical power, the surgical apparatus comprising:
 - 5 a. an articulated mechanical arm;
 - b. a tool connected to the mechanical arm at a distal end thereof, the tool being electrically powered or having at least one electrically-powered auxiliary device mounted thereto;
 - c. a flexible sleeve at least partly disposed in a bendable portion of the arm, an outer
10 surface of the sleeve comprising a plurality of surface features that define a helical wire-path around a central longitudinal axis of the sleeve; and
 - d. an electrically conductive wire for providing electrical connectivity from the electrical power source to the tool or to the mounted auxiliary device, the wire being disposed on the outside of the sleeve and engaged with one or more of the
15 surface features so as to follow therethrough the helical wire-path.
2. The surgical apparatus of claim 1 wherein the tool is a surgical tool.
3. The surgical apparatus of claim 2, wherein the surgical tool is selected from the group consisting of a grasper, forceps, scissors, a clamp, a hook and a laser.
4. The surgical apparatus of any one of claims 1 to 3, wherein is the tool and/or the
20 auxiliary device is a camera, the electrically conductive wire being for providing electrical connectivity from the electrical power source to the camera.
5. The surgical apparatus of any one of claims 1 to 4, wherein the tool and/or the auxiliary device is a data-acquisition tool.
6. The surgical apparatus of claim 5, wherein the data-acquisition tool is or comprises at
25 least one of an electrically-powered thermometer, a camera, and an electrically-powered microphone.

7. The surgical apparatus of any one of claims 1 to 6, wherein is the tool and/or the auxiliary device comprises an electrically-powered illumination source.
8. The surgical apparatus of any one of claims 1 to 7, wherein the tool has at least one internal degree of freedom.
- 5 9. The surgical apparatus of any one of claims 1 to 8, additionally comprising an actuation-cable passing through an inner conduit of the sleeve and mechanically coupled to the tool so as to: (i) modify an internal configuration of the tool with respect to one or more of the degrees of freedom; and/or (ii) mechanically operate or actuate the tool.
- 10 10. The surgical apparatus of any one of claims 1 to 9, wherein the plurality of surface features comprises non-continuous protrusions, the helical wire-path passing therebetween.
11. The surgical apparatus of any one of claims 1 to 10, wherein the plurality of surface features comprises alternating parallel longitudinal ribs and troughs, the ribs and
15 troughs being helically aligned around the central longitudinal axis of the sleeve for at least a lengthwise portion of the sleeve, the helical wire-path passing within one of the troughs.
12. The surgical apparatus of claim 11, wherein the plurality of surface features comprises at least 3 ribs and at least 3 troughs.
- 20 13. The surgical apparatus of either one of claims 11 or 12, wherein for a first lengthwise portion of the sleeve, the parallel ribs and troughs are parallel to the central longitudinal axis, and for a second lengthwise portion of the cable-sleeve the parallel ribs wind helically around the central axis.
14. The surgical apparatus of any one of claims 1 to 13, wherein a helical pitch of the
25 helical wire-path has a variability of less than $\pm 50\%$ along the length of the helical wire-path.

15. The surgical apparatus of any one of claims 1 to 13, wherein a helical pitch of the helical wire-path is either constant or has a variability of less than $\pm 10\%$ along the length of the helical wire-path.
16. The surgical apparatus of any one of claims 1 to 15, wherein a helical pitch of the helical wire-path is at least $1/3$ of the length of a central-axis path of a corresponding portion of the sleeve.
17. The surgical apparatus of any one of claims 1 to 15, wherein a helical pitch of the helical wire-path is at least $1/2$ of the length of a central-axis path of a corresponding portion of the sleeve.
18. The surgical apparatus of any one of claims 1 to 15, wherein a helical pitch of the helical wire-path is at most equal to 1.5 times the length of a central-axis path of a corresponding portion of the sleeve, or 1.25 times the length, or the length itself.
19. The surgical apparatus of any one of claims 1 to 18, wherein a ratio between a helical pitch and a helical amplitude of the helical wire-path is at least 10, or at least 20, or at least 50.
20. The surgical apparatus of any one of claims 1 to 19, wherein the bendable portion of the arm comprises a plurality of bendable segments.
21. The surgical apparatus of any one of claims 1 to 20, wherein the bendable portion of the arm comprises non-contiguous segments.
22. The surgical apparatus of any one of claims 1 to 21, wherein the sleeve is constrained to bend and/or straighten together with the bendable portion of the arm, and the path of the electric wire is maintained as helical relative to the bent and/or straightened path of the central longitudinal axis of the sleeve.
23. The surgical apparatus of claim 22, wherein the path of the electric wire is maintained as helical relative to the bent and/or straightened path of the central axis of the sleeve, for any bending of the bendable portion of the arm to a radius of curvature greater than twice the diameter of the bendable portion.

24. The surgical apparatus of claim 23, wherein the helical path of the electric wire is maintained as helical relative to the bent and/or straightened path of the central axis of the sleeve, for any bending of the bendable portion of the arm to a radius of curvature greater than 1.5 times the diameter of the bendable portion.
- 5 25. The surgical apparatus of any one of claims 1 to 24, wherein the bending and/or straightening of the sleeve assembly does not substantially increase tension in the wire.
26. The surgical apparatus of any one of claims 1 to 25, wherein the inner conduit has a circular cross-section.
- 10 27. The surgical apparatus of any one of claims 1 to 26, wherein an inner diameter of the inner conduit is at least 0.5 mm and at most 2.0 mm.
28. The surgical apparatus of any one of claims 11 to 27, wherein a maximum helical amplitude of the ribs on the outer surface of the sleeve is at least 1.0 mm and at most 2.0 mm.
- 15 29. The surgical apparatus of any one of claims 11 to 27, wherein a maximum helical amplitude of the ribs on the outer surface of the sleeve is at least 1.25 mm and at most 1.5 mm.
30. The surgical apparatus of any one of claims 1 to 29, wherein the surface features are formed integrally with the sleeve.
- 20 31. The surgical apparatus of any one of claims 1 to 30, wherein the sleeve comprises a thermoplastic elastomer that includes a rigid polyamide and a flexible polyether.
32. A teleoperated robotic surgical system comprising: the apparatus of any one of claims 1 to 31; a patient side console configured to interface with the surgical tool to actuate the surgical tool to perform one or more surgical procedures; and a surgeon side
25 console comprising one or more input devices configured to be manipulated by a surgeon and to transmit signals to control the surgical tool at the patient side console.
33. An apparatus for performing electrosurgical operations using an electrosurgical power generator, the apparatus comprising:

- a. an articulated mechanical arm;
 - b. an electrosurgical grasper comprising a plurality of jaws and connected to the mechanical arm at a distal end thereof;
 - c. a flexible sleeve at least partly disposed in a bendable portion of the arm, an outer
5 surface of the sleeve comprising a plurality of surface features that define a helical wire-path around a central longitudinal axis of the sleeve;
 - d. an actuation-cable passing through an inner conduit of the sleeve and mechanically coupled to the grasper to effect the movement of at least one jaw; and
 - 10 e. an electrically conductive wire for providing electrical connectivity from the power generator to the grasper, the wire being disposed on the outside of the sleeve and engaged with one or more of the surface features so as to follow therethrough the helical wire-path.
34. The apparatus of claim 33, wherein the plurality of surface features comprises non-
15 continuous protrusions, the helical wire-path passing therebetween.
35. The apparatus of claim 33, wherein the plurality of surface features comprises alternating parallel longitudinal ribs and troughs, the ribs and troughs being helically aligned around the central longitudinal axis of the sleeve for at least a lengthwise portion of the sleeve, the helical wire-path passing within one of the troughs.
- 20 36. The apparatus of claim 35, wherein the plurality of surface features comprises at least 3 ribs and at least 3 troughs.
37. The apparatus of either one of claims 35 or 36, wherein for a first lengthwise portion of the sleeve, the parallel ribs and troughs are parallel to the central longitudinal axis, and for a second lengthwise portion of the cable-sleeve the parallel ribs wind helically
25 around the central axis.
38. The apparatus of any one of claims 33 to 37, wherein a helical pitch of the helical wire-path has a variability of less than $\pm 50\%$ along the length of the helical wire-path.

39. The apparatus of any one of claims 33 to 37, wherein a helical pitch of the helical wire-path is either constant or has a variability of less than $\pm 10\%$ along the length of the helical wire-path.
40. The apparatus of any one of claims 33 to 39, wherein a helical pitch of the helical wire-path is at least $1/3$ of the length of a central-axis path of a corresponding portion of the sleeve.
41. The apparatus of any one of claims 33 to 39, wherein a helical pitch of the helical wire-path is at least $1/2$ of the length of a central-axis path of a corresponding portion of the sleeve.
42. The apparatus of any one of claims 33 to 39, wherein a helical pitch of the helical wire-path is at most equal to 1.5 times the length of a central-axis path of a corresponding portion of the sleeve, or 1.25 times the length, or the length itself.
43. The apparatus of any one of claims 33 to 42, wherein a ratio between a helical pitch and a helical amplitude of the helical wire-path is at least 10, or at least 20, or at least 50.
44. The apparatus of any one of claims 33 to 43, wherein the bendable portion of the arm comprises a plurality of bendable segments.
45. The apparatus of any one of claims 33 to 44, wherein the bendable portion of the arm comprises non-contiguous segments.
46. The apparatus of any one of claims 33 to 45, wherein the sleeve is constrained to bend and/or straighten together with the bendable portion of the arm, and the path of the electric wire is maintained as helical relative to the bent and/or straightened path of the central longitudinal axis of the sleeve.
47. The apparatus of claim 46, wherein the path of the electric wire is maintained as helical relative to the bent and/or straightened path of the central axis of the sleeve, for any bending of the bendable portion of the arm to a radius of curvature greater than twice the diameter of the bendable portion.

