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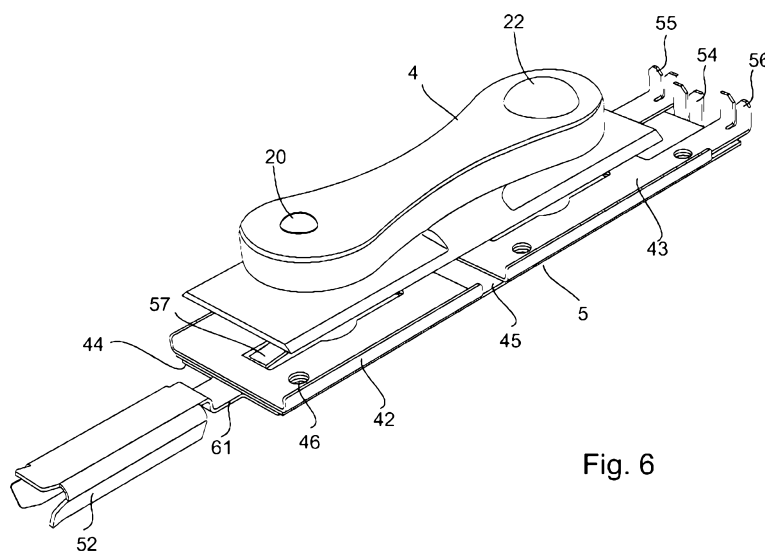


Fig. 6

(57) Abstract: An elongated electrosurgical instrument (1) has a hollow elongated main body with and electrode means (3). A switch means (4) is provided on the elongated main body (2) and arranged for supplying the electrical energy to the first means (3) in response to operating an actuator (4;4'). The switch means (5) comprises at least one first electrical contact (42; 43) and at least one second electrical contact (44). The electrical contacts have main body parts configured as conductive sheet components (50), wherein the at least one first electrical contact provided superjacent and spaced apart in order to switch said contacts between an open state and a closed state by operating the actuator (4;4').

**AN ELONGATED ELECTROSURGICAL INSTRUMENT, A SWITCH
MEANS FOR SAID INSTRUMENT, AND AN ASSEMBLY KIT**

The present invention relates to an elongated electrosurgical instrument comprising a first means for at least cutting and coagulating tissue of a patient during surgery by application of electrical energy supplied from an electrosurgical generator to a surgical site, a hollow elongated main body having a first end and an opposite second end, which first end has a first opening through which the first means protrudes, and which second end is configured for coupling the electrosurgical instrument to the electrosurgical generator and a vacuum source, a suction means for removing at least smoke from the surgical site, the suction means comprises a suction channel extending inside the hollow elongated main body, a first suction port arranged facing the first means, and a second suction port provided with a suction tubing in communication with the vacuum source, and a switch means provided on the main body and arranged for supplying the electrical energy to the first means in response to operating an actuator.

In electrosurgery high frequency (radio-frequency) current is applied by an active electrosurgical electrode to cause a cutting action, hemostasis, or coagulation of bleeding tissue. This procedure produces smoke and coagula resulting in a decreased visibility of the operative field. Electrosurgical smoke plume in high concentrations is considered hazardous and causes health care problems. Thus the reasons for facilitating effective and instantaneously evacuation of such side products are numerous and various approaches have been suggested to remedy the problems.

Some prior art elongated electrosurgical instrument has no suction channel, in which case the elongated electrosurgical can appear slim and handy. In case the instrument needs to be combined with suction, a suction channel is clicked on the

outside of the elongated electrosurgical instrument, thereby making the combined instrument very thick, ponderous and difficult to handle. Thus detachable, exterior suction channels are less preferred by surgeons. As an example US patent no. 6,146,353 discloses a smoke extraction device for use with an electrosurgical instrument. The smoke extraction device includes an elongated body portion. An attachment member serves for releasably securing the smoke extraction device exterior to the surgical instrument thereby making the assembled instrument large, clumsy and inconvenient to use for the surgeon. A substantially similar arrangement is known from US patent no. US 5,085,657.

Canadian patent application no. 2299752 relates to an electro-surgical pencil with an elongated housing having a hollow interior passageway, an open electrode end through which the electrode projects, and an open end opposite to the electrode end to be coupled to a vacuum source. The hollow interior passageway serves for aspiration and evacuation of smoke produced by the pencil. The electro-surgical pencil does not require the use of electrically powered conductors in the pencil housing. Instead an optical switch means and associated detector are coupled to the elongated housing. The switch means is operative to switch power to the electrode in response to movement of the optical switch to a selected switch position. Optical switches are however expensive due to their complicated structure and indispensable fragile components. Moreover, optical switches are susceptible to malfunction if the optical pathway gets blocked. Reflectors and sensors occupy considerable space in the instrument, which space is taken from the evacuation channel. Thus, an optical switch is unreliable, and makes the electro-surgical pencil rather thick and difficult to get a good grip around when operating. Thus optical switch means is not attractive to the surgeon.

In order to make such electrosurgical instruments smaller US patent no. US 5,242,442 proposes a smoke aspirating electrosurgical device including an electrically conductive blade attached to an axial end of a device handle shaft. The handle shaft is constructed to form an interior channel extending from the blade end of the handle shaft to the opposite end for aspiration of smoke produced by electrosurgical incisions with the blade. The interior channel can be connected to a vacuum source through a tube extending from the interior channel. The means for aspirating smoke produced by incision or cauterization is preferably a tube or an interior channel integrally formed by the handle shaft of the electrosurgical device for communicating smoke from the point of generation to a rear portion of the handle for subsequent evacuation. Flow aspiration follows an offset pathway extending from an aspiration opening above a blade electrode, below a thick switch circuitry occupying a substantial interior volume of the handle shaft. Thus aspiration takes place through a tortuous narrow passageway, which is only suited for smoke aspiration. In case that solid matter or a liquid suspension is aspirated the tortuous aspiration passageway is very vulnerable to clotting. Another problem is that the surgeon only with difficulties can see where he/she operates and uses the blade electrode, due to said electrode being hidden behind the aspiration means.

Thus there remains a need within the art for improved electrosurgical cutting and coagulation instruments.

Accordingly it is a main aspect of the present invention to provide an electrosurgical instrument of the kind mentioned in the opening paragraph, which has good suction and evacuation properties for both smoke, liquid and/or more or less homogeneous suspensions of liquid/solid matter.

It is a second aspect of the present invention to provide an inexpensive electrosurgical instrument of the kind mentioned in the opening paragraph.

5 It is a third aspect of the present invention to provide an electrosurgical instrument of the kind mentioned in the opening paragraph, which electrosurgical instrument has an ergonomic design, and does not requires use of a detachable suction channel for evacuation of matter from a surgical site.

10

It is a fourth aspect of the present invention to provide a switch means for operating an elongated electrosurgical instrument, which switch means does not protrude or extend into the suction channel.

15

It is a fifth aspect of the present invention to provide an inexpensive and ergonomic electrosurgical instrument with a suction channel, as an alternative or supplement to known electrosurgical instruments with suction channels.

20

It is a sixth aspect of the present invention to provide an ergonomic electrosurgical instrument with high flow rate through the suction channel.

25 The novel and unique features whereby these and other aspects are achieved according to the present invention consist in that the switch means comprises

- at least one first electrical contact having at least one first main body part configured as a first conductive sheet component,

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- at least one second electrical contact having at least one second main body part configured as a second conductive sheet component, wherein

- the at least one first electrical contact and the at least one second electrical contact are provided superjacent and spaced apart in order to switch said electrical contacts

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between an open state and a closed state by operating the actuator.

Within the context of the present invention the term "actuator" is used for the mechanical part of the electrosurgical instrument used to apply a force to the at least one first electrical contacts, so that the at least one first electrical contacts come to touch the at least one second electrical contact.

The term "switch means" is within the context of the present invention used for the part of the electrosurgical instrument that is used to control delivery of the electrical power from the generator to the elongated electrosurgical instrument in response to operating an actuator. The switch means can open and close an electrical circuit between the at least one first electrical contact and the at least one second electrical contact to supply current or interrupt current from an electrosurgical generator to the first means. The term "contact" is used for the parts of the switch means that are touches to complete an electrical circuit between the at least one first electrical contact and the at least one second electrical, and separate to open the electrical circuit between the at least one first electrical contact and the at least one second electrical.

Within the context of the present application the term "sheet component" refers to a component having a main portion or main body that is very thin in comparison to its length and breadth. Sheet components may preferably have thicknesses between 0,1 mm and 0,5 mm.

A first conductive sheet component and a second conductive sheet component are arranged "superjacent" each other and spaced apart. Accordingly, the sheet components are provided immediate above each other but out of direct physical contact

in the open state of the contacts, but so that the distance between the first conductive sheet component and the second conductive sheet component can be reduced to close the contacts, e.g. by pressing the first sheet components towards the second sheet components until they touch each other. The sheet components can e.g. be made of a sheet material that can deflect and/or yield in response to application of a force by virtue of the inherent properties of the selected material alone, additional designing and or combinations of these properties.

Most electrosurgical instruments with suction means include printed circuit board (PCB) mount switch means. The switches have to be soldered between conductive traces and put on top of the PCB. In response to depression of a button the conductive traces are connected. A rubber covering is often placed on top of the switch in order that together with a shell surrounding the PCB water and moisture is kept away. But the PCB, the switch and the rubber covering together are so thick that they cause the hollow elongated main body to have a ponderous wide diameter making the instrument inconvenient to hold on to, and/or the suction channel so narrow that suction rate is compromised. The switches are, together with exterior suction means, responsible for the thickness of the instrument.

By instead using a switch means made of inexpensive superjacent sheet components placed very close together, a very thin, inexpensive switch means with a simple structure is obtained. The thin switch allows for a wide, straight suction channel, thereby providing a higher suction ability and better flow properties compared to prior art elongated electrosurgical instrument with the same outer diameter.

Thus, a highly improved alternative to PCB mount switch means, is electrically conducting contacts configured as conductive sheet components, for example made of metal sheet material,

that easily can be forced in electrical contact with each other upon activating an actuator, as used for the switch means according to the present invention.

- 5 Any of the at least one first electrical contact and the at least one second electrical contact can preferably be obtained by punching, stamping, blank cutting or laser cutting the first sheet component and/or the second sheet components, or by using combinations of these methods, whatever is the most convenient and the least expensive for a given material, and given
10 situation and a certain instrument. Small sheet component are objects that can be made fast, in large numbers, in a continuous manufacturing process, and can be stored without making extraordinary precautions regarding storage conditions.
15 However any other simple method that is feasible for separating out small thin substantially flat objects in large numbers from a larger, thin sheet material are contemplated within the scope of the present invention.
- 20 The flat thin, layered structure of the switch means according to the present invention may in the following be referred to as a "stamped circuit" (SC). This expression should however not be construed as limiting the scope of the present invention, since, as explained above, the first and second conductive
25 sheet components can be made using many other methods than stamping. Thus the term "stamping" is to be understood to cover methods for separating out small sheet components with flat main bodies for use as the conductive sheet components.
- 30 An SC can be made of metal, e.g. aluminium, as well as of conductive non-metals like conductive polymers. Metal can be rolled out as thin as needed, thus to an extent where dimensional stability is preserved by the sheet component. Metal parts are easy to punch or stamp, as well as stack to
35 make the SC. A conductive polymer can alternatively easily be

moulded to the right shape and thickness, and no further machining or finishing work is necessary.

5 A major advantage of an SC is that no extra switch positioned on top of the SC is required since the SC in itself is a switch. Thus a force applied to the first conductive sheet component is sufficient to close the opposite first and second electrical contacts. By using an SC instead of a PCB the hollow elongated main body can thus be made much more handy, with less
10 protruding parts, and at the same time the suction channel can be made wider than in conventional electrosurgical instruments incorporating suctions channels. Moreover, an SC is also very cheap to fabricate and easy to assemble compared to both a PCB and any optical switch. In case that the electrosurgical
15 instruments needs to be operated in humid atmosphere or moist surroundings, the SC can optionally be covered by a rubber membrane or any other suitable thin liquid-tight material to keep water and moisture away from electrical parts.

20 The at least one first conductive sheet component and the at least one second conductive sheet component can be kept spaced apart, e.g. by means of being placed in suitable recesses in the interior wall of the elongated main body, or have holes through which taps or pins associated with the elongated main
25 body can pass to create the required distance between the opposite conductive sheet components to avoid unintended electrical contact.

30 As mentioned above use of the inventive thin switch means, i.e. the SC, makes a very straight and wide suction channel available for evacuation of any matter from a surgical site, as well as the inventive electrosurgical instruments is handy and slim to operate. A wider suction channel reduces the pressure gradient in the suction channel compared to known instruments.
35 Regarding vacuum, the suction ability is mainly influenced and limited by the section with the worst flow path, and an

unobstructed evacuation along smooth surrounding surfaces may contribute substantially to high evacuation performance. A lower pressure gradient in the suction channel means a lower pressure at the first suction port and better suction abilities also further away from the first suction port.

In the elongated electrosurgical instruments according to some of the above prior art, the part of the suction channel extending from the second suction port to the switch means normally serves as a good flow path, but the part of the suction channel that is positioned parallel to and/or below the switch means is, due to the thick or high switch means according to prior art, much narrower than the rest of the suction channel and constitutes a constriction in the flow path of the suction channel. Hence, the overall suction efficiency of the suction channel of the electrosurgical instrument according to the present invention is therefore much better than that of suction channels in known elongated electrosurgical instruments with integral suction channel.

In order to further ensure that the at least one first conductive sheet component and the at least second conductive sheet component maintain out of electrical contact when appropriate, an insulating insert can be provided between the at least one first electrical contact and the at least one second electrical contact except on at least one area left free of insulating insert for allowing the at least one first electrical contact and the at least one second electrical contact to get in contact with each other, i.e. to obtain the closed state of said contacts.