48. The apparatus of claim 47, wherein the helical path of the electric wire is maintained as helical relative to the bent and/or straightened path of the central axis of the sleeve, for any bending of the bendable portion of the arm to a radius of curvature greater than 1.5 times the diameter of the bendable portion.
- 5 49. The apparatus of any one of claims 33 to 48, wherein the bending and/or straightening of the sleeve assembly does not substantially increase tension in the wire.
50. The apparatus of any one of claims 33 to 49, wherein the inner conduit has a circular cross-section.
- 10 51. The apparatus of any one of claims 33 to 50, wherein an inner diameter of the inner conduit is at least 0.5 mm and at most 2.0 mm.
52. The apparatus of any one of claims 35 to 51, wherein a maximum helical amplitude of the ribs on the outer surface of the sleeve is at least 1.0 mm and at most 2.0 mm.
53. The apparatus of any one of claims 33 to 51, wherein a maximum helical amplitude
15 of the ribs on the outer surface of the sleeve is at least 1.25 mm and at most 1.5 mm.
54. The apparatus of any one of claims 33 to 53, wherein the surface features are formed integrally with the sleeve.
55. The apparatus of any one of claims 33 to 54, wherein the sleeve comprises a thermoplastic elastomer that includes a rigid polyamide and a flexible polyether.
- 20 56. The apparatus of any one of claims 33 to 55, wherein the electrosurgical grasper provides at least a bipolar electrosurgery mode when electrically connected to the electrosurgical power generator.
57. The apparatus of any one of claims 33 to 56, wherein the actuation-cable is mechanically coupled to the grasper such that rotation of the actuation-cable about its
25 central axis controls the movement of at the least one jaw.

58. The apparatus of any one of claims 33 to 56, wherein the actuation-cable is mechanically coupled to the grasper such that longitudinal motion of the actuation-cable within the arm controls the movement of at the least one jaw.
59. The apparatus of any one of claims 33 to 58, additionally comprising the
- 5 electrosurgical power generator, wherein an electrically conductive wire provides electrical connectivity from the power generator to the grasper.

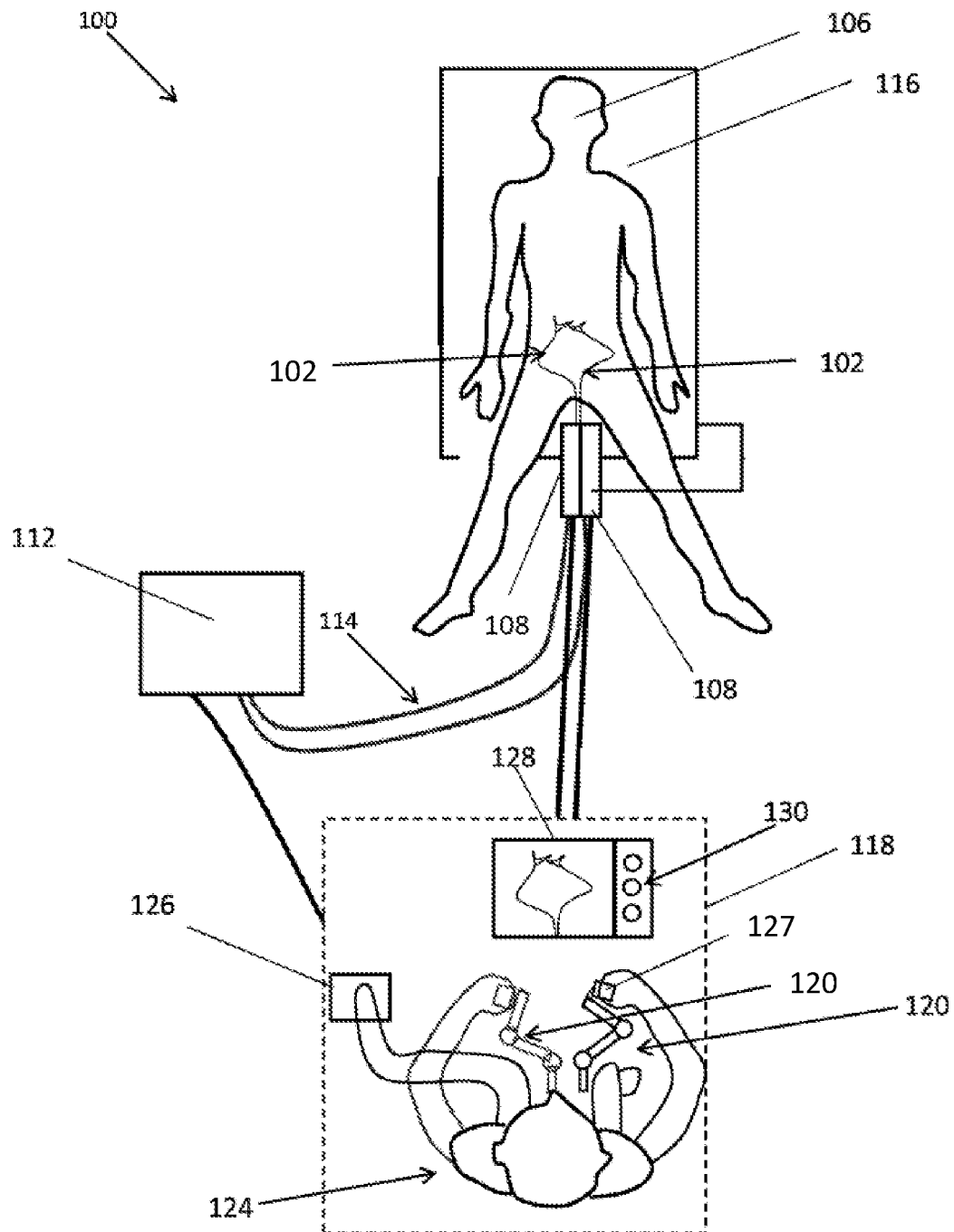
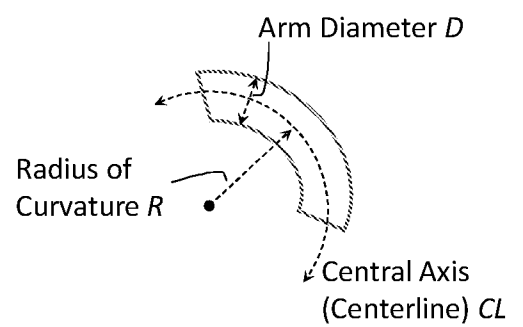
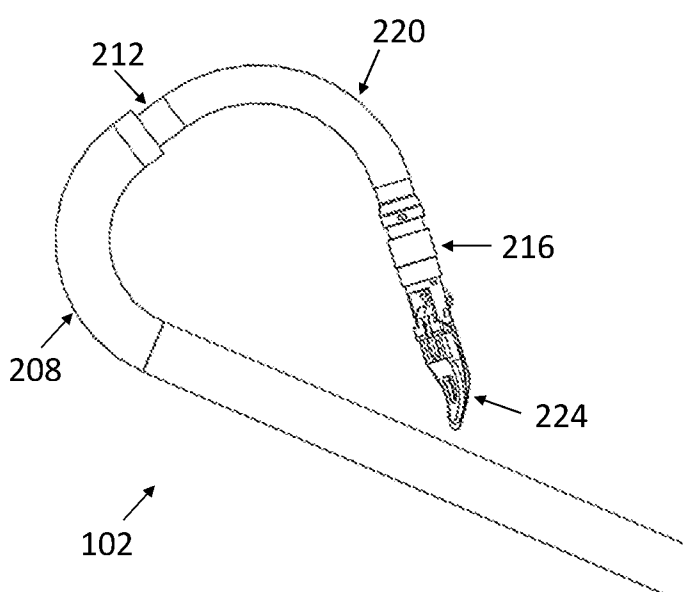
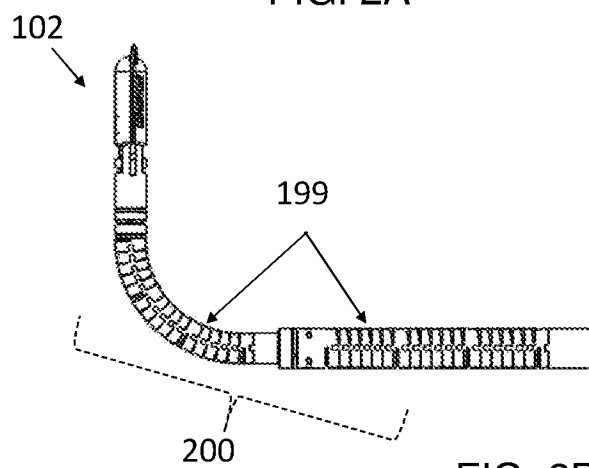
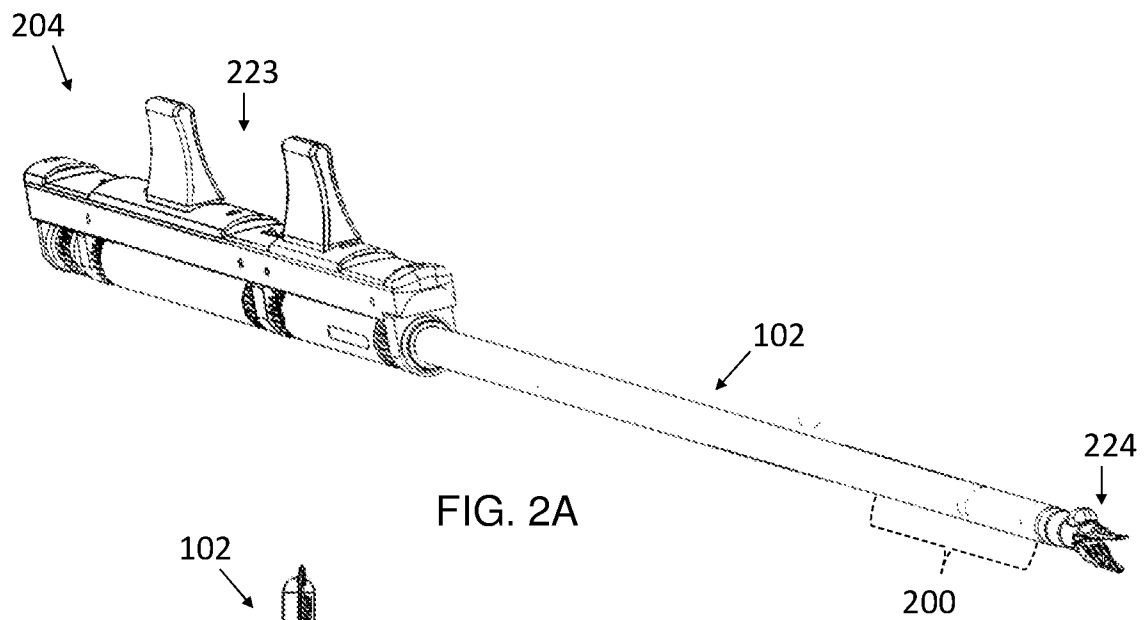


FIG. 1



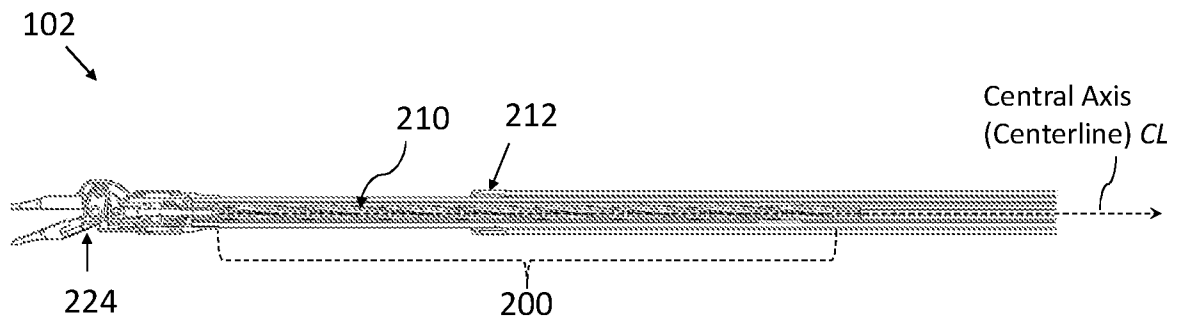


FIG. 3

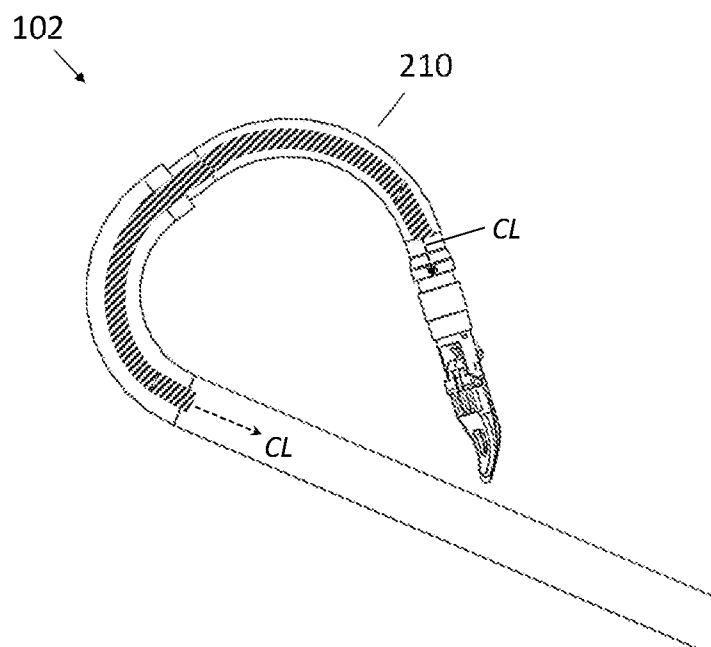
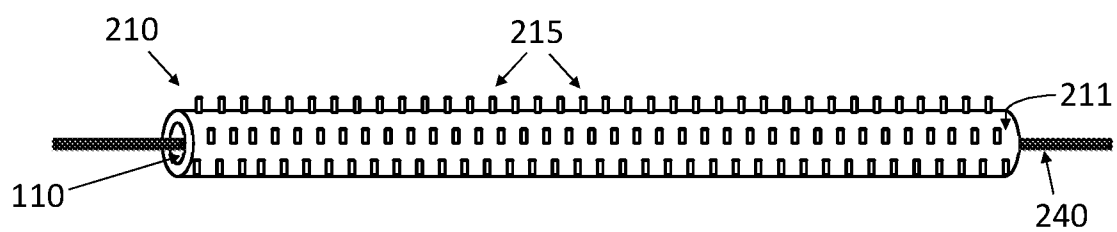
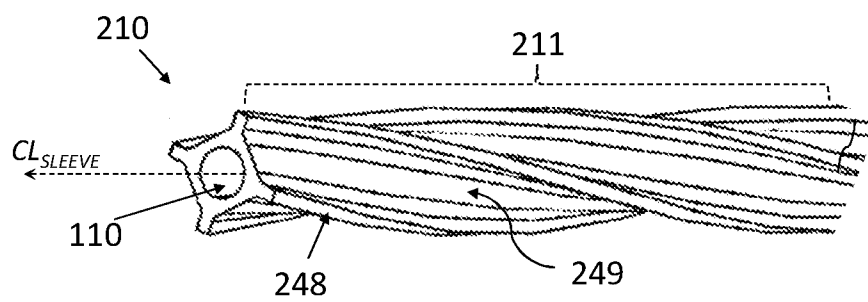
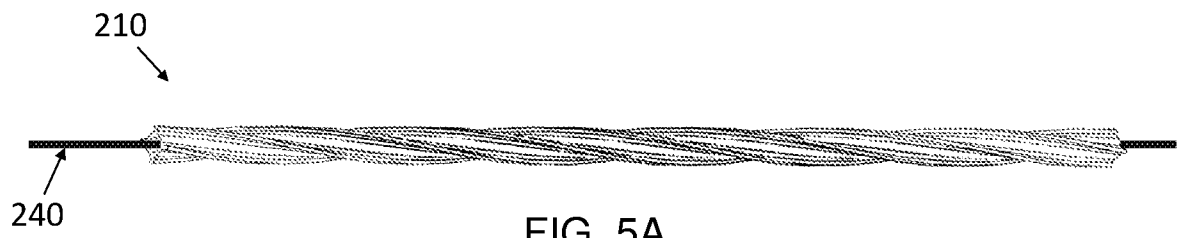


FIG. 4



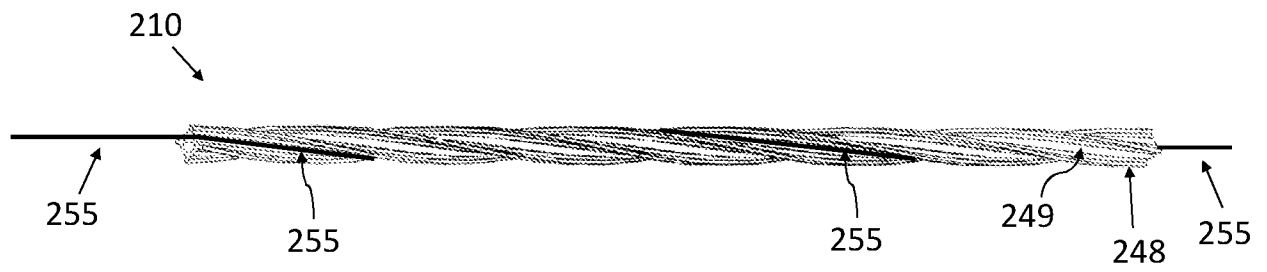


FIG. 7



FIG. 8A



FIG. 8B

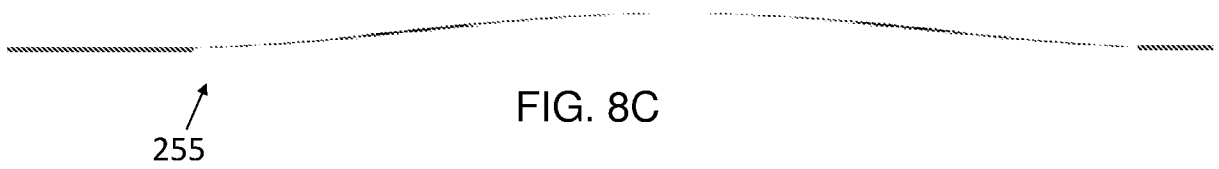


FIG. 8C

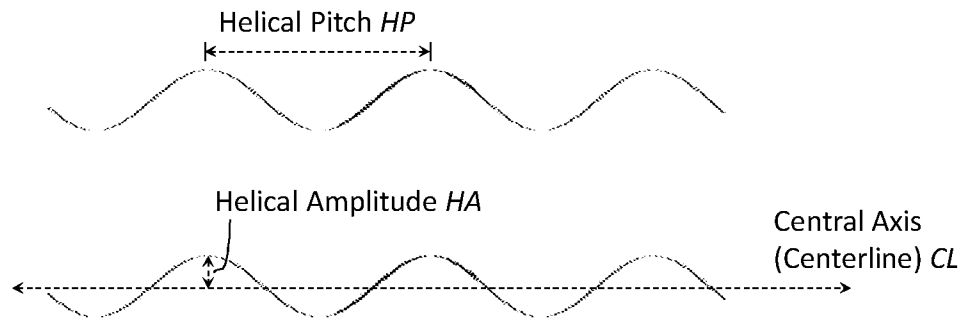


FIG. 9

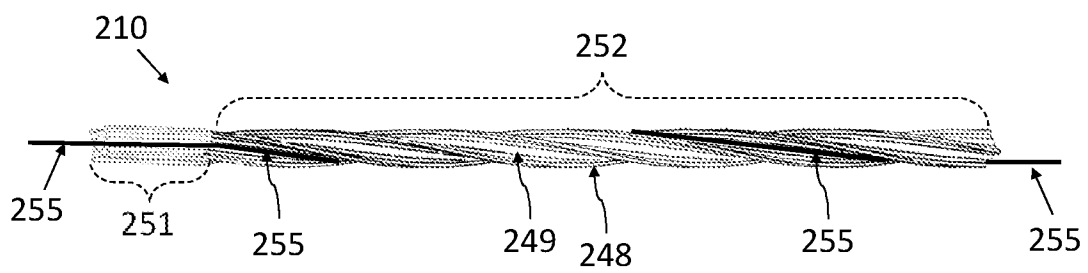


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB2020/058292

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet.