The insulating insert can expediently serve as a further precautionary measure to prevent the at least one first conductive sheet component and the at least one second conductive sheet component from getting in unintended electrical contact with each other when no force drives the at

least one first conductive sheet component towards the at least one second conductive sheet component. The actuator is provided in relation to the at least one free area in order to obtain the required electrical contact between the first and the second electrical contacts to close the circuit and supply energy to the first means.

In a preferred embodiment according to the present invention the switch means comprises at least two first electrical contacts provided in substantially the same plane superjacent the plane of the at least one second electrical contact

Two different spaced apart first electrical contacts may for example be used for activating cutting voltage and coagulating voltage, respectively. Voltages can then be applied over any of the respective two first conductive sheet components and the at least one second conductive sheet component when any of the at least two first conductive sheet components physically contact the at least one second conductive sheet component, and thereby closes the circuit between said first conductive sheet component that has been operated by the actuator, e.g. have been pressed down by the actuator, and the at least one second conductive sheet component. The closed circuit can e.g. be registered by a suitable meter, e.g. an amperemeter or voltmeter. If the meter registers that the pressed down first conductive sheet component corresponds to cutting, a cutting voltage will be sent through the at least one second conductive sheet component and through the first means to the surgical site. If the meter registers that the pressed down first conductive sheet component corresponds to coagulating, a coagulating voltage will be sent through the at least one second conductive sheet component and through the first means to the surgical site.

An embodiment wherein at least two first electrical contacts are provided in substantially the same plane superjacent the

plane of the at least one second electrical contact facilitates use of the same actuator for switching between cutting and coagulation modes of the elongated electrosurgical instrument as well as the switch means can be made very thin. The first
5 electrical contacts in form of conductive sheet components are just placed next to each other in the same plane below the actuator.

Some simple instruments may include just a single first
10 electrical contact in which case only the same level of voltage can be supplied to the first means. However, more preferred at least two first electrical contacts are arranged out of physical contact with each other to allow the surgeon to safely make his choice to shift between supplying cutting voltage or
15 coagulation voltage to the first means in response to operation of the actuator. Unintended short circuit of the at least two first electrical contacts is avoided simply because of this spaced relationship of the at least two first electrical contacts.

20 In order to close superjacent first and second electrical contacts a force can be applied to the actuator so that at least a part of the at least one first electrical contact is moved in the direction towards the at least one second
25 electrical contact to close said superjacent first and second electrical contacts.

To that aspect the actuator may be of the kind comprising a button means including a first actuator button for controlling
30 the electrosurgical cutting, and a second actuator button for controlling the electrosurgical coagulation.

The first actuator button may be provided above one first electrical contact and the second actuator button may be
35 provided above a second first electrical contact in order to independently move at least a part of the respective first

electrical contact towards and away from the at least one second electrical contact in response to forces applied to or relieved from on the respective first and second actuator button. The direction of the movement is substantially perpendicular to at least the second conductive sheet component.

The first actuator button or second actuator button, or both, can be of different kinds, however a press-button or push-button is especially simple and inexpensive to incorporate in the electrosurgical instrument according to the present invention. A press-button or push-button is easy to locate with a finger without the surgeon actually being able to see said button. Touchable pattern or other identifiers may provide further help when locating the relevant button and distinguishing between buttons.

Alternatively, the actuator can be a slide-button that also is very easy to operate. A slide button can e.g. involve a press-button movable a small distance along the longitudinal axis of the elongated main body towards the second electrical contact upon force application on the slide-button.

A reliable switch means can be obtained if the first main part of the at least one first electrical contact has a raised or projecting contact part facing the actuator, which raised or projecting contact part is designed to be displaced by means of the actuator in the direction towards the at least one second electrical contact to close said superjacent electrical contacts. The raised part can e.g. be a small convexity, indent, bulge or the like of the first main body, the first conductive sheet component, that reduces the distance a button needs to be depressed, displaced or otherwise moved in order to close the first and second electrical contact and supply energy to the first means. In case an insulating insert is provided, the raised or projecting contact part is located adjacent the

area free of insulating insert. Thus within the context of the present invention the term "raised or projecting contact part" means that a part of an otherwise thin, flat sheet component is elevated, in relation to the plane of the main body of the at least one first conductive sheet component, in the direction away from the at least one second conductive sheet component. The actuator is allowed to touch said raised or projecting contact part so such a raised or projecting contact part does not take up extra radial space, or does only take up a radial distance corresponding to or slightly more than the thickness of the insulating insert. Thus provision of a slightly raised or projection contact part need not add further thickness to the switch means.

One simple way of providing a raised or projecting contact part in the first conductive sheet component is to make two opposite slits, e.g. parallel slits, in the at least one first conductive sheet component to form a "bridge" member. By then stretching the bridge member, the bridge member can be shaped into an arched raised contact part, that is integral with the first main body of the at least one first conductive sheet component and faces the actuator by turning away from the at least one second conductive sheet component. When the first actuator button or second actuator button of the actuator is moved down, said buttons will press on the raised or projecting contact part of a respective first conductive sheet component. Since the at least one first electrical contact is provided very close to the at least one second electrical contact, thereby reducing thickness of switch means, a just slightly raised or projecting contact part will contribute to hinder and avoid unintentional contact between the at least one first conductive sheet part and the at least one second conductive sheet part that unintentionally could occur.

When the first actuator button or second actuator button are pressed down or otherwise put in contact with the raised or

projecting contact parts of the at least one first conductive sheet component, the operation of the actuator buttons serves to displace the raised or projecting contact parts towards the at least one second conductive sheet component so that the at least one first conductive sheet component and the at least one second conductive sheet component contact and close the circuit between the at least one first electrical contact and the at least one second electrical contact.

If the switching operation between the open state and the closed state of the at least one first electrical contact and the at least one second electrical contact is tactile, the surgeon can obtain inherent and immediate information of his/hers actuation and manipulation of the switch means.

If an embodiment with a raised or projecting contact part, such as a bridge member, is actuated by pressing on an actuator button, the convexity, indent or bulge of the raised or projecting contact part may snap-transform and invert into a concavity. The surgeon immediately experiences this tactile change of shape once the arched contact part snaps into the inverted shape. The inverted shape may be kept as long as the actuator button is kept down, whereby the raised or projecting contact part is kept in electrical contact with the at least one second conductive sheet component.

In order to close the first and second electrical contacts the raised or projecting contact parts may preferably project at least a distance corresponding to the distance between the spaced apart first and second main bodies of the respective first and second conductive sheet components, so that when a raised or projecting contact part is inverted or just depressed, a reliable electrical contact can be established. Thus, even in an embodiment wherein the switch means features a raised or projecting contact part the switch means is extremely

thin, and the switch means need not protrude into the suction channel as in many prior art electrosurgical instruments.

To improve and optimise the flow of e.g. air, smoke, liquid, tissue matter, coagulates and/or debris through the suction channel indentations into the suction channel or unevenness or irregularity in the walls of the suction channel should be avoided to any possible extent. Thus the surface of the interior wall of the suction channel is preferably smooth.

The electrosurgical instrument may advantageously comprise

- a first electric wire that is connected to one first conductive sheet component that is actuated in a cutting mode of the electrosurgical instrument,
- a second wire that is connected to a second first conductive sheet component that is actuated in a coagulation mode of the electrosurgical instrument, and
- a third electrical wire that is connected to the second conductive sheet component and through which cutting voltage or coagulation voltage is applied to the first means when a respective of the first conductive sheet components is actuated by operating the actuator.

Thus in simple manner switching between cutting and coagulation mode can be registered and controlled. A means for determining if the cutting circuit or the coagulation circuit is closed or not may be part of the electrosurgical generator, and the registration of this event used to trigger application of the correct level of voltage to the first means. A means for determining whether or not two opposite first and second electrical contacts are in a closed state can preferably be integral with the electrosurgical generator, e.g. a voltmeter that measures voltage difference between the third wire and the first wire or between the third wire and the second wire.

In electrosurgery a coagulation voltage is selected lower than a cutting voltage. The cutting voltage should be so high that when the first means contact the tissue the water content of the cells becomes heated to an extent where it vaporizes and causes the cells, to which high cutting voltage is applied, to explode, with the consequence that tissue is "cut". The coagulation voltage is selected to be lower in order to generate heat insufficient for this explosive vaporization, but sufficient to produce a thermal coagulum to stop bleeding from the cut.

In a preferred embodiment the hollow elongated main body may have a longitudinally extending partition wall that divides said hollow elongated main body in an elongated first compartment for accommodating at least the switch means and an electrical cable, and an elongated second compartment constituting the suction channel. The partition wall divides the hollow elongated main body in two parallel adjacent channels or compartments of each there individual cross-sections, preferably cross-sections having substantially the same size along at least the lengths of a respective elongated first or second compartment proximal to the switch means, but preferably along the entire lengths of the hollow elongated main body. In this way at least the switch means and wire components can be kept well isolated in the first compartment away from the content flowing in the suction channel.

Accordingly, the switch means is at no risk of being exposed to matter being evacuated from the surgical site. Even though a high force or high force component is applied to an actuator button the presence of the rigid and dimensionally stable partition wall prevents the switch means from being overpressed and forced down into the second compartment. Moreover, the partition wall serves as an extremely good base support for building the switch means by stacking conductive sheet components and insulating insert on top of each other at a

suitable selected location on the partition wall. The partition wall also serves as a good base for supporting and securing the electrical cable that passes from the second end of the hollow elongated main body to the switch means.

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In one way of building the switch means, the second conductive sheet component is first bedded on the partition wall, if appropriate for the intended embodiment of the electrosurgical instrument, an insulating insert is provided on top of the second conductive sheet component, and finally one or more, e.g. two, first conductive sheet components are arranged on top of the insulating insert, and thereby spaced apart and insulated from the second conductive sheet component. At least an area, e.g. the raised or projecting part, of these one or more first conductive sheet components can pass through the insulating insert, if present, and in electrical contact with the second conductive sheet component.

The hollow elongated main body, which due to the partition wall is designed with the first compartment and second compartment, can in one embodiment be moulded in a single step as a unitary piece with an opening in its circumferential wall to allow for mounting of the switch means by introducing the switch means components one by one or already joined via the opening. Wiring can then be made subsequently or before inserting the individual or joined switch means components into the first compartment.

In one embodiment the hollow elongated main body is made up of e.g. two separate elongated parts that are assembled, e.g. by heat sealing or ultrasonic welding, once other components of the electrosurgical instrument have been arranged properly. The second compartment may e.g. be moulded as a tubular part where part of its circumferential wall is the partition wall on which the switch means rests. An elongated shell or elongated cover part may serve to encapsulate at least the switch means when

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said elongated shell part or cover part later is joined with the tubular part to obtain the slim electrosurgical instrument according to the present invention. In this latter design of the electrosurgical instrument, the switch means is especially
5 easy to incorporate, e.g. as described above by stacking components on top of each other in correct and easy identifiable positions on the partition wall prior to closing the first elongated compartment by placing the shell or cover part on top of the tubular part. In summary, the partition wall
10 offers an easy accessible supporting face with plenty of space for building the switch means in situ prior to assembling the tubular part with the shell part.

To ensure that the switch means are provided in the correct
15 position longitudinal partition wall, thus in relation to the elongated main body, said longitudinal partition wall may have means for securing any of the at least one first conductive sheet component and/or the at least second conductive sheet component of the switch means in a fixed predetermined and
20 recognised location.

The cross-section of the elongated second compartment can expediently be larger than the cross-section of the elongated first compartment at least at any location below the switch
25 means. By using a very flat and thin switch means, that can be kept isolated from the suction channel inside a narrow first compartment, the presence of the switch has substantially no impact on the cross-section of the suction channel below the switch means, and thus the elongated main body has an overall
30 small cross-section as well as less protruding actuators compared to e.g. conventional electrosurgical instruments with detachable suction channel or conventional electrosurgical instruments with PCB switch means.

35 The cross-section of the elongated second compartment is preferably larger than the cross-section of the elongated first

compartment at least along the length of the elongated first compartment proximal to the switch means.

Further, the cross-section of the elongated second compartment is preferably larger than the cross-section of the elongated first compartment at least along the length of the elongated first compartment distal to the switch means.

The inventive configuration and design of the switch means also makes it possible to make an electrosurgical instrument with an ergonomic shape. The suction channel and switch means are confined in respective second and first compartments of the hollow elongated main body, whereby the exterior of the electrosurgical instrument can be kept very slim without the functionality and performance of the electrosurgical instrument is affected negatively. On the contrary, the electrosurgical instrument according to the present invention has improved suction capacity and high flow rate through the suction channel when compared to conventional electrosurgical instruments of similar kind and purpose, and can be manufactured at low cost, due to the conductive sheet components being much less expensive to obtain than PCB's, as well as the assembling method described above reduces manufacturing costs substantially.

Suitable examples of relations between the cross-section of the first compartment and the cross-section of the second compartment can e.g. be selected so that the cross-section of the elongated first compartment is at least 30 % smaller than the cross-section of the elongated second compartment along a major part of the length of the electrosurgical instrument.

In one embodiment of the electrosurgical instrument according to the present invention, the elongated second compartment may have

- a first part extending parallel to and below the switch means,
- a second part extending from the first part to the second suction port, where
- 5 - the first part has a cross-section that is at least 50% of the cross-section of the second part, preferably at least 60% of the cross-section of the second part, more preferably at least 70% of the cross-section of the second part, even more preferably at least 80% of the cross-section of the
- 10 second part, further more preferably at least 90% of the cross-section of the second part and most preferably at least 100% of the cross-section of the second part.

As evident from the above description, for being able to apply
15 a selected voltage to a surgical site, the first means needs to be electrically connected to the switch means, in particular to the second conductive sheet component. The first means has a free electrode end and an opposite coupling end secured to the hollow elongated main body and electrically connected to the
20 switch means. Preferably the first means extends in elongation of the first compartment but with at least the coupling end of the coupling rod isolated from the switch means so that evacuated matter cannot reach the current-carrying parts of said switch means. Thus, the electrical connection between the
25 switch means and the first means is kept entirely separate and insulated from the second compartment.