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 extra sheet.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

Databases consulted: Google Patents, Google Scholar, Orbit

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2011270081 A1 MEDTRONIC XOMED, INC. 03 Nov 2011 (2011/11/03) the whole document	1-59
Y	US 2004138700 A1 INTUITIVE SURGICAL, INC. 15 Jul 2004 (2004/07/15) the whole document	1-59
A	US 2008004606 A1 LONG GARY L.; SWAIN PAUL C. 03 Jan 2008 (2008/01/03) the whole document	1-59
A	US 2008065098 A1 INTUITIVE SURGICAL, INC. 13 Mar 2008 (2008/03/13) the whole document	1-59
A	US 2014236083 A1 FISHER & PAYKEL HEALTHCARE LIMITED; SIMS DAVID JOHN2014-08-21 21 Aug 2014 (2014/08/21) the whole document	1-59



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

“D” document cited by the applicant in the international application

“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

11 Jan 2021

Date of mailing of the international search report

11 Jan 2021

Name and mailing address of the ISA:

Israel Patent Office

Technology Park, Bldg.5, Malcha, Jerusalem, 9695101, Israel

Email address: pctoffice@justice.gov.il

Authorized officer

ORENSHTEIN-VILENSKY Liya

Telephone No. 972-73-3927241

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report			Publication date	Patent family member(s)			Publication Date
US	2008004606	A1	03 Jan 2008	US	2008004606	A1	03 Jan 2008
				AT	399035	T	15 Jul 2008
				AT	412441	T	15 Nov 2008
				AU	2003266436	A1	01 Jul 2004
				AU	2003266436	B2	05 Mar 2009
				AU	2003271310	A1	21 Oct 2004
				AU	2003271310	B2	07 May 2009
				AU	2004227920	A1	21 Oct 2004
				AU	2004227920	B2	24 Mar 2011
				AU	2004227926	A1	21 Oct 2004
				AU	2004227926	B2	20 Jan 2011
				BR	0305836	A	17 May 2005
				BR	0305994	A	17 May 2005
				BR	0305994	B1	18 Feb 2014
				CA	2452182	A1	05 Jun 2004
				CA	2452182	C	18 Nov 2008
				CA	2463214	A1	03 Oct 2004
				CA	2463214	C	17 Dec 2013
				CA	2521242	A1	21 Oct 2004
				CA	2521242	C	06 Dec 2011
				CA	2522198	A1	21 Oct 2004
				CA	2522198	C	22 May 2012
				CN	1506023	A	23 Jun 2004
				CN	100384365	C	30 Apr 2008
				CN	1535649	A	13 Oct 2004
				CN	100542474	C	23 Sep 2009
				CN	1767869	A	03 May 2006
				CN	100464798	C	04 Mar 2009
				CN	1859941	A	08 Nov 2006
				CN	1859941	B	09 Jun 2010

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
	DE 60321764	D1	07 Aug 2008
	DE 60324378	D1	11 Dec 2008
	EP 1426072	A1	09 Jun 2004
	EP 1426072	B1	29 Oct 2008
	EP 1426073	A1	09 Jun 2004
	EP 1426073	B1	25 Jun 2008
	EP 1608424	A1	28 Dec 2005
	EP 1608424	B1	23 Nov 2011
	EP 1620157	A2	01 Feb 2006
	EP 1620157	B1	16 Nov 2011
	ES 2374398	T3	16 Feb 2012
	ES 2374400	T3	16 Feb 2012
	GB 0307715	D0	07 May 2003
	JP 2006521895	A	28 Sep 2006
	JP 4527111	B2	18 Aug 2010
	JP 2004181250	A	02 Jul 2004
	JP 4531378	B2	25 Aug 2010
	JP 2004305714	A	04 Nov 2004
	JP 4601943	B2	22 Dec 2010
	JP 2006521893	A	28 Sep 2006
	JP 4650901	B2	16 Mar 2011
	US 2004111019	A1	10 Jun 2004
	US 7226410	B2	05 Jun 2007
	US 2004199087	A1	07 Oct 2004
	US 7288074	B2	30 Oct 2007
	US 2004111020	A1	10 Jun 2004
	US 7351202	B2	01 Apr 2008
	US 2004199088	A1	07 Oct 2004
	WO 2004089455	A2	21 Oct 2004
	WO 2004089455	A3	02 Dec 2004
	WO 2004089456	A1	21 Oct 2004

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report			Publication date	Patent family member(s)			Publication Date
US	2008065098	A1	13 Mar 2008	US	2008065098	A1	13 Mar 2008
				AT	155059	T	15 Jul 1997
				AT	215430	T	15 Apr 2002
				AT	238140	T	15 May 2003
				AT	305639	T	15 Oct 2005
				AT	310264	T	15 Dec 2005
				AT	365953	T	15 Jul 2007
				AT	439808	T	15 Sep 2009
				AT	446721	T	15 Nov 2009
				AT	449576	T	15 Dec 2009
				AT	460127	T	15 Mar 2010
				AT	464852	T	15 May 2010
				AT	495703	T	15 Feb 2011
				AT	500793	T	15 Mar 2011
				AT	521923	T	15 Sep 2011
				AT	523157	T	15 Sep 2011
				AT	544414	T	15 Feb 2012
				AT	547059	T	15 Mar 2012
				AT	547060	T	15 Mar 2012
				BR	112012028374	A2	21 Mar 2017
				BR	112012028375	A2	21 Mar 2017
				BR	112012028465	A2	19 Jul 2016
				BR	112012028465	B1	07 Apr 2020
				BR	112012029169	A2	18 Jul 2017
				BR	112012029169	B1	05 May 2020
				CA	2128606	A1	22 Jul 1993
				CA	2128606	C	22 Jul 2008
				CA	2189775	A1	16 Nov 1995
				CA	2189775	C	11 Jul 2000
				CA	2255692	A1	27 Nov 1997

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
	CA 2255692	C	09 Dec 2003
	CA 2255934	A1	27 Nov 1997
	CA 2255934	C	13 Sep 2005
	CA 2273939	A1	18 Jun 1998
	CA 2273939	C	11 Apr 2006
	CA 2498922	A1	27 Nov 1997
	CA 2498922	C	11 Apr 2006
	CA 2632123	A1	22 Jul 1993
	CA 2632123	C	23 Mar 2010
	CN 101027010	A	29 Aug 2007
	CN 101027010	B	07 Sep 2011
	CN 101222882	A	16 Jul 2008
	CN 101222882	B	27 Mar 2013
	CN 101227870	A	23 Jul 2008
	CN 101227870	B	08 Aug 2012
	CN 101242788	A	13 Aug 2008
	CN 101242788	B	13 Apr 2011
	CN 101242789	A	13 Aug 2008
	CN 101242789	B	19 Oct 2011
	CN 101321606	A	10 Dec 2008
	CN 101321606	B	17 Apr 2013
	CN 101325920	A	17 Dec 2008
	CN 101325920	B	01 Feb 2012
	CN 101340848	A	07 Jan 2009
	CN 101340848	B	21 Mar 2012
	CN 101340850	A	07 Jan 2009
	CN 101340850	B	15 Jun 2011
	CN 101340852	A	07 Jan 2009
	CN 101340852	B	28 Dec 2011
	CN 101426412	A	06 May 2009
	CN 101426412	B	11 Dec 2013

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
		CN 101500470 A	05 Aug 2009
		CN 101500470 B	25 Mar 2015
		CN 101912307 A	15 Dec 2010
		CN 101912307 B	24 Jun 2015
		CN 102058437 A	18 May 2011
		CN 102058437 B	25 Mar 2015
		CN 102076276 A	25 May 2011
		CN 102076276 B	14 Jan 2015
		CN 102170835 A	31 Aug 2011
		CN 102170835 B	21 Jan 2015
		CN 102327152 A	25 Jan 2012
		CN 102327152 B	23 Feb 2018
		CN 102341054 A	01 Feb 2012
		CN 102341054 B	16 Mar 2016
		CN 102341055 A	01 Feb 2012
		CN 102448399 A	09 May 2012
		CN 102448399 B	16 Dec 2015
		CN 102448680 A	09 May 2012
		CN 102448680 B	27 Apr 2016
		CN 102458294 A	16 May 2012
		CN 102764159 A	07 Nov 2012
		CN 102764159 B	21 Jan 2015
		CN 102802550 A	28 Nov 2012
		CN 102802550 B	09 Mar 2016
		CN 102892363 A	23 Jan 2013
		CN 102892374 A	23 Jan 2013
		CN 102892374 B	24 Jun 2015
		CN 102892375 A	23 Jan 2013
		CN 102892375 B	19 Aug 2015
		CN 102892376 A	23 Jan 2013
		CN 102892376 B	20 Apr 2016

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
		CN 102905641 A	30 Jan 2013
		CN 102905641 B	16 Mar 2016
		CN 103192388 A	10 Jul 2013
		CN 103192388 B	10 Feb 2016
		CN 103211563 A	24 Jul 2013
		CN 103211563 B	16 Oct 2018
		CN 103930063 A	16 Jul 2014
		CN 103930063 B	16 Nov 2016
		CN 103930064 A	16 Jul 2014
		CN 103930064 B	19 Apr 2017
		CN 104334109 A	04 Feb 2015
		CN 104334109 B	23 Jun 2017
		CN 104334110 A	04 Feb 2015
		CN 104334110 B	03 Oct 2017
		CN 104363850 A	18 Feb 2015
		CN 104363850 B	18 Aug 2017
		CN 104490474 A	08 Apr 2015
		CN 104490474 B	05 Apr 2017
		CN 104688281 A	10 Jun 2015
		CN 104688281 B	19 Apr 2017
		CN 104688282 A	10 Jun 2015
		CN 104688327 A	10 Jun 2015
		CN 104688327 B	09 Jun 2017
		CN 104688328 A	10 Jun 2015
		CN 104688328 B	29 Mar 2017
		CN 104688349 A	10 Jun 2015
		CN 104688349 B	10 May 2017
		CN 104717935 A	17 Jun 2015
		CN 104717935 B	06 Apr 2018
		CN 104718054 A	17 Jun 2015
		CN 104718054 B	01 Mar 2017

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
		CN 104720887 A	24 Jun 2015
		CN 104720887 B	10 May 2017
		CN 104736093 A	24 Jun 2015
		CN 104736093 B	05 Jun 2018
		CN 104736094 A	24 Jun 2015
		CN 104736094 B	28 Jul 2017
		CN 104758055 A	08 Jul 2015
		CN 104758055 B	05 Mar 2019
		CN 104958085 A	07 Oct 2015
		CN 104958085 B	26 Sep 2017
		CN 104958111 A	07 Oct 2015
		CN 104958111 B	03 Oct 2017
		CN 105050526 A	11 Nov 2015
		CN 105050526 B	01 Jun 2018
		CN 105050528 A	11 Nov 2015
		CN 105050528 B	19 Apr 2019
		CN 105050529 A	11 Nov 2015
		CN 105050529 B	28 Aug 2018
		CN 105073058 A	18 Nov 2015
		CN 105073058 B	13 Mar 2018
		CN 105120788 A	02 Dec 2015
		CN 105120788 B	16 Oct 2018
		CN 105125263 A	09 Dec 2015
		CN 105125263 B	02 Feb 2018
		CN 105338920 A	17 Feb 2016
		CN 105338920 B	26 Jan 2018
		CN 105616007 A	01 Jun 2016
		CN 105616007 B	17 May 2019
		CN 105748026 A	13 Jul 2016
		CN 105748026 B	10 Nov 2017
		CN 105852974 A	17 Aug 2016

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
	CN 105852974	B	08 Jan 2019
	CN 105852976	A	17 Aug 2016
	CN 105852976	B	05 Nov 2019
	CN 106236277	A	21 Dec 2016
	CN 106236277	B	31 May 2019
	CN 106456265	A	22 Feb 2017
	CN 106456265	B	30 Jul 2019
	CN 106901837	A	30 Jun 2017
	CN 106901837	B	08 Nov 2019
	CN 107397591	A	28 Nov 2017
	CN 107397591	B	03 Apr 2020
	CN 107595392	A	19 Jan 2018
	CN 107595392	B	27 Nov 2020
	CN 108143497	A	12 Jun 2018
	CN 108143497	B	26 Jun 2020
	CN 108309454	A	24 Jul 2018
	CN 108309458	A	24 Jul 2018
	CN 108524001	A	14 Sep 2018
	CN 109077699	A	25 Dec 2018
	CN 109171975	A	11 Jan 2019
	CN 109700535	A	03 May 2019
	CN 110115630	A	13 Aug 2019
	CN 110604619	A	24 Dec 2019
	DE 60022911	D1	09 Feb 2006
	DE 60022911	T2	22 Jun 2006
	DE 60024079	D1	22 Dec 2005
	DE 60024079	T2	17 Aug 2006
	DE 60143909	D1	03 Mar 2011
	DE 69312053	D1	14 Aug 1997
	DE 69312053	T2	30 Oct 1997
	DE 69331789	D1	08 May 2002

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
	DE 69331789	T2	13 Mar 2003
	DE 69332914	D1	28 May 2003
	DE 69332914	T2	26 Feb 2004
	DE 69535523	D1	09 Aug 2007
	DE 69535523	T2	03 Apr 2008
	DE 69941305	D1	01 Oct 2009
	DE 69941600	D1	10 Dec 2009
	DE 69941725	D1	07 Jan 2010
	DE 69942129	D1	22 Apr 2010
	DE 69942281	D1	02 Jun 2010
	DE 102006059163	A1	16 Aug 2007
	DE 102006059163	B4	06 Jun 2019
	DE 102006059165	A1	09 Aug 2007
	DE 102006059165	B4	04 Sep 2014
	DE 602006020599	D1	21 Apr 2011
	EP 0623066	A1	09 Nov 1994
	EP 0623066	B1	09 Jul 1997
	EP 0758469	A1	19 Feb 1997
	EP 0758469	A4	05 Nov 1997
	EP 0758469	B1	27 Jun 2007
	EP 0776738	A2	04 Jun 1997
	EP 0776738	A3	16 Jul 1997
	EP 0776738	B1	03 Apr 2002
	EP 0776739	A2	04 Jun 1997
	EP 0776739	A3	16 Jul 1997
	EP 0776739	B1	23 Apr 2003
	EP 1015068	A1	05 Jul 2000
	EP 1015068	A4	09 Apr 2008
	EP 1015068	B1	07 Sep 2011
	EP 1015944	A1	05 Jul 2000
	EP 1015944	A4	31 Dec 2008

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
	EP 1015944	B1	27 Feb 2013
	EP 1131004	A1	12 Sep 2001
	EP 1131004	A4	11 Jul 2007
	EP 1131004	B1	28 Oct 2009
	EP 1139881	A1	10 Oct 2001
	EP 1139881	A4	11 Jul 2007
	EP 1139881	B1	25 Nov 2009
	EP 1146830	A1	24 Oct 2001
	EP 1146830	A4	29 Dec 2004
	EP 1146830	B1	21 Apr 2010
	EP 1148807	A1	31 Oct 2001
	EP 1148807	A4	11 Jul 2007
	EP 1148807	B1	10 Mar 2010
	EP 1150601	A2	07 Nov 2001
	EP 1150601	A4	15 Aug 2007
	EP 1150601	B1	19 Aug 2009
	EP 1181627	A2	27 Feb 2002
	EP 1181627	A4	16 Oct 2002
	EP 1181627	B1	16 Nov 2005
	EP 1269389	A1	02 Jan 2003
	EP 1269389	A4	29 Oct 2003
	EP 1269389	B1	28 Sep 2005
	EP 1355565	A2	29 Oct 2003
	EP 1355565	A4	26 Aug 2009
	EP 1355565	B1	19 Jan 2011
	EP 1356781	A2	29 Oct 2003
	EP 1356781	A3	24 Jul 2013
	EP 1471830	A1	03 Nov 2004
	EP 1471830	A4	20 Oct 2010
	EP 1650615	A1	26 Apr 2006
	EP 1650615	B1	24 Aug 2011

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
		EP 1793761 A2	13 Jun 2007
		EP 1793761 B1	01 May 2013
		EP 1840818 A2	03 Oct 2007
		EP 1840818 A3	01 Jul 2015
		EP 1849566 A2	31 Oct 2007
		EP 1849566 A3	01 Jul 2015
		EP 1885273 A2	13 Feb 2008
		EP 1885273 B1	08 Feb 2012
		EP 1893118 A1	05 Mar 2008
		EP 1893118 B1	11 Jul 2018
		EP 1897511 A2	12 Mar 2008
		EP 1897511 A3	23 Jul 2008
		EP 1897511 B1	12 Feb 2014
		EP 1901884 A2	26 Mar 2008
		EP 1901884 B1	13 Feb 2019
		EP 1928342 A1	11 Jun 2008
		EP 1928342 B1	12 Feb 2020
		EP 1931275 A1	18 Jun 2008
		EP 1931275 B1	09 Mar 2011
		EP 1962711 A1	03 Sep 2008
		EP 1962711 B1	29 Feb 2012
		EP 1965711 A2	10 Sep 2008
		EP 1965711 B1	31 Aug 2016
		EP 1965717 A2	10 Sep 2008
		EP 1965717 B1	16 May 2012
		EP 2037794 A2	25 Mar 2009
		EP 2037794 A4	04 Mar 2015
		EP 2038712 A2	25 Mar 2009
		EP 2038712 B1	17 Aug 2011
		EP 2038712 B2	28 Aug 2019
		EP 2046538 A2	15 Apr 2009

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
	EP 2046538	B1	21 Dec 2011
	EP 2106764	A2	07 Oct 2009
	EP 2106764	A3	23 Dec 2009
	EP 2135577	A2	23 Dec 2009
	EP 2135577	A3	25 Aug 2010
	EP 2135637	A2	23 Dec 2009
	EP 2135637	A3	15 Feb 2012
	EP 2135637	B1	21 May 2014
	EP 2138105	A2	30 Dec 2009
	EP 2138105	A3	31 Mar 2010
	EP 2138105	B1	29 Feb 2012
	EP 2231050	A1	29 Sep 2010
	EP 2231050	B1	20 Jun 2012
	EP 2253288	A2	24 Nov 2010
	EP 2253288	A3	17 Jul 2013
	EP 2253288	B1	27 Mar 2019
	EP 2253289	A2	24 Nov 2010
	EP 2253289	A3	27 Jun 2012
	EP 2253289	B1	24 Aug 2016
	EP 2263592	A2	22 Dec 2010
	EP 2263592	A3	20 Mar 2013
	EP 2263592	B1	09 Dec 2015
	EP 2263593	A2	22 Dec 2010
	EP 2263593	A3	13 Mar 2013
	EP 2263593	B1	11 Mar 2015
	EP 2263594	A2	22 Dec 2010
	EP 2263594	A3	10 Apr 2013
	EP 2263594	B1	31 Aug 2016
	EP 2263595	A2	22 Dec 2010
	EP 2263595	A3	06 Mar 2013
	EP 2263595	B1	17 Sep 2014

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
	EP 2269500	A2	05 Jan 2011
	EP 2269500	A3	18 May 2011
	EP 2269500	B1	21 Jun 2017
	EP 2289455	A2	02 Mar 2011
	EP 2289455	A3	06 Apr 2016
	EP 2289455	B1	13 Nov 2019
	EP 2298216	A2	23 Mar 2011
	EP 2298216	A3	22 Oct 2014
	EP 2298216	B1	20 Apr 2016
	EP 2298217	A2	23 Mar 2011
	EP 2298217	A3	22 Oct 2014
	EP 2298217	B1	10 Aug 2016
	EP 2298218	A2	23 Mar 2011
	EP 2298218	A3	13 Jun 2012
	EP 2298218	B1	15 Jun 2016
	EP 2298219	A2	23 Mar 2011
	EP 2298219	A3	30 May 2012
	EP 2298219	B1	20 Apr 2016
	EP 2298222	A2	23 Mar 2011
	EP 2298222	A3	07 Mar 2012
	EP 2326277	A1	01 Jun 2011
	EP 2326277	B1	21 Mar 2018
	EP 2332477	A2	15 Jun 2011
	EP 2332477	A3	22 Aug 2012
	EP 2332477	B1	07 Mar 2018
	EP 2332478	A2	15 Jun 2011
	EP 2332478	A3	14 Nov 2012
	EP 2332478	B1	16 Aug 2017
	EP 2332479	A2	15 Jun 2011
	EP 2332479	A3	22 Aug 2012
	EP 2332479	B1	05 Jul 2017

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
	EP 2332480	A2	15 Jun 2011
	EP 2332480	A3	10 Oct 2012
	EP 2332480	B1	26 Apr 2017
	EP 2332481	A2	15 Jun 2011
	EP 2332481	A3	29 Aug 2012
	EP 2332481	B1	05 Jul 2017
	EP 2332482	A2	15 Jun 2011
	EP 2332482	A3	28 Nov 2012
	EP 2332482	B1	12 Apr 2017
	EP 2332483	A2	15 Jun 2011
	EP 2332483	A3	14 Nov 2012
	EP 2332483	B1	12 Apr 2017
	EP 2332484	A2	15 Jun 2011
	EP 2332484	A3	26 Sep 2012
	EP 2332484	B1	25 Jan 2017
	EP 2335635	A1	22 Jun 2011
	EP 2335635	B1	20 Jul 2016
	EP 2338432	A1	29 Jun 2011
	EP 2338432	B1	11 Feb 2015
	EP 2338433	A1	29 Jun 2011
	EP 2338433	B1	11 Feb 2015
	EP 2349053	A1	03 Aug 2011
	EP 2349053	B1	21 Feb 2018
	EP 2356951	A1	17 Aug 2011
	EP 2359769	A1	24 Aug 2011
	EP 2359769	B1	14 Oct 2015
	EP 2359770	A1	24 Aug 2011
	EP 2359770	B1	06 May 2015
	EP 2360708	A1	24 Aug 2011
	EP 2362283	A2	31 Aug 2011
	EP 2362283	A3	05 Mar 2014