For electrosurgical cutting and coagulation the first means is a conductive electrode selected from the group comprising e.g.
30 a conductive blade electrode or a needle electrode, however other feasible conductive electrodes are intended within the scope of the present invention.

The electrosurgical instrument may comprise means for securing
35 the first means to the electrosurgical instrument. The securing means is configured to both ensure that the first means is

located in an appropriate position to maintain electrical connection to the electrosurgical generator via the second conductive sheet component, and to ensure that the first means does not drop off by accident during use of the electrosurgical instrument. The securing means can e.g. be made integral with or otherwise associated with at least any of the switch means and/or the elongated main body. Optionally, the first means may be detachably secured to the elongated main body.

10 To facilitate effective suction the electrosurgical instrument may comprise a suction tip that encircles the first means and the first suction port. Suction tips of different designs and preference for a given surgical procedure can be mounted covering the first suction port if the suction tip is
15 detachable mounted on the first end of the elongated hollow main body of the electrosurgical instrument.

If at least a tip part of the suction tip is transparent the surgeon can also monitor the effect of voltage application by
20 the first means as well see if and how waste is evacuated from the surgical site.

Another advantageous feature, which the suction tip can have, is tactile means, so that the surgeon can locate, confirm and
25 adjust the position of the suction tip on the elongated main body without actually seeing the suction tip. When doing so it is important that the first means is firmly positioned and secured to the elongated main body so that the first means does not detach or gets loose if accidentally hit during
30 manipulation of suction tip.

Depending on how much of the first means that is beneficial to expose from the suction tip for various patients, under various surgical conditions and for various circumstances and
35 situations, the surgeon may benefit from a means to adjust the longitudinal position of the suction tip in relation to the

longitudinal axis of the elongated main body. In a length-adjustable embodiment of the suction tip, the suction tip is provided with an internally radiating means for adjusting the longitudinal position of a suction opening of the suction tip in relation to the longitudinal axes of the elongated main body and the first means, which internally radiating means may engage corresponding engagement means on the exterior surface of the elongated main body.

The elongated main body of the electrosurgical instrument may further comprise a first coupling part to be secured to the second end of the elongated main body in order to attach and/or detach at least a suction tubing in tandem with said hollow elongated main body. By attaching the suction tubing entirely in tandem with the hollow elongated main body no suction tubing is left free along the length of the elongated main body to distract the surgeon, no volumen is added to the spatial configuration of the electrosurgical instrument along its length, and the surgeon avoids getting entangled with a suction tubing extending, and optionally suspended, parallel to the hollow elongated main body. The first coupling part may expediently be configured to be clicked-in in the opening at the second end of the elongated main body.

It is preferred that a cable that includes the first, the second and the third wire extends inside the suction tubing, outside the suction tubing or combinations of these alternatives depending on the selected design of the first coupling part, the design of the hollow elongated main body, or both, which cable serves to provide current to the first means from the electrosurgical generator.

It is intended within the scope of the present invention to exclude switch means based on expensive printed circuit boards or optical switches.

The invention further relates to the switch means described in relation to the above electrosurgical instrument. Accordingly the advantages of the switch means is defined and discussed in detail above. It should be understood that similar switch means can be implemented in other medical equipment and instruments and that such use are intended within the scope of the present invention.

However, in particular the invention relates to a switch means for an elongated electrosurgical instrument configured for at least cutting and coagulating tissue of a patient during surgery by application of electrical energy supplied from an electrosurgical generator to a surgical site as described above.

The switch means comprises

- at least one first electrical contact having at least a first main body part configured as a first conductive sheet component,
- at least one second electrical contact having at least one second electrical contact configured as a second conductive sheet component, wherein
- the at least one first electrical contact and the at least one second electrical contact are provided superjacent and spaced apart in order to switch said contacts between an open state and a closed state by operating an actuator.

Due to being made up of inexpensive conductive sheet component the assembled switch means has a flat, thin shape and appearance, that does not take up much space inside the elongated electrosurgical instrument, is inexpensive to manufacture and to incorporate in the electrosurgical instrument, simple to operate, and is made up of so few, simple and robust components, that the risk that a component, and thus the switch means, malfunctions is not likely.

The at least one first electrical contact and the at least one second electrical contact are obtained as separate object in a mechanical manufacturing process, such as e.g. blank cutting or laser cutting. Combinations of these methods are intended within the scope of the present invention as well as similar mechanical processing methods that facilitate a fast production of small, thin, conductive sheet components, e.g. of conductive metal, such as aluminium. Optionally the conductive sheet components also has an inherent resiliency that allow a first conductive sheet component to deflect or be bend to get into and out of physical contact with a second conductive sheet component in order to close and open mutual contact, and thereby controlling on/off modes of the switch means by operating the actuator.

The distance between the at least one first conductive sheet components and the at least one second conductive sheet component can e.g be less than 2 mm, more preferably less than 1 mm, even more preferably less than 0.5 mm and most preferably less than 0.3 mm, so that the combined thickness of superjacent conductive sheet components can be kept as low as 1.3 mm or even smaller if the first conductive sheet component and the second conductive sheet component are made from an even thinner sheet material and moved closer to each other.

An insulating insert may be provided between the at least one first electrical contact and the at least one second electrical contact except on at least one area left free of insulating insert for allowing the at least one first electrical contact and the at least one second electrical contact to get in contact with each other, i.e. touching each other. The insulating insert contributes in keeping the at least one first conductive sheet component and the at least one second sheet component out of electrical contact at certain areas of the sheet components, where flow of current between said component occasionally not is allowed, and to ensure that when the

actuator is depressed only the part of the first conductive sheet component below the actuator can be forced towards the second conductive sheet component.

5 Preferably, at least two first electrical contacts are provided in substantially the same plane superjacent the plane of the at least one second electrical contact, in which case the adjacent first electrical contacts take much up less space than if they were radially offset in relation to the longitudinal axis of
10 the elongated main body. In order that either cutting voltage or coagulation voltage can be applied in a safe and reliable manner the at least two first electrical contacts are provided out of physical contact with each other.

15 In a preferred embodiment a first main part of the at least one first electrical contact has a raised or projecting contact part facing the actuator, which raised or projecting contact part is designed to be displaced by means of the actuator in the direction towards the at least one second electrical
20 contact to close said superjacent electrical first and second electrical contacts.

The switching operation between the open state and the closed state of the at least one first electrical contact and the at
25 least one second electrical contact may preferably be tactile in order for the surgeon to actually feel that the electrosurgical instrument switches into a certain voltage application mode. If e.g. the actuator are of the push-button kind, the push-buttons or corresponding actuator parts for
30 switching cutting voltage or coagulation voltage on or off, can have different shapes or different surface textures so that the surgeon has a further easy and helpful means to distinguish between said buttons just by touching a button with his/her finger. When the correct push-button is located the surgeon
35 depresses it and due to the tactile feeling the surgeon gets inherent immediate information that voltage in accordance with

the selected push-button, or other appropriate kind of actuator, is being applied to the surgical site via the first means.

5 In order to provide an extraordinary slim and ergonomic electrosurgical instrument with suction means and having a simple and inexpensive structure, the switch means used for the electrosurgical instrument according to the present inventions does not include printed circuit boards or optical switches.

10

The invention also relates to an assembly kit for an electrosurgical instrument with a switch means wired to a cable as described above. The kit comprising several separate components, including at least

- 15 - the elongated main body configured with switch means and actuator as defined in any of the preceding claims,
- a first means for cutting and/or coagulation of tissue,
- at least one suction tip,
- at least one suction tubing, as defined in any of the
20 preceding claims,
- at least one first coupling part for securing the suction tubing to the second end of the elongated main body, and
- at least one second coupling part for connecting the suction tubing to the electrosurgical generator.

25

The kit enables assembly of exactly the electrosurgical instrument the surgeon needs and prefer and individual modifications of same. Providing the electrosurgical instrument as a kit makes the electrosurgical instrument versatile and the
30 surgical clinic or hospital need only to have the kits at stock in order to also have inexpensive access to a plurality of different electrosurgical instruments.

In an alternative embodiment any of the components of the kit
35 can be provided as spare parts to the kits or as individual bulk components.

A suction tip, a method for its use and kit assemblies suited for use in the electrosurgical instrument according to the present invention is disclosed in the applicant's co-pending international patent application entitled *"An elongated electrosurgical instrument, a suction tip for the electrosurgical instrument and method of adjusting the axial position of the suction tip on the electrosurgical instrument"*.

10 A click-in coupling means and various kit assemblies suited for use in the electrosurgical instrument according to the present invention is disclosed in the applicant's co-pending international patent application entitled *"A coupling means connecting an electrosurgical instrument to a vacuum source, an electrosurgical instrument provided with the coupling means, a*
15 *kit including the coupling means and their uses"*.

A first means suited for use in the electrosurgical instrument according to the present invention is disclosed in the applicant's co-pending international patent application entitled *"An electrosurgical instrument and electrosurgical conductive electrode for use with the instrument"*.

The disclosures of the switch means, the first means, and the click-in coupling means made in the above international patent applications, including their special design features, functions and uses, are contemplated used in the present invention and incorporated by references.

30 The invention will be described in further details below with reference to the drawing, in which exemplary embodiments are shown in accordance with the present invention.

Fig. 1 shows a perspective top view of a first embodiment of an elongated electrosurgical instrument according to the present invention,

fig. 2 shows the elongated main body, the first means, and the switch means in an exploded, enlarged scale perspective view,

5 fig. 3 shows the tubular part of the first embodiment shown in fig. 1 in a perspective view seen from below,

fig. 4 is a sectional view of the elongated main body shown in fig. 1 taken along line IV-IV illustrating the joining of the
10 tubular part and the cover part, but without the cable,

fig. 5 shows an exploded, perspective view of the switch means and a fragment of an associated cable,

15 fig. 6 shows an enlarged scale view of the switch means in assembled state with an actuator arranged above,

fig. 7 shows a perspective view seen inside the cavity of the cover part, wherein the switch means and the first means has
20 been inserted,

fig. 8 is a top view of the cover part,

fig. 9 is a view inside the elongated cavity of the cover part
25 provided with the actuator,

fig. 10 shows the cover part seen from the side,

fig. 11 is a fragmentary, enlarged scale view of the first end
30 of the tubular part encircled in fig. 2,

fig. 12 is an axial sectional view taken along line XII-XII in fig. 11,

fig. 13 shows the tubular part seen through the first end of the elongated main body, and prior to inserting the first means,

5 fig. 14 is an oblique, cross-sectional view taken along line XIV-XIV in fig. 11 seen from the first end of the tubular part, fig. 15 is a perspective view of the suction tip in front of the elongated main body,

10 fig. 16 is an end view of the suction tip seen inside the bore of the suction tip from the coupling end part,

fig. 17 is an enlarged scale axial, sectional view of the front end of the tubular part provided with a suction tip,

15

fig. 18 shows the elongated main body seen from the second end with a fragment of a cable,

20 fig. 19 is a perspective view seen oblique from a first plug end part of a first embodiment of the first coupling part used in the electrosurgical instrument seen in fig. 1,

fig. 20 shows the same seen oblique from a second plug end part,

25

fig. 21 shows the same mounted with cable and suction tubing,

30 fig. 22 is a perspective view seen oblique from a first plug end part of a second embodiment of the first coupling part for use in an electrosurgical instrument according to the present invention,

fig. 23 shows the same seen oblique from a second plug end part,

35

fig. 24 shows the same mounted with cable and suction tubing,

fig. 25 is a perspective view seen oblique from a first plug
end part of a third embodiment of the first coupling part for
use in an electrosurgical instrument according to the present
invention,

fig. 26 shows the same seen oblique from a second plug end
part,

fig. 27 shows the same mounted with a cable,

fig. 28 is an oblique perspective view of the second coupling
part seen from the end intended for being connected to the
vacuum source,

fig. 29 shows the same seen from the opposite end for being
connected to the second end of the suction tubing,

fig. 30 shows a modification of the second coupling seen in the
same view as in fig. 29,

fig. 31 shows a second embodiment of an actuator for use with
the present invention, and

fig. 32 shows the actuator seen directly from a short side, to
illustrate the stems of the actuator buttons.

The electrosurgical instrument and switch means according to
the present invention is described in more details below by way
of exemplary embodiments. The electrosurgical instrument and
switch means are versatile and the components of the
electrosurgical instrument and switch means can be combined
into a plurality of electrosurgical instrument having different
properties, functionalities and designs.

Below selected embodiments are described as examples only, of the many ways the components can be combined into various electrosurgical instruments for various purposes. Functionality and design of the electrosurgical instrument can be changed either at the manufacturing stage or by the surgeon in advance of or in relation to the surgical procedure, as will be understood by the following description. Thus electrosurgical instruments comprising other combinations and arrangements of the inventive components, such as e.g. actuators, first and second coupling parts, providing the cable for connecting to the electrosurgical generator outside and/or inside the suction tubing, kinds of electrodes, and shapes of the elongated main body, and how these components are combined are also intended within the scope of the present invention.

Thus the electrosurgical instrument according to the present invention may be provided to the consumer as a kit including various components to be assembled as desired, e.g. various electrosurgical electrodes, first and/or second coupling parts and tubings of various lengths and properties, to be mounted to the elongated main body according to the surgeons choice and surgical requirements for a given surgical procedure. The surgeon is able to modify the inventive electrosurgical instrument when desired and to compose exactly the instrument he/she prefers for a given surgical patient and medical condition.

Fig. 1 shows a perspective view, seen from an actuator side, of a first embodiment of an elongated electrosurgical instrument 1 according to the present invention. The electrosurgical instrument 1 is of the kind configured for at least cutting and coagulating tissue of a patient during surgery by application of electrical energy supplied from an electrosurgical generator (not shown) to a surgical site (not shown).