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
	EP 2362283	B1	25 Nov 2015
	EP 2362284	A2	31 Aug 2011
	EP 2362284	A3	22 May 2013
	EP 2362284	B1	20 May 2015
	EP 2362285	A2	31 Aug 2011
	EP 2362285	A3	03 Jul 2013
	EP 2362285	B1	25 Mar 2015
	EP 2362286	A2	31 Aug 2011
	EP 2362286	A3	26 Feb 2014
	EP 2362286	B1	02 Sep 2015
	EP 2363091	A2	07 Sep 2011
	EP 2363091	A3	28 Mar 2012
	EP 2363091	B1	27 Apr 2016
	EP 2391289	A1	07 Dec 2011
	EP 2391289	B1	23 Nov 2016
	EP 2391290	A1	07 Dec 2011
	EP 2391290	B1	05 Feb 2020
	EP 2414137	A2	08 Feb 2012
	EP 2414137	B1	21 Jun 2017
	EP 2416727	A2	15 Feb 2012
	EP 2416727	B1	17 May 2017
	EP 2441394	A2	18 Apr 2012
	EP 2441394	A3	02 Jul 2014
	EP 2441394	B1	05 Apr 2017
	EP 2441395	A2	18 Apr 2012
	EP 2441395	A3	18 Jun 2014
	EP 2442743	A1	25 Apr 2012
	EP 2442743	B1	03 Oct 2018
	EP 2444004	A2	25 Apr 2012
	EP 2444004	A3	18 Jul 2012
	EP 2444004	B1	02 Mar 2016

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
		EP 2444005 A2	25 Apr 2012
		EP 2444005 A3	18 Jul 2012
		EP 2444005 B1	19 Aug 2015
		EP 2444006 A2	25 Apr 2012
		EP 2444006 A3	18 Jul 2012
		EP 2444006 B1	26 Aug 2015
		EP 2445436 A1	02 May 2012
		EP 2445436 B1	30 Nov 2016
		EP 2559396 A2	20 Feb 2013
		EP 2559396 A3	11 Dec 2013
		EP 2559396 B1	25 Mar 2020
		EP 2568894 A1	20 Mar 2013
		EP 2568908 A1	20 Mar 2013
		EP 2568908 B1	11 Mar 2020
		EP 2568909 A1	20 Mar 2013
		EP 2568909 B1	08 Nov 2017
		EP 2568912 A1	20 Mar 2013
		EP 2568912 B1	28 Nov 2018
		EP 2568913 A1	20 Mar 2013
		EP 2568913 B1	12 Feb 2020
		EP 2687182 A1	22 Jan 2014
		EP 2687183 A1	22 Jan 2014
		EP 2687183 B1	25 Mar 2020
		EP 2687184 A1	22 Jan 2014
		EP 2687184 B1	01 Mar 2017
		EP 2687185 A1	22 Jan 2014
		EP 2687185 B1	17 Apr 2019
		EP 2687186 A1	22 Jan 2014
		EP 2689740 A1	29 Jan 2014
		EP 2689740 B1	25 Oct 2017
		EP 2745795 A1	25 Jun 2014

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
	EP 2745795	B1	28 Oct 2020
	EP 2775950	A1	17 Sep 2014
	EP 2775950	A4	26 Aug 2015
	EP 2775950	B1	08 Jan 2020
	EP 2775951	A1	17 Sep 2014
	EP 2775951	A4	26 Aug 2015
	EP 2854687	A1	08 Apr 2015
	EP 2854687	A4	17 Feb 2016
	EP 2854688	A1	08 Apr 2015
	EP 2854688	A4	17 Feb 2016
	EP 2854690	A1	08 Apr 2015
	EP 2854690	A4	27 Jan 2016
	EP 2854690	B1	01 Apr 2020
	EP 2884935	A1	24 Jun 2015
	EP 2884935	A4	22 Jun 2016
	EP 2884935	B1	08 Apr 2020
	EP 2884936	A1	24 Jun 2015
	EP 2884936	A4	27 Apr 2016
	EP 2884937	A1	24 Jun 2015
	EP 2884937	A4	13 Apr 2016
	EP 2885114	A1	24 Jun 2015
	EP 2885114	A4	29 Jun 2016
	EP 2932884	A1	21 Oct 2015
	EP 2932884	B1	09 Sep 2020
	EP 2969403	A1	20 Jan 2016
	EP 2969404	A1	20 Jan 2016
	EP 2969405	A1	20 Jan 2016
	EP 2969406	A1	20 Jan 2016
	EP 2969407	A1	20 Jan 2016
	EP 2969409	A1	20 Jan 2016
	EP 2969409	A4	16 Nov 2016

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
	EP 2987461	A1	24 Feb 2016
	EP 2987461	B1	13 Sep 2017
	EP 3042625	A1	13 Jul 2016
	EP 3042625	B1	01 May 2019
	EP 3104324	A1	14 Dec 2016
	EP 3104324	B1	18 Apr 2018
	EP 3111876	A2	04 Jan 2017
	EP 3111876	A3	29 Mar 2017
	EP 3111876	B1	24 Jul 2019
	EP 3115159	A1	11 Jan 2017
	EP 3115159	B1	16 May 2018
	EP 3119319	A1	25 Jan 2017
	EP 3119319	A4	22 Nov 2017
	EP 3119319	B1	15 Jul 2020
	EP 3181087	A1	21 Jun 2017
	EP 3181087	B1	18 Dec 2019
	EP 3199120	A1	02 Aug 2017
	EP 3199120	B1	24 Jul 2019
	EP 3231386	A1	18 Oct 2017
	EP 3231387	A1	18 Oct 2017
	EP 3231387	B1	06 Nov 2019
	EP 3231388	A1	18 Oct 2017
	EP 3246135	A1	22 Nov 2017
	EP 3281752	A1	14 Feb 2018
	EP 3281752	B1	05 Aug 2020
	EP 3351203	A1	25 Jul 2018
	EP 3372184	A1	12 Sep 2018
	EP 3372184	B1	12 Aug 2020
	EP 3385039	A1	10 Oct 2018
	EP 3385039	B1	06 Nov 2019
	EP 3395508	A1	31 Oct 2018

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
	EP 3398728	A1	07 Nov 2018
	EP 3398728	B1	27 Nov 2019
	EP 3459429	A1	27 Mar 2019
	EP 3590459	A1	08 Jan 2020
	EP 3613547	A1	26 Feb 2020
	EP 3632629	A1	08 Apr 2020
	EP 3636197	A1	15 Apr 2020
	EP 3639784	A1	22 Apr 2020
	EP 3673857	A1	01 Jul 2020
	EP 3677209	A1	08 Jul 2020
	EP 3753522	A1	23 Dec 2020
	ES 2248066	T3	16 Mar 2006
	ES 2287934	T3	16 Dec 2007
	ES 2371533	T3	04 Jan 2012
	ES 2381462	T3	28 May 2012
	ES 2381975	T3	04 Jun 2012
	FR 2894807	A1	22 Jun 2007
	FR 2894807	B1	03 Aug 2012
	FR 2895230	A1	29 Jun 2007
	FR 2895230	B1	27 Jul 2012
	FR 2974000	A1	19 Oct 2012
	FR 2974000	B1	20 Dec 2013
	FR 2996116	A1	04 Apr 2014
	FR 2996116	B1	19 Apr 2019
	JP H07504363	A	18 May 1995
	JP 3583777	B2	04 Nov 2004
	JP 2002504863	A	12 Feb 2002
	JP 3999816	B2	31 Oct 2007
	JP 2002500524	A	08 Jan 2002
	JP 4058113	B2	05 Mar 2008
	JP 2002503976	A	05 Feb 2002

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
		JP 4077516 B2	16 Apr 2008
		JP 2005261956 A	29 Sep 2005
		JP 4156606 B2	24 Sep 2008
		JP H10504763 A	12 May 1998
		JP 4172816 B2	29 Oct 2008
		JP 2004322310 A	18 Nov 2004
		JP 4324511 B2	02 Sep 2009
		JP 2007325960 A	20 Dec 2007
		JP 4430095 B2	10 Mar 2010
		JP 2007325961 A	20 Dec 2007
		JP 4430096 B2	10 Mar 2010
		JP 2007050270 A	01 Mar 2007
		JP 4443548 B2	31 Mar 2010
		JP 2005515012 A	26 May 2005
		JP 4723186 B2	13 Jul 2011
		JP 2007260429 A	11 Oct 2007
		JP 4799489 B2	26 Oct 2011
		JP 2007260430 A	11 Oct 2007
		JP 4799490 B2	26 Oct 2011
		JP 2008514357 A	08 May 2008
		JP 4943338 B2	30 May 2012
		JP 2007167644 A	05 Jul 2007
		JP 5043414 B2	10 Oct 2012
		JP 2009520573 A	28 May 2009
		JP 5101519 B2	19 Dec 2012
		JP 2009183733 A	20 Aug 2009
		JP 5131598 B2	30 Jan 2013
		JP 2009522017 A	11 Jun 2009
		JP 5152993 B2	27 Feb 2013
		JP 2009509653 A	12 Mar 2009
		JP 5193049 B2	08 May 2013

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
	JP 2011025058	A	10 Feb 2011
	JP 5207558	B2	12 Jun 2013
	JP 2011156407	A	18 Aug 2011
	JP 5213993	B2	19 Jun 2013
	JP 2011183186	A	22 Sep 2011
	JP 5219226	B2	26 Jun 2013
	JP 2011183187	A	22 Sep 2011
	JP 5255670	B2	07 Aug 2013
	JP 2009522016	A	11 Jun 2009
	JP 5264505	B2	14 Aug 2013
	JP 2012120884	A	28 Jun 2012
	JP 5283241	B2	04 Sep 2013
	JP 2009509654	A	12 Mar 2009
	JP 5288609	B2	11 Sep 2013
	JP 2011200666	A	13 Oct 2011
	JP 5289504	B2	11 Sep 2013
	JP 2011194247	A	06 Oct 2011
	JP 5301607	B2	25 Sep 2013
	JP 2010214166	A	30 Sep 2010
	JP 5318826	B2	16 Oct 2013
	JP 2009539573	A	19 Nov 2009
	JP 5324432	B2	23 Oct 2013
	JP 2012213655	A	08 Nov 2012
	JP 5372225	B2	18 Dec 2013
	JP 2012152583	A	16 Aug 2012
	JP 5386602	B2	15 Jan 2014
	JP 2012061350	A	29 Mar 2012
	JP 5398036	B2	29 Jan 2014
	JP 2007167643	A	05 Jul 2007
	JP 5403864	B2	29 Jan 2014
	JP 2012157744	A	23 Aug 2012

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
		JP 5431527 B2	05 Mar 2014
		JP 2012115690 A	21 Jun 2012
		JP 5458122 B2	02 Apr 2014
		JP 2011525845 A	29 Sep 2011
		JP 5583123 B2	03 Sep 2014
		JP 2012125589 A	05 Jul 2012
		JP 5610547 B2	22 Oct 2014
		JP 2013066775 A	18 Apr 2013
		JP 5642208 B2	17 Dec 2014
		JP 2013135859 A	11 Jul 2013
		JP 5649143 B2	07 Jan 2015
		JP 2012504017 A	16 Feb 2012
		JP 5675621 B2	25 Feb 2015
		JP 2013075195 A	25 Apr 2013
		JP 5700584 B2	15 Apr 2015
		JP 2013188574 A	26 Sep 2013
		JP 5707449 B2	30 Apr 2015
		JP 2013027733 A	07 Feb 2013
		JP 5709318 B2	30 Apr 2015
		JP 2014054535 A	27 Mar 2014
		JP 5744130 B2	01 Jul 2015
		JP 2013528064 A	08 Jul 2013
		JP 5775154 B2	09 Sep 2015
		JP 2014004483 A	16 Jan 2014
		JP 5778234 B2	16 Sep 2015
		JP 2013530738 A	01 Aug 2013
		JP 5782114 B2	24 Sep 2015
		JP 2013138965 A	18 Jul 2013
		JP 5787374 B2	30 Sep 2015
		JP 2014012212 A	23 Jan 2014
		JP 5791203 B2	07 Oct 2015

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
	JP 2014076361	A	01 May 2014
	JP 5807974	B2	10 Nov 2015
	JP 2014057849	A	03 Apr 2014
	JP 5839612	B2	06 Jan 2016
	JP 2014057850	A	03 Apr 2014
	JP 5839613	B2	06 Jan 2016
	JP 2014057851	A	03 Apr 2014
	JP 5839614	B2	06 Jan 2016
	JP 2014054534	A	27 Mar 2014
	JP 5839615	B2	06 Jan 2016
	JP 2014057853	A	03 Apr 2014
	JP 5839616	B2	06 Jan 2016
	JP 2012521855	A	20 Sep 2012
	JP 5840121	B2	06 Jan 2016
	JP 2013526337	A	24 Jun 2013
	JP 5849090	B2	27 Jan 2016
	JP 2014057848	A	03 Apr 2014
	JP 5851459	B2	03 Feb 2016
	JP 2014028228	A	13 Feb 2014
	JP 5851460	B2	03 Feb 2016
	JP 2014111080	A	19 Jun 2014
	JP 5866123	B2	17 Feb 2016
	JP 2012143582	A	02 Aug 2012
	JP 5868746	B2	24 Feb 2016
	JP 2013135862	A	11 Jul 2013
	JP 5898105	B2	06 Apr 2016
	JP 2015006423	A	15 Jan 2015
	JP 5996592	B2	21 Sep 2016
	JP 6058111	B2	11 Jan 2017
	JP 6087368	B2	01 Mar 2017
	JP 2013150833	A	08 Aug 2013

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
	JP 6087697	B2	01 Mar 2017
	JP 6104353	B2	29 Mar 2017
	JP 6113787	B2	12 Apr 2017
	JP 6130428	B2	17 May 2017
	JP 6153936	B2	28 Jun 2017
	JP 6189889	B2	30 Aug 2017
	JP 6220877	B2	25 Oct 2017
	JP 6255401	B2	27 Dec 2017
	JP 6255402	B2	27 Dec 2017
	JP 6255403	B2	27 Dec 2017
	JP 6261629	B2	17 Jan 2018
	JP 6262216	B2	17 Jan 2018
	JP 6285064	B2	28 Feb 2018
	JP 6291484	B2	14 Mar 2018
	JP 6368710	B2	01 Aug 2018
	JP 6421171	B2	07 Nov 2018
	JP 6422530	B2	14 Nov 2018
	JP 6423853	B2	14 Nov 2018
	JP 6433481	B2	05 Dec 2018
	JP 6475804	B2	27 Feb 2019
	JP 6535653	B2	26 Jun 2019
	JP 6576002	B2	18 Sep 2019
	JP 6585265	B2	02 Oct 2019
	JP 6617114	B2	04 Dec 2019
	JP 6637529	B2	29 Jan 2020
	JP 6691578	B2	28 Apr 2020
	JP 6782750	B2	11 Nov 2020
	JP 6793797	B2	02 Dec 2020
	JP 2007289726	A	08 Nov 2007
	JP 2007325959	A	20 Dec 2007
	JP 2008544814	A	11 Dec 2008

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
		JP 2009542362 A	03 Dec 2009
		JP 2012061351 A	29 Mar 2012
		JP 2012179363 A	20 Sep 2012
		JP 2012254360 A	27 Dec 2012
		JP 2012529970 A	29 Nov 2012
		JP 2013081870 A	09 May 2013
		JP 2013528065 A	08 Jul 2013
		JP 2014057852 A	03 Apr 2014
		JP 2014057854 A	03 Apr 2014
		JP 2014097431 A	29 May 2014
		JP 2014111081 A	19 Jun 2014
		JP 2014138903 A	31 Jul 2014
		JP 2014236969 A	18 Dec 2014
		JP 2014236976 A	18 Dec 2014
		JP 2015051287 A	19 Mar 2015
		JP 2015061671 A	02 Apr 2015
		JP 2015062734 A	09 Apr 2015
		JP 2015062751 A	09 Apr 2015
		JP 2015091331 A	14 May 2015
		JP 2015107340 A	11 Jun 2015
US 2014236083 A1	21 Aug 2014	US 2014236083 A1	21 Aug 2014
		US 10010693 B2	03 Jul 2018
		CN 103857434 A	11 Jun 2014
		CN 103857434 B	24 Nov 2017
		EP 2726133 A2	07 May 2014
		EP 2726133 A4	01 Apr 2015
		US 2018280652 A1	04 Oct 2018
		WO 2013002655 A2	03 Jan 2013
		WO 2013002655 A3	03 Apr 2014
US 2011270081 A1	03 Nov 2011	US 2011270081 A1	03 Nov 2011

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
		US 9226800 B2	05 Jan 2016
		AU 2011245296 A1	13 Dec 2012
		AU 2011245296 B2	06 Mar 2014
		AU 2014209251 A1	27 Aug 2015
		AU 2014209251 B2	25 Oct 2018
		AU 2014209323 A1	27 Aug 2015
		AU 2014209323 B2	30 Aug 2018
		CA 2797359 A1	03 Nov 2011
		CA 2797359 C	01 Nov 2016
		CA 2898485 A1	31 Jul 2014
		CA 2898636 A1	31 Jul 2014
		CA 2942656 A1	03 Nov 2011
		CA 2942656 C	05 Nov 2019
		CA 3056567 A1	03 Nov 2011
		CN 103068332 A	24 Apr 2013
		CN 103068332 B	04 May 2016
		CN 105007851 A	28 Oct 2015
		CN 105007851 B	20 Jul 2018
		CN 105073034 A	18 Nov 2015
		CN 105073034 B	27 Apr 2018
		CN 105877844 A	24 Aug 2016
		CN 105877844 B	20 Jul 2018
		EP 2405846 A1	18 Jan 2012
		EP 2405846 B1	01 May 2019
		EP 2563260 A2	06 Mar 2013
		EP 2563260 B1	12 Jun 2019
		EP 2948074 A1	02 Dec 2015
		EP 2948074 B1	19 Sep 2018
		EP 2948090 A1	02 Dec 2015
		EP 2948090 B1	12 Sep 2018

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
		EP 3556313 A1	23 Oct 2019
		EP 3563788 A1	06 Nov 2019
		ES 2740003 T3	05 Feb 2020
		JP 2013534832 A	09 Sep 2013
		JP 5613826 B2	29 Oct 2014
		JP 2016505344 A	25 Feb 2016
		JP 6143890 B2	07 Jun 2017
		JP 2016509511 A	31 Mar 2016
		JP 6246236 B2	13 Dec 2017
		KR 20130038261 A	17 Apr 2013
		KR 101478264 B1	31 Dec 2014
		KR 20150116442 A	15 Oct 2015
		US 2010234724 A1	16 Sep 2010
		US 8504139 B2	06 Aug 2013
		US 2013137954 A1	30 May 2013
		US 9226688 B2	05 Jan 2016
		US 2014012130 A1	09 Jan 2014
		US 9226689 B2	05 Jan 2016
		US 2013317355 A1	28 Nov 2013
		US 9232985 B2	12 Jan 2016
		US 2016120609 A1	05 May 2016
		US 10568699 B2	25 Feb 2020
		US 2016113729 A1	28 Apr 2016
		US 2020188037 A1	18 Jun 2020
		WO 2010104850 A1	16 Sep 2010
		WO 2011137301 A2	03 Nov 2011
		WO 2011137301 A3	29 Dec 2011
		WO 2014116853 A1	31 Jul 2014
		WO 2014116961 A1	31 Jul 2014
US 2004138700 A1	15 Jul 2004	US 2004138700 A1	15 Jul 2004

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
	US 7320700	B2	22 Jan 2008
	AT 547992	T	15 Mar 2012
	AT 551964	T	15 Apr 2012
	AU 2002318461	A1	03 Mar 2003
	AU 2002318461	A8	23 Apr 2009
	AU 2002322374	B2	26 Oct 2006
	AU 2003293353	A1	30 Jun 2004
	AU 2003293353	A8	30 Jun 2004
	CA 2451824	A1	09 Jan 2003
	CA 2451824	C	24 Feb 2015
	CA 2792000	A1	09 Jan 2003
	CA 2792000	C	16 Aug 2016
	CA 2927478	A1	09 Jan 2003
	CN 1728972	A	01 Feb 2006
	CN 100389730	C	28 May 2008
	CN 101181167	A	21 May 2008
	CN 101181167	B	08 May 2013
	CN 101340853	A	07 Jan 2009
	CN 101978928	A	23 Feb 2011
	CN 101978928	B	25 May 2016
	CN 102028545	A	27 Apr 2011
	CN 102028545	B	03 May 2017
	DE 102006059379	A1	16 Aug 2007
	EP 1408846	A2	21 Apr 2004
	EP 1408846	A4	09 Jul 2008
	EP 1408846	B1	07 Mar 2012
	EP 1575439	A2	21 Sep 2005
	EP 1575439	A4	05 Aug 2009
	EP 1575439	B1	04 Apr 2012
	EP 1585425	A2	19 Oct 2005
	EP 1585425	A4	23 Feb 2011