The electrosurgical instrument 1 comprises a hollow elongated main body 2, a first means 3 in the form of a blade electrode 3, an actuator 4 for manual application of a force to a switch means 5 below the actuator 4, which switch means 5 is incorporated inside the elongated main body 2 and thus not visible in fig. 1. A suction tip 6 is mounted at a first end 7 of the elongated main body 2 to surround the blade electrode 3 as well as a first suction port 40 (not visible in fig. 1). A first embodiment of a first coupling part 8 is inserted into a second end 9 of the elongated main body 2 opposite the first end 7, which first coupling part 8 serves as an intermediate member for connecting the second end 9 of the elongated main body 2 to a first end 10 of a flexible suction tubing 11, in the present case e.g. of disposable transparent plastic material. A cable 12 is connected to the switch means 5 to deliver current from an electrosurgical generator (not shown) to the blade electrode 3 in response to actuation of the actuator 4. A logo may be provided on the elongated main body 2, as well as other kinds of decoration and information can be provided on the exterior surface of the elongated main body.

In the present embodiment of the electrosurgical instrument 1 the cable 12 extends inside the suction tubing 11 towards a second end 13 of the suction tubing 11, at which second end 13 a second coupling part 14 is mounted in order for said suction tubing 11 to be appropriately coupled to a vacuum source (not shown). In other embodiments the cable 12 can extend exterior to the suction tubing 11.

The structure and design of the elongated main body 2 is seen more clearly in the exploded, perspective, enlarged scale view of fig. 2.

The first end 7 of the elongated main body 2 has a first opening 15 into which the first means 3, in the present case the blade electrode 3, can pass, to be mounted to the elongated

main body 2, thus the combined tubular part 16 and cover part 17, in conductive communication with the switch means 5, optionally in a replaceable manner, so that the surgeon can arrange the angle of the blade electrode 3 in relation to the main body 2, as desired, or replace the blade electrode 3 with another kind of electrosurgical electrode.

The elongated main body 2 includes two main components, a tubular part 16 and a cover part 17 respectively, which parts 16,17 preferably are manufactured as individual parts which are joined, e.g. by heat sealing, in order to create the elongated main body 2, once all electrosurgical components relevant for the instrument's performance, such as switch means and wires, are mounted appropriately. The tubular part 16 and the cover part 17 may be manufactured by any suitable kind of moulding method and subsequently joined.

A wall 18 of the cover part 17 has a substantially semicircular cross-section for, inside the elongated main body 2, providing space for accommodating both the switch means 5 and at least the part of the actuator 4 that serves to engage said switch means 5. The actuator 4 protrudes only to a minimum extent beyond the outermost circumference of the wall 18 of the cover part 17, but sufficiently for the surgeon to be able to actuate the switch means 5 by using the actuator 4. The actuator 4 does not extend into the tubular part 16, which as will be described in further details later, defines a suction channel 27. In this way the overall exterior appearance of the first embodiment of the electrosurgical instrument 1 is kept elegant and slim in order not only to be easy to handle, but also to preserve a design of the electrosurgical instrument that allows said instrument to be introduced through a very small surgical incision, while at the same time obtaining an electrosurgical instrument with high suction efficiency. Other cross-sections of cover parts 17 may be appropriate too. The cover part 17 may

thus be made without a perfect semicircular cross-section, e.g. be made more flat.

5 The wall 18 of the cover part 17 also has a first aperture part 19, through which a first actuator button 20 for application of a cutting voltage can pass in order to actuate the cutting mode of the switch means 5, and a second aperture part 21 through which a second actuator button 22 for application of a coagulation voltage can pass in order to actuate the switch means 5 in a coagulation mode of the switch means 5. An exterior side 23 of the wall 18 of the cover part 17 has protruding ribs 24, barbs or other tactile means adjacent the first aperture part 19 and the second aperture part 21. The ribs 24 extend along the longitudinal axis of the cover part 17 on both longitudinal sides of the actuator 4 in order for, on the one hand providing guidance to the surgeon for locating the actuator buttons 20,22, and on the other hand helping the surgeon to get a good hold on the elongated main body 2 during operating the electrosurgical instrument 1. Although preferred, grasping ribs 24, barbs or tactile means at the actuator's position on the main body 2 are optional.

At the first end 7 of the elongated main body 2, both the cover part 17 and the tubular part 16 have opposite facing similar circumferential engagement means 25, e.g. an external thread or spaced apart circumferentially protruding beads, for securing the suction tip 6 in adjustable manner in selected suction position in relation to the longitudinal axis of the elongated main body 2, as shown in fig. 1. A stop web 26 defines an end position of the suction tip 6 on the elongated main body 2. Due to the stop web 26 the suction tip 6 cannot be accidentally pushed too far against the actuator 4 when adjusting the suction position of the suction tip 6. The closer the suction tip 6 gets to the stop web 26 the more of the first means, in the present case the blade electrode 3, is exposed from the suction tip 6. In this way the surgeon is able to choose the

distance between the tip of the blade electrode and the suction opening of the suction tip.

5 The tubular part 16 constitutes a second elongated compartment 27 of the hollow elongated main body when the tubular part 16 is assembled with the cover part 17. The tubular part 16 has a substantially semi-circular exterior wall part 28, which circumferentially merges into an elongated wall part 29 having a substantially flat base 30. The base 30 of the wall part 29
10 becomes the partition wall 30 of the elongated main body 2 when assembled with the cover part 17. The wall part 29 seals the second compartment 27 from the surroundings to allow the second compartment 27 to serve as the suction channel 27.

15 The partition wall 30 has guide pins 31 projecting away from the suction channel 27, for arranging the switch means 5 in the correct position in relation to the elongated main body 2, e.g. as shown in fig. 2, closer to the first end 7 of the elongated main body 2 than to the second end 9 of said elongated main
20 body 2. A cable trap 32, defined by a tortuous path for the cable 12, is provided on the partition wall 30 between the second end 9 of the elongated main body 2 and the projecting guide pins 31 for the switch means 5. The cable trap 32 serves to secure the cable 12 firmly inside the electrosurgical
25 instrument 1 to prevent it from being teared off so that electrical connection to the switch means 5 accidentally is lost, e.g. when the surgeon uses the electrosurgical instrument 1.

30 Between the guide pins 31 and the first end 7 of the elongated main body 2 the tubular part 16 has a holder 33 for securing the blade electrode 3, which blade electrode 3 has a conductive coupling rod 34 that extends into a conductive electrode tip part 35 via a conductive securing part 36. The conductive
35 securing part 36 includes a first engagement part 37 of first pentagonal cross-section, which first engagement part 37 is

provided opposite a coupling end 39 of the coupling rod 34. An insulation sleeve 36a may extend axially over at least the part of the length of the securing part not including the first engagement part 37, but can also extend over the first engagement part 37, in which case the pentagonal circumference and thus the first pentagonal cross-section of the first engagement part is due to shaping of the insulation sleeve 36a. Furthermore the securing part 36 may, as shown in fig. 2 have a scale denominator or one or more indicator lines 36b, 36c to help in achieving the correct axial position of the first means 3. As will be described later with reference to e.g. figs. 11 - 14, the holder 33 of the tubular body 16 is shaped complementary to at least a longitudinal section, including the first engagement part 37, of the blade electrode 3 in order to firmly secure the blade electrode 3 or other first means correct inside the holder 33. Thus the holder 33 defines a channel 71, as seen in figs. 11 - 14, with recesses and cavities that accommodate and secure different parts or longitudinal sections of a first means 3. Accordingly, the holder 33 has a second engagement part 38 with a bore with an interior second pentagonal cross-section for engaging the first engagement part 37 of the blade electrode 3 or other first means, which first engagement part 37 has a mating first pentagonal cross-section. Thus, the first engagement part 37 and the hollow second engagement part 38 are dimensioned to mate so intimately that the orientation of the first means 3 maintains fixed during operation of the electrosurgical instrument 1. In case the electrosurgical instrument 1 is intended for use with replaceable first means 3, said first means 3 can advantageously be detachably mounted in the holder 33, and detachably coupled to the switch means 5.

The tubular part 16 can advantageously be moulded as a unit piece including a.o. the exterior wall 28, partition wall 30, protruding guide pins 31, holder 33, exterior ribs 25, and cable trap 32.

As is seen more clearly in fig. 3, the tubular part 16 has the first suction port 40 arranged facing the first means 3 opposite a second suction port 41 at the second end 9 of the elongated main body 2.

5

A switch means 5 to be provided on the partition wall 30 of the tubular part 16 of the elongated main body 2 is arranged for supplying the electrical energy to the first means 3 in response to operating the actuator 4 above the switch means 5.

10

The switch means 5 has a first electrical contact 42, another first electrical contact 43 out of physical contact with the first electrical contact 42, and a second electrical contact 44 superjacent the first electrical contacts 42,43. Thus there is a very small distance between the plane of the first electrical contacts 42,43 and the plan of the second electrical contact 44 in the assembled state of the switch means 5, which distance defines a gap into which an insulating insert 45 is provided to prevent unintended closure of circuits and diverted current flow.

20

The first electrical contact 42 is activated for application of a cutting voltage by means of the first actuator button 20, and the other first electrical contact 43 is activated for application of a coagulation voltage by means of the second actuator button 21. Both first electrical contacts 42,43, the second electrical contact 44, and the insulating insert 45 has holes 46 for receiving the protruding, confronting guide pin 31 on the partition wall 30.

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In this way the switch means 5 can in a very simple and fast manner be built on the partition wall 30 by stacking the very few individual components of the switch means on top of each other on the partition wall 30, connecting the cable 12 appropriately to put the switch means 5 into electrical contact with the first means 3, and enclose the switch means 5 by

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putting the cover part 17 on top of the tubular part 16 to define a first compartment 59a, as seen in figs. 4 and 18, where inside the first compartment 59a the cable 12 for putting the switch means 5 and the first means 3 in electrical communication with the electrosurgical generator extends.

By proper dimensioning of the holes 46 in the electrical contacts 42,43,44 and the diameter of the guide pins 31 on the partition wall 30, individual distances between the first electrical contacts 42,43, and well-defined gaps between any of the first electrical contacts 42,43 and the second electrical contact 44 can be defined in a simple manner. Tapered guide pins 31 can e.g. only pass through the hole 46 just to the extent where the tapered guide pin's 31 diameter's and the hole's diameter's are the same. Simply by making larger holes 46 in the second electrical contact 44, said second electrical contact 44 is able to receive e.g. the full length of the guide pins 31, while smaller holes 46 in the first electrical contacts 42,43 serve to preserve the required insulation distance between any of the first electrical contacts 42,43 and the second electrical contact 44 without the absolute requirement of inserting the insulating insert 45, although such an insulation insert 45 is preferred in most embodiments. The lateral distance between the two first electrical contacts 42,43 is obtained by corresponding suitable allocation of the guide pins 31 across the partition wall 30.

Fig. 4 is a cross-sectional view taken along line IV-IV in fig. 1 shown without the cable 12 or any other component inside the cover part 17 to better illustrate the size of the compartments. The suction channel 27 is the second compartment 27 of the tubular part 16, and the first compartment 59a is created when a cavity 59 of the cover part 17 is placed arching the partition wall 30 of the tubular part 16. Due to the partition wall 30 all electronic components can be kept inside the first compartment 59a isolated from the large suction flow

pathway 27. The unobstructed large cross-section of the suction channel 27 provides a very high flow velocity and therefore confers high suction performance to the electrosurgical instrument according to the present invention.

5

Fig. 5 is an exploded perspective view of the switch means 5, which was shown in assembled state in fig. 2, and is seen in the perspective view in fig. 6 with the actuator arranged aligned above.

10

The first electrical contact 42 has a first main body part 47 configured as a first conductive sheet component 47, the other first electrical contact 43, i.e. the second first electrical contact 43 has a second first main body part 48 configured as a second first conductive sheet component 48. The second electrical contact 44 has a second main body part 50 configured as a second conductive sheet component 50. The second conductive sheet component 50 has an electrode contacting end 51 with an electrode connection terminal 52 for securing the first means 3, and an opposite cable connection end 53 with a third wire connection terminal 54. The electrode connection terminal 52 is configured as a clamp 52 to fittingly engage the conductive coupling rod 34 of the blade electrode 3. The conductive coupling rod 34 is inserted into the electrode connection terminal 52 of the second conductive sheet component 50 to establish electrical contact to the conductive blade electrode tip 35. In the present embodiment the electrode connection terminal 52 is illustrated as a clamp, however other designs are foreseen within the scope of the present invention.

30

The third wire connection terminal 54 is used for securing a third 12c of three wires of the cable 12 so that the correct voltage can be supplied to the first means 3 from an electrosurgical generator in response to a measurement of an electrical parameter representing an identification of which actuator buttons 20,22 that have been actuated. To that aspect

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the first 42 of the first electrical contacts 42,43 has a first wire connection terminal 55 for securing a first 12a of three wires of the cable 12, and the second 43 of the first electrical contacts 42,43 has a second wire connection terminal 56 for securing a second 12b of three wires of the cable 12. In the present case the cable 12 is a Schneider cable, where the conductor insulation is penetrated once the wire is introduced in a respective wire connection terminal.

10 The first conductive sheet component 47 of the first 42 of the first electrical contacts 42,43 has a raised or projecting contact part 57, and the second first conductive sheet component 48 of the second 43 of the first electrical contacts 42,43 has a raised or projecting contact part 58. The
15 insulating insert 45 has actuating apertures 49a,49b, to allow passage of the aligned selected raised or projecting contact part 57,58 of the respective first electrical contacts 42,43 towards the second conductive sheet component 50 in response to a force application on the similarly aligned respective
20 actuator button 20,21. When a raised or projecting contact part 57,58 touch the second conductive sheet component 50, a circuit is closed so that current of a voltage level related to the actuated actuator buttons 20,21 can flow from the electrosurgical generator to the conductive blade electrode 3
25 via the cable 12. No expensive optical switches or thick and complex PCB's are required. The use of simple, thin, substantially flat stacked conductive sheet components makes it possible to create a switch means 5 that appear considerable flatter than known switch means used in conventional
30 electrosurgical instruments for similar purposes. The conductive sheets components 47,48,50 used in the inventive switch means 5 can easily be stamped, punched or cut from of thin plate, e.g. of metal. The holes for the guide pins and cutting of slits to make the raised parts can be made in the
35 same process step. Wire connection terminals and the terminal

for the first means can be made by subsequent or simultaneous bending or folding.

In the exemplary embodiment of the switch means 5 shown in
5 figs. 2, 5 and 6 the first 42,43 electrical contacts have
bended sides or walls, that facilitates fitting of the first
electrical contacts 42,43 on the partition wall 30. Bended
sides or walls are expedient when placing the sheet components
on the partition wall, however not mandatory features of the
10 first electrical contacts 42,43, but can if desired be made in
the same bending process as the terminals 55,56. In case
further electrical functionalities in addition to cutting and
coagulation is desired implemented in the electrosurgical
instrument 1 according to the present invention, more than two
15 first electrical contacts can be included in the switch means
5, and the actuator 4 be adapted accordingly, at minimal
further costs. For example, it is possible to make an
electrosurgical instrument where the surgeon is able to switch
between more that two voltage levels by using easy accessible
20 buttons on the instrument instead of reaching to the
electrosurgical generator simply by including an inexpensive
further first electrical contact and wiring in the switch
means, and corresponding actuator button.

25 In fig. 6 the switch means 5 is illustrated with the actuator 4
arranged above so that the actuator buttons 20,21 are aligned
with the raised or projecting parts 57,58.

Fig. 7 is a fragmentary perspective view inside the elongated
30 opening or cavity 59 of the cover part 17 of the elongated main
body 2. The switch means 5 is inserted in the cover part 17 and
seen from a bottom side 60 of the second electrical contact 44.
The electrode connecting terminal 52 protrudes towards the
first end 7 of the elongated main body 2's cover part 17, and
35 the coupling rod 34 of the blade electrode 3 is clamped into
said electrode connecting terminal 52, while the remainder of

the first means 3 extends through the holder 33 of the tubular part 16 when joined with the cover part. The switch means 5 is isolated from the suction channel and cannot get into contact with sucked matter from the surgical site. Appropriate sealing can e.g. be obtained by providing a sealing material 62 at a conductive transition 61 between the electrode connecting terminal 52 and the second conductive sheet component 50. The sealing material 62 can e.g. be provided during the process of heat-sealing the cover part 17 together with the tubular part 16. The sealing material 62 can also be provided as a transverse wall or a sealing part distal to or around e.g. the conductive transition 61. The insulation material 62 can be of the same or other plastic material as used for the elongated main body 2.

The cavity 59 of the cover part 17 has a first cable guide member 63 disposed a short distance from the second end 9 of the cover part 17 of the elongated main body 2. Proximal to the first cable guide member 63 said second end 9 is designed to receive the first coupling part 8 for providing communication to the vacuum source. In order for the cable 12 to pass smoothly without kinks inside the cover part 17 a second cable guide member 64 is made integral with the wall of the cover part 17 proximal to the first cable guide member 63. One or both of the cable guide members 63,64 can be left out if expedient or more cable guide members be included if necessary.

The elongated edges of the circumferential wall 18 of the cover part 17 has respective coupling webs 65a,66a to mate with complementary coupling webs 65b,66b, as seen in fig. 2, on the tubular part 16 when tubular part 16 and cover part 17 are joined to create the double-lumened elongated main body. A plurality of distance members 67 is distributed inside the cavity 59 along the elongated sides to further serves to locate the tubular part 16 on the partition wall 30 correct, as well

as to enforce the joined structure 16,17 and provide structural stability to the elongated main body 2.

An alternative method of joining the tubular part 16 and the cover part 17 could be gluing, however combinations of methods are within the scope of the present invention. Glue can be applied if considered expedient at any surfaces, such as e.g. at any of the coupling webs 65a,66a, the complementary coupling webs 65b,66b and the distance members 67.

Fig. 8 is a top view of the cover part 17. The actuator 4 is illustrated with different designs of actuator buttons 20,22. The differences in designs helps the surgeon to identify the correct button, and thus serves as a safety means for application either cutting voltage or coagulation voltage. The ribs 24 on both sides of the cover part 17's circumferential wall 18 next to the actuator 4 helps the surgeon to find and maintain the hand and fingers on the correct longitudinal position on the elongated main body 2. If the elongated main body 2 gets slippery the surface irregularities provided by the ribs 24 that are shaped substantially as barbs in the present embodiment prevents the surgeon from loosing his/her grip.

In the view of the cover part 17 seen in fig. 9 the switch means has been left out, so that stems 68,69 of the first actuator button 20 and the second actuator button 22, respectively, can be seen. When the free ends of the stems 68,69 are forced towards the raised parts 57,58 of the first conductive sheets components 47,48 towards the second conductive sheet component 50 a circuit is closed and current allowed to flow to the first means, as previously described.

Fig. 10 shows the cover part seen from the side and how the stems 68,69 pass through respective first 19 and second 21 aperture halves. The very limited extent of projection of the actuator 4 from the wall 18 of the cover part 17 is due to the

very flat switch means 5 that gives the electrosurgical instrument 1 a very streamlined appearance and small largest diameter. The actuator 4 is of the kind that has a common hinge 70 for the first actuator button 20 and the second actuator button 22, but other kinds of actuators having individual actuator buttons are also foreseen, as illustrated in figs. 30 and 31.

The first means 3 needs to be mounted or be mountable to the elongated main body in a safe manner. Longitudinal displacement or accidentally dropping out must be avoided, and the correct angular position in relation to the location of the actuator may be important to the surgeon. A hook electrode bent as an L must e.g. be positioned so that operating tip of the hook electrode faces towards the tissue when the surgeon holds the instrument in a manner that enables him/her also to operate the actuator, and thus to operate the switch means.

These problems are solved according to the present invention by providing a specially designed holder 33 at the first end 7 of the elongated main body 2.

Fig. 11 is a fragmentary, enlarged scale view of the first end 7 of the tubular part 16 encircled in fig. 2.

The holder 33 has a holder body with a channel 71 for accommodating the blade electrode 3, and securing both the angular and axial position of said blade electrode 3 to the elongated main body 2. The second engagement part 38 of the holder 33 has an interior section crosswise the longitudinal axis of the channel of the holder. The second engagement part 38 has a second pentagonal cross-section sized to intimately engage the first pentagonal cross-section of the first engagement part 37 of the blade electrode 3. In case the electrosurgical instrument 1 is intended for use with replaceable first means 3, said first means 3 can

advantageously be detachably mounted in the holder 33, thus also be detachably coupled to the switch means 5.

Each of the pentagonal cross-sections of blade electrode 3 and second engagement part 38 of holder 33, respectively, have five engaging edges thereby providing five potentially different positions and angular orientations into which a first means 3 can be placed and arranged. Conventionally first means 3 has first engagement parts 37 with hexagonal cross-section, and if the electrode tip 35 has a symmetrical design, such a conventional electrode tip can only be positioned and orientated in three different angular positions. Thus a pentagonal cross-section of the first engagement part confers more versatile positioning of in particular a first means with a symmetrical electrode tip, i.e. a symmetrical electrode tip part for cutting and coagulation of tissue.

Thus, the first engagement part 37 and the second engagement part 38 engage intimately so that the orientation of a first means 3, in this case the blade electrode 3, maintains firmly fixed during operation of the instrument. In contrast most engagement parts on conventional electrosurgical electrodes have six edges, thus they have hexagonal cross-sections. However, the more edges the more circular the cross-section becomes and the higher the risk that the electrosurgical electrode be dislocated during use, or is not placed correct during the assembling process, in particular gets angular dislocated. Engagement parts with less than five edges, e.g. having squared cross-sections, are less preferred due to the limited number of possible angular positions.

The conductive securing part 36 of the first means 3 includes the enveloping insulation sleeve 36a that improves sealing and engagement at the first opening 15 of the tubular part when the conductive securing part 36 is fitted into the hollow socket 72 of the holder 33 distal to said second engagement part 38. The

conductive securing part 36 with enveloping insulation sleeve 36a has a larger cross-section or is wider than the second pentagonal cross-section of the second engagement part 38 of the holder 33, so that the securing part 36 with enveloping insulation sleeve 36a can serve as a plug or stop in a socket 72 to thereby prevent displacement of the first means 3 in relation to the longitudinal axis of the elongated main body 2 towards the second end 9 of said elongated main body 2 so that the switch means 5 gets damaged. In summary the arrangement of the securing part 36 with enveloping insulation sleeve 36a and the socket 72 ensures the axial position and engagement of pentagonal part 37 of first means 3 and pentagonal part 38 of holder 33 in relation to each other. The pentagonal parts 38, 37 of the holder 33 and first means 3, respectively, with pentagonal cross-sections serve to prevent any unintended angular dislocation or repositioning while still offering the possibility of deliberate, preselected, angular positioning of the first means 3. The holder 33 has an annular collar part 73 proximal to the pentagonal second engagement part 38 of holder 33 and a hollow connection piece 74 proximal to the annular collar part 73. The hollow connection piece 74 extends with the bore of the hollow connection piece 74 on both sides of the annular collar part 73, through said annular collar part 73, into the pentagonal second engagement part 38 of holder 33, and ends in hollow socket 72 thereby creating channel 71, with the first opening 15 at the first end 7 of the elongated main body 2 and an opposite channel entry 75, through which the coupling rod 34 of the first means 3 protrudes for engaging the electrode connection terminal 52 of the switch means 5. The first end 7 of the elongated main body 2 tapers towards the hollow socket 72 and the holder 33 can be configured to extend above the plane of the partition wall 30 to an extent that allows the first means to protrude from the opening 15 substantially concentric with the suction opening 77, as seen in fig. 15, of the suction tip, thus so that it is ensured that electrode tip part 35 and suction tip 6 does not contact.

Fig. 12 is a sectional view taken along line XII-XII in fig. 11 to visualize the longitudinal channel 71 of the holder 33 that serves to accommodate and secure the first means 3. The second engagement part 38 of pentagonal cross-section appears proximal to annular socket 72 and distal to annular collar part 73.

Fig. 13 is a front view inside the channel 71, seen from the tapering, hollow, annular socket 72 of the tubular part 16, prior to inserting the first means 3. Fig. 14 shows substantially the same but is a cross-sectional view taken along line XIV-XIV in fig. 11, distal to the first suction port 40 of the tubular part 16, but seen slightly oblique from the first end 7 of the tubular part 16, in order to better see the location of the pentagonal cross-section of the second engagement part 38 of the holder 33 inside channel 71.

The suction tip 6 is seen in perspective view in fig. 15 in front of the first suction port 40 of the elongated main body 2, which elongated main body 2 includes joined cover part 17 and tubular part 16.

The suction tip 6 has a coupling end part 76 opposite the suction opening 77. The coupling end part 76 is dimensioned to fit sealingly over the first end 7 of the elongated main body 2 to cover the first suction port 40, optionally in detachable manner. The coupling end part 76 of the suction tip 6 has a first engagement means 78 for engagement with the second engagement means 25, the circumferential second engagement means 25, as an example in form of an exterior thread, on the first end 7 of the elongated main body 2 proximal to the first suction port 40. The first engagement means 78 and the second engagement means 25 are configured so that an axial position of the suction tip 6 in relation to the first means 3 is adjustable in response to movement of the suction tip 6 about and/or along a longitudinal axis A of said suction tip 6. In a preferred embodiment the suction tip 6 is transparent to allow

the surgeon to monitor, not only adjusting axial location of suction tip 6 in relation to the blade electrode 3, but also to see composition of sucked matter at any convenient point of time during surgery.

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The first engagement means 78 is provided on an interior side of a circumferential coupling wall 79 of the coupling end part 76 and protrudes radially inside a bore 80 of suction tip 6 at the coupling end part 76 in order to engage the second engagement means 25 of the elongated main body 2, as is seen more clearly in figs. 16 and 17. The first engagement means 78 can e.g. be an interior thread, at least one annular bead, one or more spaced apart engagement elements, or combinations of the aforementioned.

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The coupling end part 76 of the suction tip 6 extends via an intermediate, optionally tapering, suction part 81 into a suction end part 82 part with a tubular, non-tapering mouth 83 that ends in the suction opening 77. Other designs or modifications of the mouth 83 are intended within the scope of the present invention. The mouth 83 can e.g. have a flared skirt part (not shown) to further improve turbulence at the suction opening 77 and through the suction channel 27 out of the second end 9 of the elongated main body 2. Regarding transparency, it is most preferred that at least the suction end part 82, the intermediate suction part 81 and the mouth 83 are made of a transparent material, e.g. a plastic material that can be recycled.

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The coupling end part 76 of the suction tip 6 has exterior tactile means 84 to allow the surgeon to actually feel operation of the suction tip 6 when manipulating the axial position of the suction tip 6, should he/she suddenly discover that it would be better to expose more or less of the blade electrode part 35 from the suction opening 77 at a given moment during the surgical procedure, e.g. in order to change distance

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of mouth 83 to the wound created by the voltage applied by the blade electrode tip part 35. Thus, not only can the surgeon operate the actuator 4 with his/hers fingers without looking at the electrosurgical instrument 1, he/she can also make a qualified adjustment of the axial position of the suction tip 6 without actually being able to see what he/she is doing because he/she knows the position of the tactile means 84, e.g. one or more ribs, beads, corrugations, indents or other uneven surface topography.

In the present exemplary embodiment the first engagement means 78 is achieved by five spaced apart engagement elements 78a, 78b, 78c, 78d, 78e in the form of radial webs provided close to the opening at the coupling end 76 of the suction tip, as can be seen in the end view of the suction tip 6 seen in fig. 16 inside the bore 80. Alternative engagement elements can be provided. An interior thread may e.g. serve to be screwed on the exterior thread 25 on the elongated main body 2. Just one radial web may be required to achieve the beneficial inventive adjustable engagement between suction tip and hollow elongated main body.