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
	EP 1585425	B1	31 Aug 2016
	EP 1853193	A1	14 Nov 2007
	EP 1965718	A2	10 Sep 2008
	EP 1965718	B1	30 Aug 2017
	EP 2338434	A2	29 Jun 2011
	EP 2338434	A3	26 Oct 2016
	EP 2359767	A2	24 Aug 2011
	EP 2359767	A3	29 May 2013
	EP 2359767	B1	30 Aug 2017
	EP 2359768	A2	24 Aug 2011
	EP 2359768	A3	29 May 2013
	EP 2359768	B1	03 Oct 2018
	EP 2659853	A2	06 Nov 2013
	EP 2659853	A3	15 Mar 2017
	EP 2659853	B1	07 Nov 2018
	EP 2659854	A2	06 Nov 2013
	EP 2659854	A3	21 Jun 2017
	EP 2659854	B1	15 Apr 2020
	EP 2659855	A2	06 Nov 2013
	EP 2659855	A3	22 Mar 2017
	EP 2659855	B1	03 Oct 2018
	EP 2735278	A2	28 May 2014
	EP 2735278	A3	27 Aug 2014
	EP 2735278	B1	23 May 2018
	EP 2865351	A1	29 Apr 2015
	EP 2865351	B1	28 Nov 2018
	EP 2901958	A1	05 Aug 2015
	EP 2901958	B1	06 Feb 2019
	EP 2901959	A1	05 Aug 2015
	EP 2901959	B1	06 Feb 2019
	EP 3087901	A1	02 Nov 2016

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
	EP 3087901	B1	01 May 2019
	EP 3087944	A1	02 Nov 2016
	EP 3278715	A2	07 Feb 2018
	EP 3278715	A3	25 Apr 2018
	EP 3278715	B1	14 Oct 2020
	EP 3498213	A2	19 Jun 2019
	EP 3498213	A3	03 Jul 2019
	EP 3524201	A1	14 Aug 2019
	FR 2895665	A1	06 Jul 2007
	JP 2005502398	A	27 Jan 2005
	JP 4332031	B2	16 Sep 2009
	JP 2005507679	A	24 Mar 2005
	JP 4347043	B2	21 Oct 2009
	JP 2006508765	A	16 Mar 2006
	JP 4486503	B2	23 Jun 2010
	JP 2009148557	A	09 Jul 2009
	JP 4938753	B2	23 May 2012
	JP 2009136684	A	25 Jun 2009
	JP 5021607	B2	12 Sep 2012
	JP 2007175502	A	12 Jul 2007
	JP 5305370	B2	02 Oct 2013
	JP 2011131072	A	07 Jul 2011
	JP 5339472	B2	13 Nov 2013
	JP 2012152562	A	16 Aug 2012
	JP 5415578	B2	12 Feb 2014
	JP 2011131071	A	07 Jul 2011
	JP 5437288	B2	12 Mar 2014
	JP 2010099530	A	06 May 2010
	JP 5455171	B2	26 Mar 2014
	JP 2012143581	A	02 Aug 2012
	JP 5460767	B2	02 Apr 2014

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
		JP 2013046772 A	07 Mar 2013
		JP 5652922 B2	14 Jan 2015
		JP 2013208506 A	10 Oct 2013
		JP 5969960 B2	17 Aug 2016
		JP 2015061613 A	02 Apr 2015
		JP 6078039 B2	08 Feb 2017
		JP 2013081823 A	09 May 2013
		JP 6097085 B2	15 Mar 2017
		JP 2015110053 A	18 Jun 2015
		JP 6155292 B2	28 Jun 2017
		JP 2016127976 A	14 Jul 2016
		JP 6177364 B2	09 Aug 2017
		JP 2017029783 A	09 Feb 2017
		JP 6305489 B2	04 Apr 2018
		JP 2017080418 A	18 May 2017
		JP 6388628 B2	12 Sep 2018
		JP 2008531222 A	14 Aug 2008
		JP 2012000487 A	05 Jan 2012
		JP 2013198782 A	03 Oct 2013
		JP 2015126892 A	09 Jul 2015
		JP 2017038947 A	23 Feb 2017
		JP 2018140241 A	13 Sep 2018
		JP 2018140242 A	13 Sep 2018
		JP 2020044376 A	26 Mar 2020
		KR 20100132562 A	17 Dec 2010
		KR 101026692 B1	07 Apr 2011
		KR 20050075451 A	20 Jul 2005
		KR 101057002 B1	17 Aug 2011
		KR 20100132560 A	17 Dec 2010
		KR 101087996 B1	01 Dec 2011
		KR 20100132561 A	17 Dec 2010

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
	KR 101118049	B1	24 Feb 2012
	KR 20130090922	A	14 Aug 2013
	KR 101486866	B1	29 Jan 2015
	KR 20080089579	A	07 Oct 2008
	KR 101487817	B1	05 Feb 2015
	KR 20140022966	A	25 Feb 2014
	KR 101487819	B1	29 Jan 2015
	US 2003018323	A1	23 Jan 2003
	US 6699235	B2	02 Mar 2004
	US 2003036748	A1	20 Feb 2003
	US 6817974	B2	16 Nov 2004
	US 2002188293	A1	12 Dec 2002
	US 6994708	B2	07 Feb 2006
	US 2004162547	A1	19 Aug 2004
	US 7066926	B2	27 Jun 2006
	US 2006048787	A1	09 Mar 2006
	US 7306597	B2	11 Dec 2007
	US 2004267254	A1	30 Dec 2004
	US 7367973	B2	06 May 2008
	US 2005251110	A1	10 Nov 2005
	US 7386365	B2	10 Jun 2008
	US 2007156119	A1	05 Jul 2007
	US 7691098	B2	06 Apr 2010
	US 2005090809	A1	28 Apr 2005
	US 7736356	B2	15 Jun 2010
	US 2006079884	A1	13 Apr 2006
	US 7824401	B2	02 Nov 2010
	US 2007239203	A1	11 Oct 2007
	US 7862580	B2	04 Jan 2011
	US 2010198231	A1	05 Aug 2010
	US 8105320	B2	31 Jan 2012

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
	US 2010228284	A1	09 Sep 2010
	US 8142421	B2	27 Mar 2012
	US 2011118755	A1	19 May 2011
	US 8337521	B2	25 Dec 2012
	US 2006074415	A1	06 Apr 2006
	US 8398634	B2	19 Mar 2013
	US 2012083801	A1	05 Apr 2012
	US 8452447	B2	28 May 2013
	US 2013096540	A1	18 Apr 2013
	US 8690908	B2	08 Apr 2014
	US 2013274922	A1	17 Oct 2013
	US 8761930	B2	24 Jun 2014
	US 2011125166	A1	26 May 2011
	US 8790243	B2	29 Jul 2014
	US 2010191251	A1	29 Jul 2010
	US 8827996	B2	09 Sep 2014
	US 2012220831	A1	30 Aug 2012
	US 8911428	B2	16 Dec 2014
	US 2008046122	A1	21 Feb 2008
	US 9002518	B2	07 Apr 2015
	US 2012190920	A1	26 Jul 2012
	US 9005112	B2	14 Apr 2015
	US 2013110130	A1	02 May 2013
	US 9014856	B2	21 Apr 2015
	US 2014330434	A1	06 Nov 2014
	US 9085083	B2	21 Jul 2015
	US 2013012928	A1	10 Jan 2013
	US 9095317	B2	04 Aug 2015
	US 2010191250	A1	29 Jul 2010
	US 9144452	B2	29 Sep 2015
	US 2008114494	A1	15 May 2008

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
	US 9317651	B2	19 Apr 2016
	US 2006079889	A1	13 Apr 2006
	US 9358031	B2	07 Jun 2016
	US 2013158542	A1	20 Jun 2013
	US 9526560	B2	27 Dec 2016
	US 2015320501	A1	12 Nov 2015
	US 9585641	B2	07 Mar 2017
	US 2015314451	A1	05 Nov 2015
	US 9623563	B2	18 Apr 2017
	US 2010198218	A1	05 Aug 2010
	US 9693794	B2	04 Jul 2017
	US 2015066002	A1	05 Mar 2015
	US 9717486	B2	01 Aug 2017
	US 2015313452	A1	05 Nov 2015
	US 9730572	B2	15 Aug 2017
	US 2017181805	A1	29 Jun 2017
	US 9872737	B2	23 Jan 2018
	US 2017281296	A1	05 Oct 2017
	US 10105128	B2	23 Oct 2018
	US 2017311778	A1	02 Nov 2017
	US 10506920	B2	17 Dec 2019
	US 2017156804	A1	08 Jun 2017
	US 10524868	B2	07 Jan 2020
	US 2018185109	A1	05 Jul 2018
	US 10595946	B2	24 Mar 2020
	US 2005182298	A1	18 Aug 2005
	US 2006178556	A1	10 Aug 2006
	US 2006199999	A1	07 Sep 2006
	US 2011028991	A1	03 Feb 2011
	US 2019046173	A1	14 Feb 2019
	US 2020107700	A1	09 Apr 2020

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2020/058292

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
		US 2020107892 A1	09 Apr 2020
		WO 03001986 A2	09 Jan 2003
		WO 03001986 A8	04 Dec 2003
		WO 03001986 A3	19 Mar 2009
		WO 03001987 A2	09 Jan 2003
		WO 03001987 A3	20 Nov 2003
		WO 03001987 A9	13 May 2004
		WO 2004052171 A2	24 Jun 2004
		WO 2004052171 A3	07 Apr 2005
		WO 2006094242 A1	08 Sep 2006
		WO 2007120353 A2	25 Oct 2007
		WO 2007120353 A3	22 May 2008

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IB2020/058292

A. CLASSIFICATION OF SUBJECT MATTER:

IPC (20210101) A61B 1/00, A61B 1/005, A61B 1/008, H01B 11/02, A61B 34/30, A61B 17/00, A61M 25/09, A61B 17/29, A61B 34/00, A61B 1/31

CPC (20130101) A61B 1/00149, A61B 1/005, A61B 1/008, H01B 11/02, A61B 34/30, A61B 2017/00946, A61M 2025/09191, A61B 17/29, A61B 34/71, A61B 2017/2905, A61B 1/00, A61B 1/31, A61B 1/0008, A61B 1/0016

B. FIELDS SEARCHED:

* Minimum documentation searched (classification system followed by classification symbols)

IPC (20210101) A61B 1/00, A61B 1/005, A61B 1/008, H01B 11/02, A61B 34/30, A61B 17/00, A61M 25/09, A61B 17/29, A61B 34/00, A61B 1/31

CPC (20130101) A61B 1/00149, A61B 1/005, A61B 1/008, H01B 11/02, A61B 34/30, A61B 2017/00946, A61M 2025/09191, A61B 17/29, A61B 34/71, A61B 2017/2905, A61B 1/00, A61B 1/31, A61B 1/0008, A61B 1/0016