The interaction of the first engagement means 78 and the second engagement means 25 creates a further tactile means for adjusting and fine tuning axial position of suction tip 6 on the first end 7 of the elongated main body 2. In the present embodiment adjusting of mutual axial position between first engagement means 78 and second engagement means 25 can, as an example, be done by screwing or rotating the coupling end part 76 of the suction tip 6 onto the second engagements means 25, or by application of a small axial force to the suction tip 6, e.g. by pushing the suction tip 6 towards and away from the stop element in form of a stop web 26 on the cover part 17 of the elongated main body 2. When webs 78a, 78b, 78c, 78d, 78e snaps into valleys 85 between ribs 86 of the thread or other circumferential projections of the second engagement means 25

the surgeon can easily feel it. So the surgeon easily experiences displacement or adjusting actions. Pushing the suction tip 6 may be preferred in preference to or in combination with rotation for initial adjusting and fine adjustment, but it is up to the surgeon to decide if rotation or axial force application are most preferred, e.g. in dependency of the surgical condition and spatial limitations and requirements. Embodiments including just on radial web are contemplated within the scope of the present invention.

The enlarged scale view of fig. 17 shows a fragment of the first end 7 of the tubular part 16 with the suction tip mounted at the elongated main body 2 to illustrate how the exterior tactile means 84 of the suction tip is arranged encircling the first engagement means 25. Only one of the webs 78, namely web 78e can be seen in fig. 17. Web 78e engages valley 85 to ensure the axial position in relation to the second engagement means 25.

The second end 9 of the elongated main body 2 could, as conventional electrosurgical instruments be adapted to be directly coupled to the vacuum source. It is however intended that the electrosurgical instrument 1 can be used with the cable outside the suction tubing, the cable inside the suction tubing or without the suction tubing.

To that aspect the electrosurgical instrument or the assembly kit for the electrosurgical instrument may, e.g. as an accessories comprise one or more different first coupling parts designed for fitting into the second coupling end 9 of the elongated main body 2, which second coupling end 9 is seen in fig. 18. The cable 12 is bedded in second cable guide member 64 of the cover part 17 and emerges from a first click-in opening 87 of the elongated first compartment 59a at the second end 9 of the elongated main body 2 above a second click-in opening 88 of the suction channel 27.

Fig. 19 is a perspective view seen oblique from a first plug end part 89 of a first embodiment of the first coupling part 8 used in the electrosurgical instrument 1 seen in fig. 1, and fig. 20 is the same seen from the opposite end.

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The first plug end part 89 has a first end-closed click-in part 90 for engaging, e.g. by force-fitting into frictional engagement, and closing off the first click-in opening 87 of the elongated first compartment 59a. Below the first end-closed click-in part 90 the first plug end part 89 has a hollow second click-in part 91 for engaging the second click-in opening 88 of the suction channel 27, to thereby allow suction from the surgical site to a waste receptacle.

15 The first plug end part 89 extends via a circumferential collar 92 into a bevelled second plug end part 93 that fits into the first end 10 of the suction tubing 11. Coupling barbs 94 is provided on the exterior side of the second plug end part 93 to prevent unintended detachment of the suction tubing 11 once
20 connected.

The circumferential collar 92 has substantially the same outline as or slightly larger than the outline of the second end 9 of the elongated main body 2. The collar 92 serves to end
25 fit said elongated main body 2, as well as a stop for the suction tubing 11.

The hollow second click-in part 91 has a suction inlet 95 that extends into the bore 96 of the second plug end part 93 towards
30 a suction outlet 97 thereby allowing passage of sucked matter from the elongated main body 2, through the first coupling part 8, and into the suction tubing 11.

A first cable groove 98 is provided in the first plug end part
35 89 to receive the cable 12 when the first end-closed click-in part 90 is mounted inside the first click-in opening 87. The

first cable groove 98 becomes substantially axially aligned with a corresponding cable groove of at least any of the first and second cable guide members 63,64 of the cover part 17, to allow the cable 12 to pass in recessed manner and the suction tubing 11 to be mounted to surround the cable 12. When using the first embodiment of a first coupling part 8 the cable 12 passes inside the suction tubing 11, as is seen more clearly in fig. 21.

10 Figs. 22 and 23 show a second embodiment of a first coupling part 8' that corresponds substantially to the first coupling part 8, and for like parts same reference numerals are used.

15 The second embodiment of a first coupling parts 8' is modified in that the circumferential collar 92' is thicker, i.e. has a longer axial extent, and that the first cable groove 98' ends blind in the circumferential collar 92' to enable exit of the cable 12 at this location, as illustrated in fig. 24.

20 Fig. 25 and 26 show a third embodiment of a first coupling part 8'' for use in an elongated main body 2 according to the present invention. The third embodiment of a first coupling part 8'' has a modified first plug end part 89', and for like parts same reference numerals are used.

25 The first plug end part 89'' has a first end-closed click-in part 90'' for engaging, e.g. by force-fitting into frictional engagement, and closing off the first click-in opening 87 of the elongated first compartment 59a. Below the first end-closed click-in part 90'' the first plug end part 89'' has a blind second click-in part 99 for engaging the second click-in opening 88 of the suction channel 27, to thereby close the suction channel 27 and allow the electrosurgical instrument 1 to be used without suction, thus as a simple electrosurgical pencil if desired.

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In a manner similar to the first cable groove 98 of the first embodiment of the first end-closed click-in part 90, the first cable groove 98'' extends into the first end-closed click-in part 90'' through the circumferential collar 92'' where the first cable groove 98'' exits into a bevelled second plug end part 93'' that is end capped by base surface, wall part or cap 100.

Fig. 27 shows the third embodiment of a first coupling part 8'' with a cable 12 arranged inside the first cable groove 98'', thus the suction channel 27 will be closed by the second plug end part 93''.

Fig. 28 is an oblique perspective view of the second coupling part 14 seen from a vacuum source coupling end part 101, i.e. from the end intended for being connected to the vacuum source.

The vacuum source coupling end part 101 has two concentric tubes, an inner tube 102 and an outer tube 103 of larger internal diameter than the inner tube 102. Due to the different diameters of the tubes 102,103 the second coupling part 14 can be connected to vacuum sources having vacuum connection pieces of two different sizes. Use of the second coupling part therefore facilitates use of the electrosurgical instrument according to the present invention, as well as other medical devices that requires connection to a vacuum source, using one and the same second coupling part 14. Accordingly, often it is not necessary to invest in new vacuum sources or adapters for being able to make use of suction from a conventional vacuum source.

The vacuum source coupling end part 101 extends into the suction tubing end part 104 defined by an annular wall 105 with a second cable groove 106 and serrations 107. The cable groove 105 is provided in a manner similar to the first cable groove 98 of the first coupling end part 8 to allow the cable 12 to

exit the suction tubing 11 just in form of vacuum source coupling end part 101, i.e. close to the vacuum source. A evacuation channel 108 extends via the inner tube 102 and into suction tubing end part 104, as seen in fig. 29 that shows the second coupling part from the end to be connected to the second end 13 of the suction tubing 11.

In a modified embodiment of the second coupling part 14 no second cable groove 105 is provided. The modified second coupling part 14 without second cable groove 106 is suited for use with for example the second embodiment of the first coupling part 8''.

A modification of a second coupling part is shown in fig. 30. The modified second coupling part corresponds to the embodiment shown in fig. 28 and 29 and for like parts same reference numerals are used. The modified second coupling part 14 only differs in that outer tube 103 has one or more slots 109 extending from the free end 110 and inside the other tube. Due to the one or more slots 109, of which only one is shown in fig. 30, the circumferential skirt that defines the wall of the outer tube is split to allow the sides of the slots to overlap and reduce the diameter of the outer tube, so that the outer tube can be compacted to be inserted into a connection piece instead of surrounding the connection piece.

The second coupling parts according to the present invention thus fit standard connection pieces of many different diameters.

A second embodiment of an actuator 4' is seen in fig. 31. The actuator corresponds substantially to the first embodiment of an actuator 4, and for like part same reference numerals are used.

The first embodiment of an actuator 4' is configured as a rocker with opposite rocker arms merging into each other. In contrast the second embodiment of an actuator 4' has no rocker arm. Instead the actuator buttons 20',22' is provided as
5 separate parts with respective stem 68',69'. The buttons 20',22' has different height and surface texture and/or surface to enable the surgeon to identify the relevant button, as seen more clear in the view of fig. 32, where the second embodiment of an actuator 4' is seen from the left side of fig. 31.

10 Since the at least one first electrical contact can be forced against the second electrical contact no further mechanical or electrical components are required to close contacts. The part of the actuator that shall be accessible from outside the
15 elongated main body can be kept inferior or be entirely eliminated without affecting the high suction properties. In fact the switch means are so flat and thin that the first compartment also has sufficient radial space for accommodating the thickness of the actuator to an extent where the actuator
20 buttons are substantially flush with the outer surfaces of the elongated main body, although in some embodiment of actuators the actuator buttons are allowed to protrude radially by 1-3 mm.

Claims

1. An elongated electrosurgical instrument (1) comprising
- a first means (3) for at least cutting and coagulating
5 tissue of a patient during surgery by application of
electrical energy supplied from an electrosurgical
generator to a surgical site,
 - a hollow elongated main body (2) having a first end (7)
and an opposite second end (9), which first end (7) has
10 a first opening (15) through which the first means (3)
protrudes, and which second end (9) is configured for
coupling the electrosurgical instrument (1) to the
electrosurgical generator and a vacuum source,
 - a suction means for removing at least smoke from the
15 surgical site,
 - the suction means comprises a suction channel (27)
extending inside the hollow elongated main body (2), a
first suction port (40) arranged facing the first means
(3), and a second suction port (41) provided with a
20 suction tubing (11) in communication with the vacuum
source, and
 - a switch means (5) provided on the elongated main body
(2) and arranged for supplying the electrical energy to
the first means (3) in response to operating an
25 actuator (4;4'),
characterised in that the switch means (5) comprises
 - at least one first electrical contact (42;43) having at
least one first main body part (47;48) configured as a
first conductive sheet component (47;48),
 - 30 - at least one second electrical contact (44) having at
least one second main body part (50) configured as a
second conductive sheet component (50), wherein
 - the at least one first electrical contact (42;43) and
the at least one second electrical contact (44) are
35 provided superjacent and spaced apart in order to

switch said contacts between an open state and a closed state by operating the actuator (4;4').

- 5 2. An electrosurgical instrument (1) according to claim 1,
 characterised in that any of the at least one first
 electrical contact (42;43) and the at least one second
 electrical contact (44) are obtained by blank cutting or
10 laser cutting the first conductive sheet component (48)
 and/or the second conductive sheet component (50), or
 combinations of these methods.
3. An electrosurgical instrument (1) according to any of
 claims 1 or 2, **characterised** in that an insulating insert
15 (45) is provided between the at least one first electrical
 contact (42;43) and the at least one second electrical
 contact (44) except on at least one area (49a,49b) left
 free of insulating insert (44) for allowing the at least
 one first electrical contact (42;43) and the at least one
20 second electrical contact (44) to get in contact with each
 other.
4. An electrosurgical instrument (1) according to any of the
 claims 1, 2 or 3, **characterised** in that at least two first
25 electrical contacts (42;43) are provided in substantially
 the same plane superjacent the plane of the at least one
 second electrical contact (44).
5. An electrosurgical instrument (1) according to claim 4,
30 **characterised** in that the at least two first electrical
 contacts (42;43) are provided out of physical contact with
 each other.
6. An electrosurgical instrument (1) according to any of the
35 preceding claims 1 - 5, **characterised** in that the actuator
 (4;4') is configured to apply a force that moves at least

a part of the at least one first electrical contact (42;43) in the direction towards the at least one second electrical contact (44) to close said superjacent first (42;43) and second (44) electrical contacts.

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7. An electrosurgical (1) instrument according to any of the preceding claims 1 - 6, **characterised** in that the actuator (4;4') comprises a button means (20,22;20'22') including a first actuator button (20;20') for controlling the electrosurgical cutting and a second actuator button (22;22') for controlling the electrosurgical coagulation.

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8. An electrosurgical instrument (1) according to claim 7, **characterised** in that the first actuator button (20,;20') is provided above the first electrical contact (42) and the second actuator button (22;22') is provided above a second first electrical contact (43) in order to independently move at least a part of the respective first electrical contact (42;43) towards and away from the at least one second electrical contact (44) in response to forces applied to or relieved from the respective first actuator button (20;20') or second actuator button (22;22').

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9. An electrosurgical instrument (1) according to any of claims 7 or 8, **characterised** in that any of the first actuator button (20;20') or second actuator button (22;22'), or both, are a press-button or a push button.

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10. An electrosurgical instrument (1) according to any of the preceding claims 1 - 9, **characterised** in that the actuator is a slide-button.

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11. An electrosurgical instrument (1) according to any of the preceding claims 1 - 10, **characterised** in that the first main part of the at least one first electrical contact

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(42) has a raised or projecting contact part (57;58) facing the actuator (4;4'), which raised or projecting contact part (57,58) is designed to be displaced by means of the actuator (4;4') in the direction towards the at least one second electrical contact (44) to close said superjacent electrical contacts (42,43;44).

12. An electrosurgical instrument (1) according to any of the preceding claims 1 - 11, **characterised** in that a switching operation between the open state and the closed state of the at least one first electrical contact (42;43) and the at least one second electrical contact (44) is tactile.

13. An electrosurgical instrument (1) according to any of the preceding claims 1 - 12, **characterised** in that the switch means (5) does not protrude into the suction channel (27).

14. An electrosurgical instrument (1) according to any of the preceding claims 1 - 13, **characterised** in that the electrosurgical instrument (1) comprises

- a first electric wire (12a) that is connected to the first conductive sheet component (47) that is actuated in a cutting mode of the electrosurgical instrument (1),
- a second wire (12b) that is connected to a second first conductive sheet component (48) that is actuated in a coagulation mode of the electrosurgical instrument (1), and
- a third electrical wire (12c) that is connected to the second conductive sheet component (50) and through which cutting voltage or coagulation voltage is applied to the first means (3) when a respective of the first conductive sheet components (47;48) is actuated by operating the actuator (4;4').

15. An electrosurgical instrument (1) according to any of the preceding claims 1 - 14, **characterised** in that the electrical energy is supplied as either a coagulation voltage or a cutting voltage, preferably the coagulation voltage is lower than the cutting voltage.

16. An electrosurgical instrument (1) according to any of the preceding claims 1 - 15, **characterised** in that the hollow elongated main body (2) has a longitudinal extending partition wall (30) that divides said hollow elongated main body (2) in an elongated first compartment (59a) for accommodating at least the switch means (5) and a second compartment (27) constituting the suction channel (27).

17. An electrosurgical instrument (1) according to claim 16, **characterised** in that the longitudinal partition wall (30) has means for securing any of the at least one first conductive sheet component (47;48) and/or the at least second conductive sheet component (50) of the switch means (5) in a fixed location.

18. An electrosurgical instrument (1) according to any of the claims 16 or 17, **characterised** in that the cross-section of the elongated second compartment (27) is larger than the cross-section of the elongated first compartment (59a) at any location along the length of the first compartment (59a) below the switch means (5).

19. An electrosurgical instrument (1) according to any of the claims 16, 17 or 18, **characterised** in that the cross-section of the elongated second compartment (27) is larger than the cross-section of the elongated first compartment (59a) at least along the length of the elongated first compartment (27) proximal to the switch means (5).

20. An electrosurgical instrument (1) according to any of the preceding claims 16 - 19, **characterised** in that the cross-section of the elongated second compartment (27) is larger than the cross-section of the elongated first compartment (59a) along the length of the elongated first compartment (59a) distal to the switch means (5).

21. An electrosurgical instrument (1) according to any of the preceding claims 16 - 20, **characterised** in that the first means (3) extends in elongation of the first compartment (59a).

22. An electrosurgical instrument (1) according to any of the preceding claims 1 - 21, **characterised** in that the electrical connection between the switch means (5) and the first means (3) is insulated from the suction channel (27).

23. An electrosurgical instrument (1) according to any of the preceding claims 1 - 22, **characterised** in that the first means (3) is a conductive electrode selected from the group comprising at least a conductive blade electrode, a needle electrode, a hook electrode, or a ball electrode.

24. An electrosurgical instrument (1) according to any of the preceding claims 1 - 23, **characterised** in that the electrosurgical instrument (1) comprises securing means for securing the first means (3) to the electrosurgical instrument (1).

25. An electrosurgical instrument (1) according to any of the preceding claims 1 - 24, **characterised** in that the electrosurgical instrument (1) comprises a suction tip (6) that encircles the first means (3) and the first suction port (40).

26. An electrosurgical instrument (1) according to claim 25, **characterised** in that the suction tip (6) is detachable mounted on the first end (7) of the elongated main body (2) of the electrosurgical instrument (1).

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27. An electrosurgical instrument according to any of the claims 25 or 26, **characterised** in that at least a tip part (82,83) of the suction tip (6) is transparent.

10 28. An electrosurgical instrument (1) according to any of the claims 25, 26 or 27, **characterised** in that the suction tip (6) has tactile means (84).

15 29. An electrosurgical instrument (1) according to any of the preceding claims 25 - 28, **characterised** in that the suction tip (6) has an internally radiating first engagement means (78) for adjusting the longitudinal position of a suction opening (77) of the suction tip (6) in relation to the elongated main body (2) and the first
20 means (3), and the elongated main body (2) has corresponding second engagement means (25).

30. An electrosurgical instrument (1) according to any of the preceding claims 1 - 29, **characterised** in that the
25 elongated main body (2) of the electrosurgical instrument (1) comprises a first coupling part (8) to be secured to the second end (9) of the elongated main body (2) in order to attach and/or detach at least a suction tubing (11) in tandem with said elongated main body (2).

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31. An electrosurgical instrument (1) according to any of the preceding claims 1 - 30, **characterised** in that a cable (12) that includes the first (12a), the second (12b) and the third wire (12c) extends inside the suction tubing
35 (11), outside the suction tubing (11) or combinations of

these alternative to provide voltage to the first means (3) from the electrosurgical generator.

32. An electrosurgical instrument (1) according to any of the preceding claims 1 - 31, **characterised** in that the switch means (5) does not include printed circuit boards or optical switches.

33. A switch means (5) for an elongated electrosurgical instrument (1) configured for at least cutting and coagulating tissue of a patient during surgery by application of electrical energy supplied from an electrosurgical generator to a surgical site, **characterised** in that the switch means (5) comprises

- at least one first electrical contact (42;43) having at least a first main body part (47;48) configured as a first conductive sheet component (47;48),
- at least one second electrical contact (44) having at least one second main body part (50) configured as a second conductive sheet component (50), wherein
- the at least one first electrical contact (42;43) and the at least one second electrical contact (44) are provided superjacent and spaced apart in order to switch said contacts between an open state and a closed state by operating an actuator (4;4').

34. A switch means (5) according to claim 33, **characterised** in that any of the at least one first electrical contact (42;43) and the at least one second electrical contact (44) are obtained by blank cutting or laser cutting the first conductive sheet component (47;48) and/or the second conductive sheet component (50), or by combinations of these methods.

35. A switch means (5) according to any of claims 33 or 34, **characterised** in that an insulating insert (45) is

provided between the at least one first electrical contact (42;43) and the at least one second electrical contact (44) except on at least one area (49a,49b) left free of insulating insert (44) for allowing the at least one first electrical contact (42;43) and the at least one second electrical contact (44) to get in contact with each other.

36. A switch means (5) according to any of claims 33, 34 or 35, **characterised** in that at least two first electrical contacts (42;43) are provided in substantially the same plane superjacent the plane of the at least one second electrical contact (44).

37. A switch means (5) according to any of the preceding claims 33 - 36, **characterised** in that the at least two first electrical contacts (42;43) are provided out of physical contact with each other.

38. A switch means (5) according to any of the preceding claims 33 - 37, **characterised** in that a first main part (47;48) of the at least one first electrical contact (42;43) has a raised or projecting contact part (57;58) facing the actuator (4;4'), which raised or projecting contact part (47;48) is designed to be displaced by means of the actuator (4;4') in the direction towards the at least one second electrical contact (44) to close said superjacent electrical contacts (42,43;44).

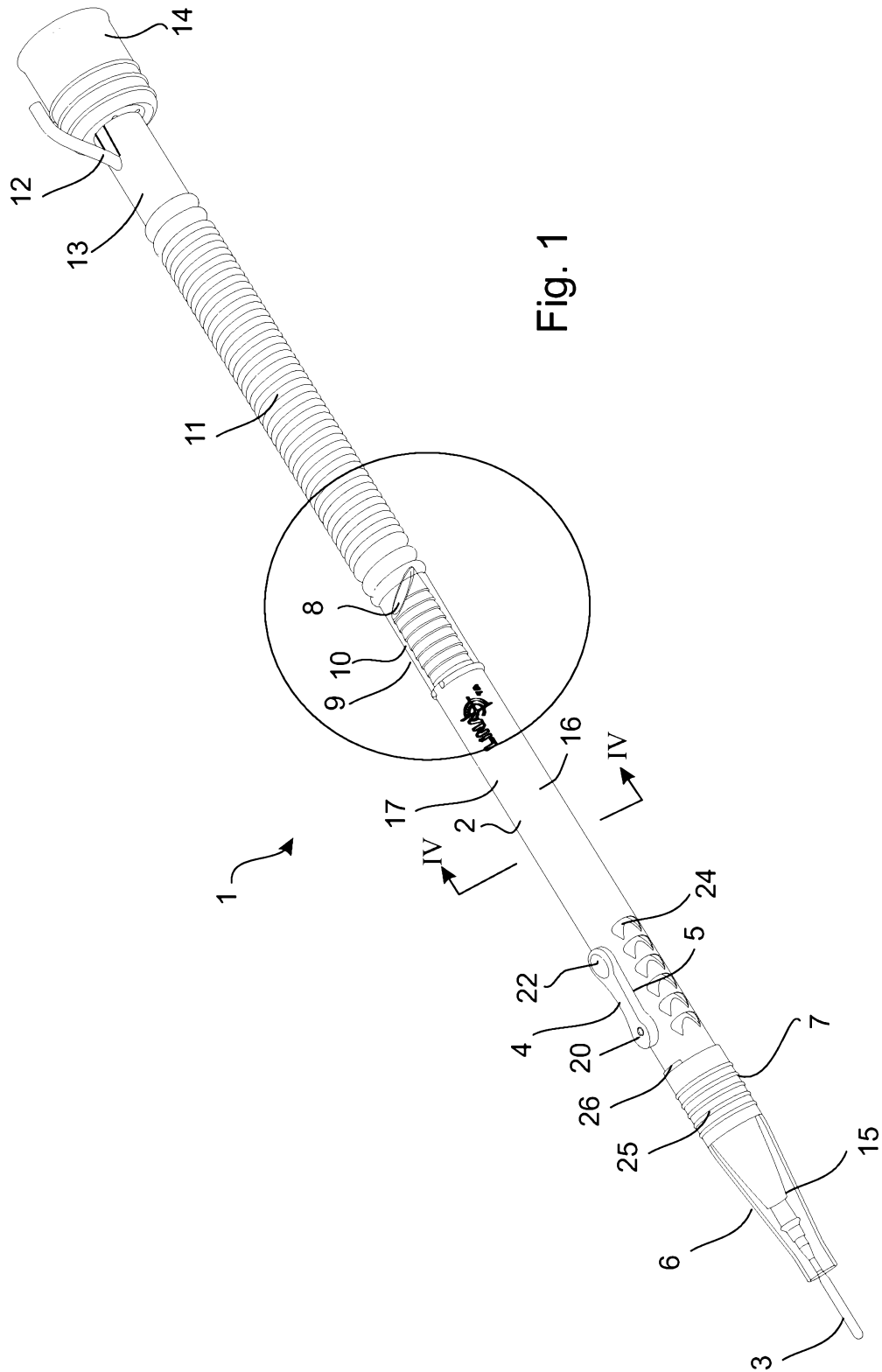
39. A switch means (5) according to any of the preceding claims 33 - 38, **characterised** in that a switching operation between the open state and the closed state of the at least one first electrical contact (42;43) and the at least one second electrical contact (44) is tactile.

40. A switch means (5) according to any of the preceding claims 33 - 39, **characterised** in that the switch means (5)

does not include printed circuit boards or optical switches.

41. An assembly kit for an electrosurgical instrument (1) with
5 a switch means (5) wired to a cable (12) according to any
of the preceding claims, the kit comprising at least
- the elongated main body (2) configured with switch
means (5), actuator (4;4') and cable (12) as defined in
any of the preceding claims,
 - 10 - a first means (3) for cutting and/or coagulation of
tissue,
 - at least one suction tip (6),
 - at least one suction tubing (11), as defined in any of
the preceding claims,
 - 15 - at least one first coupling part (8;8';8'') for
securing the suction tubing (11) to the second end (9)
of the elongated main body (2), and
 - at least one second coupling part (14) for connecting
the suction tubing (11) to the electrosurgical
20 generator.

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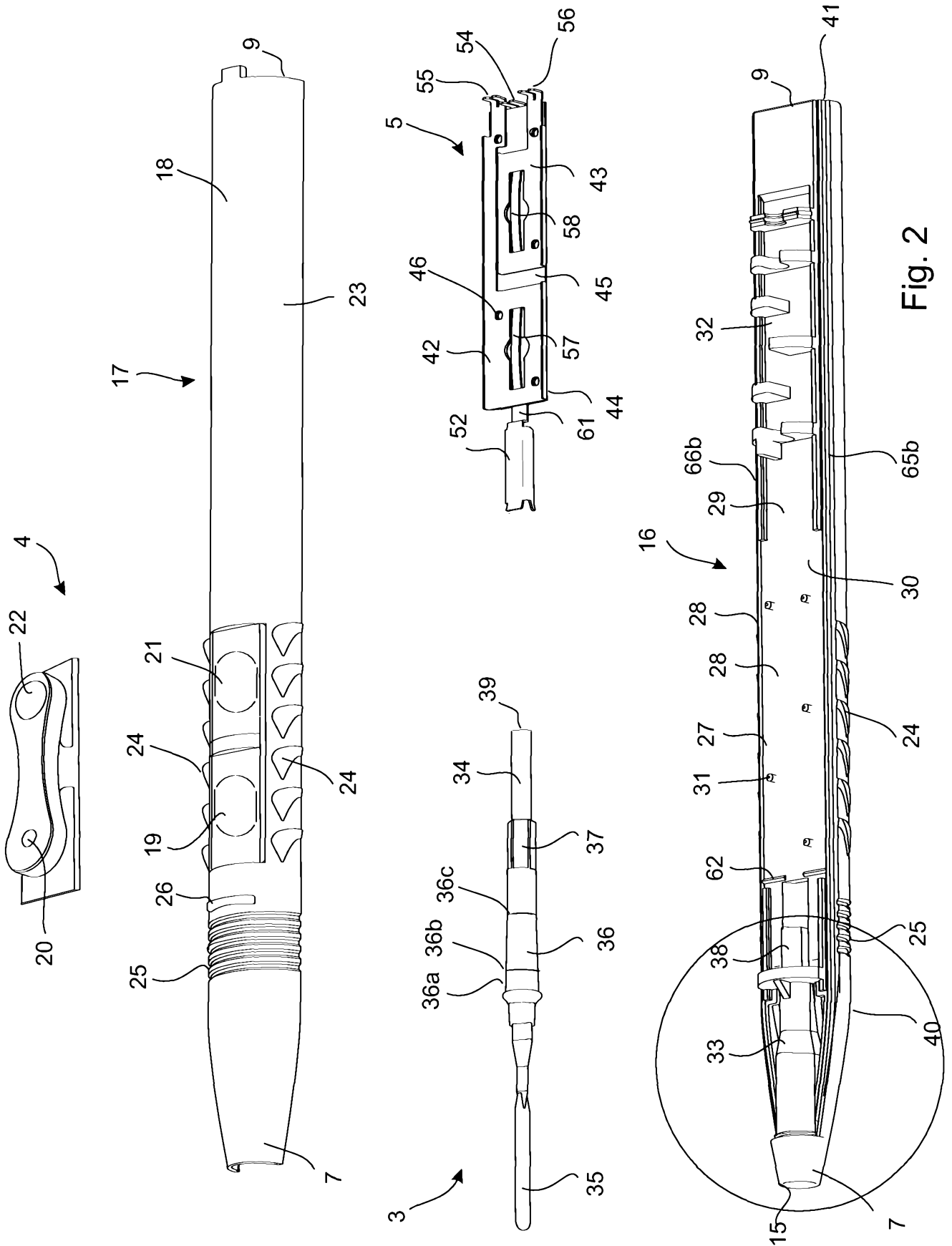


Fig. 2

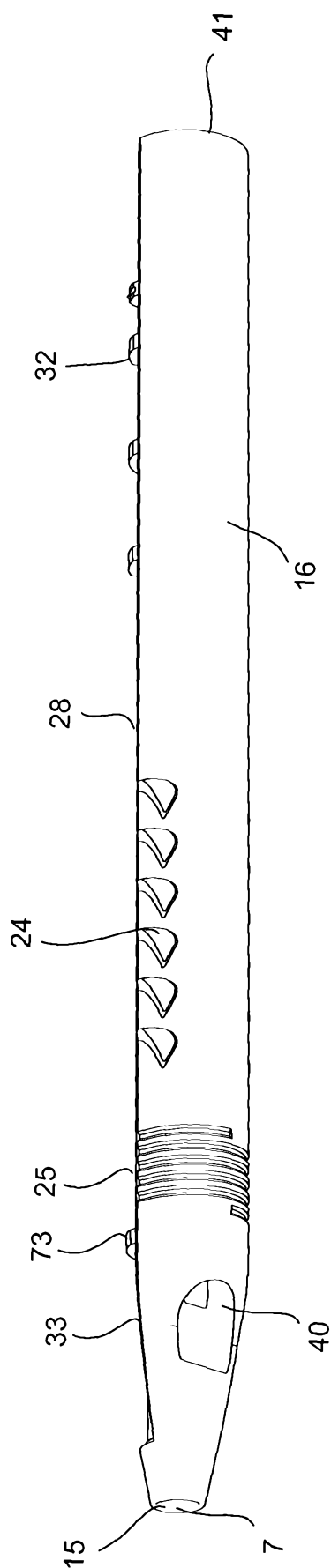


Fig. 3

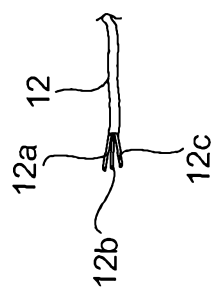
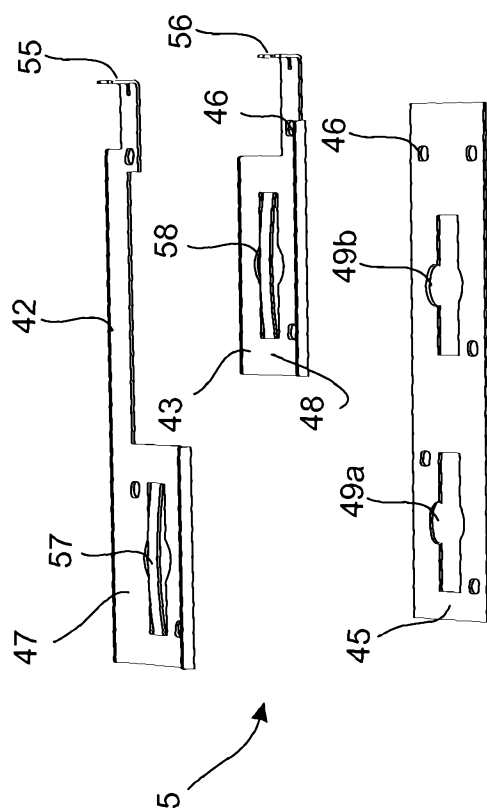
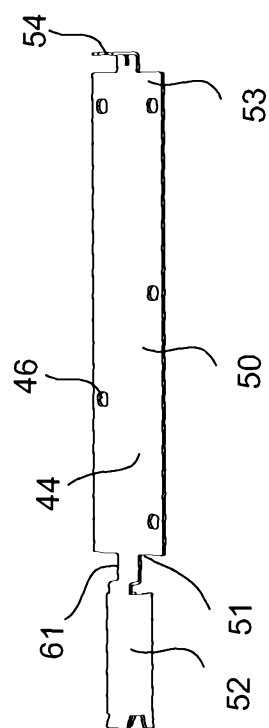


Fig. 5



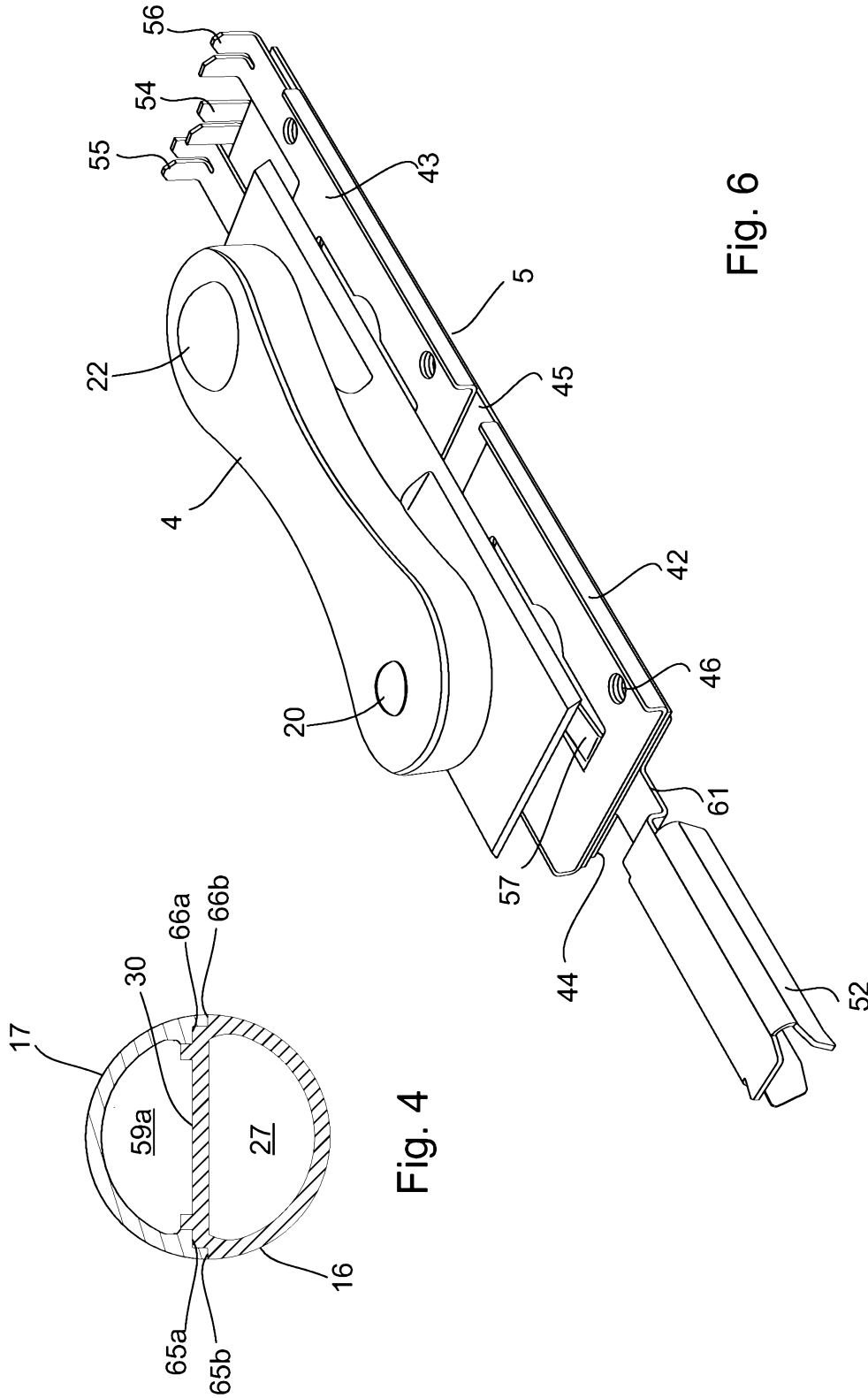


Fig. 4

Fig. 6

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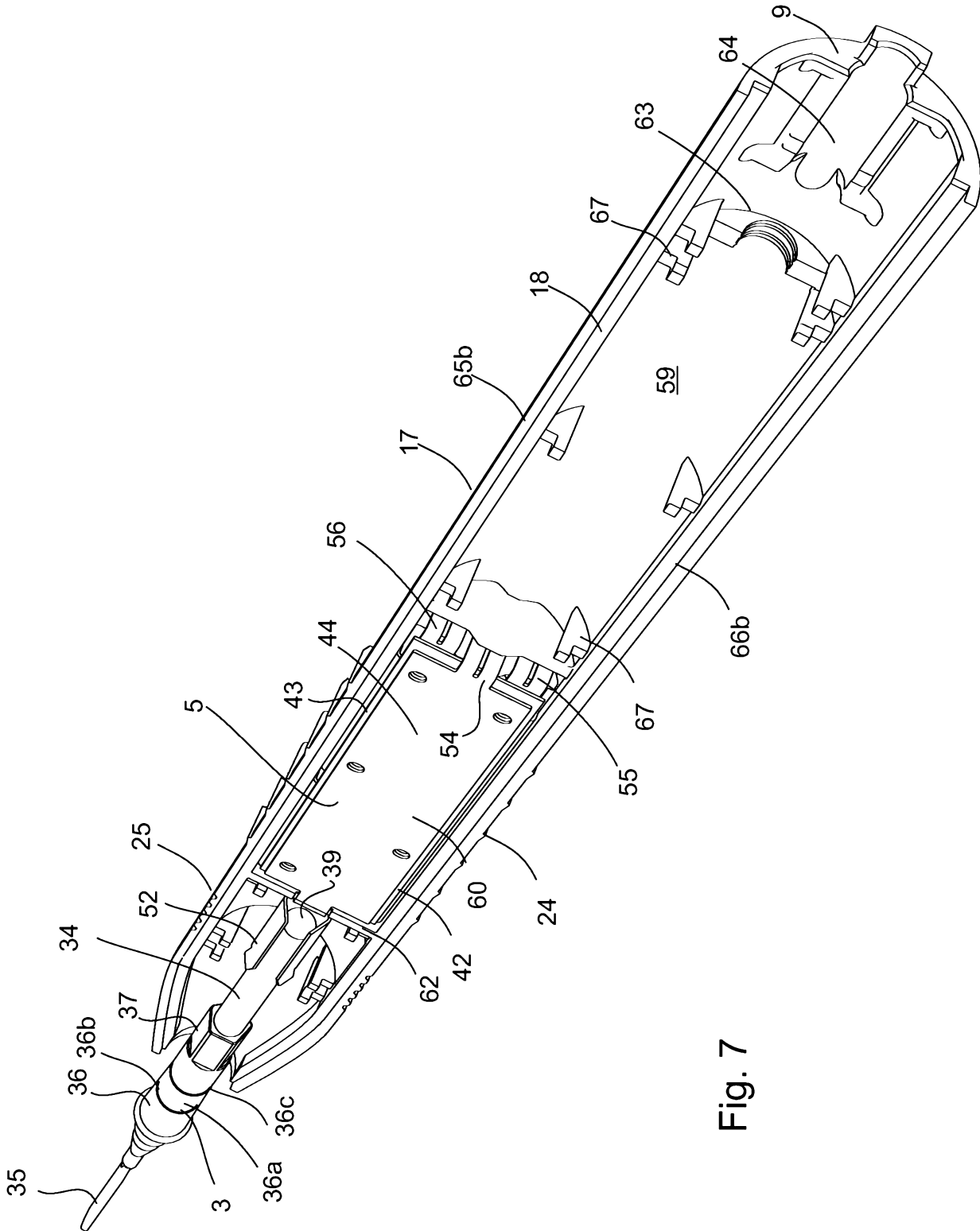
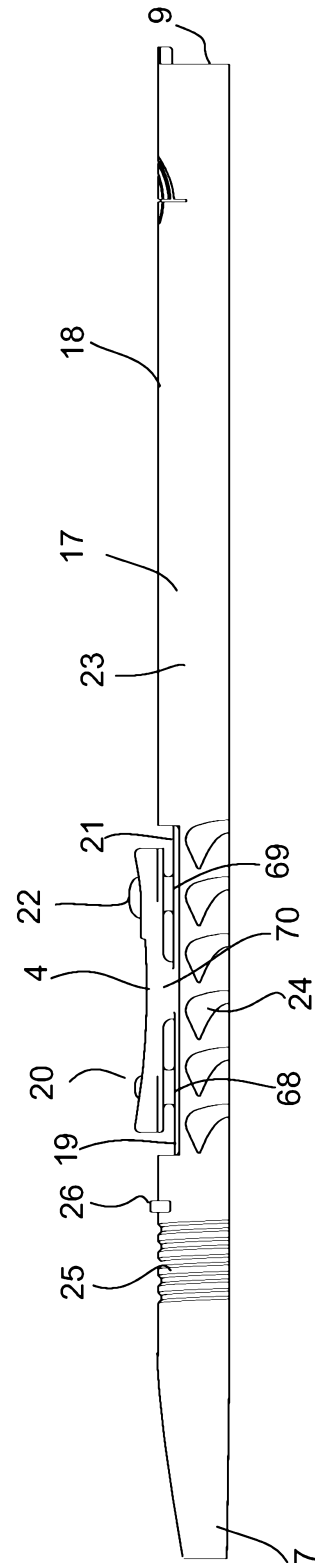
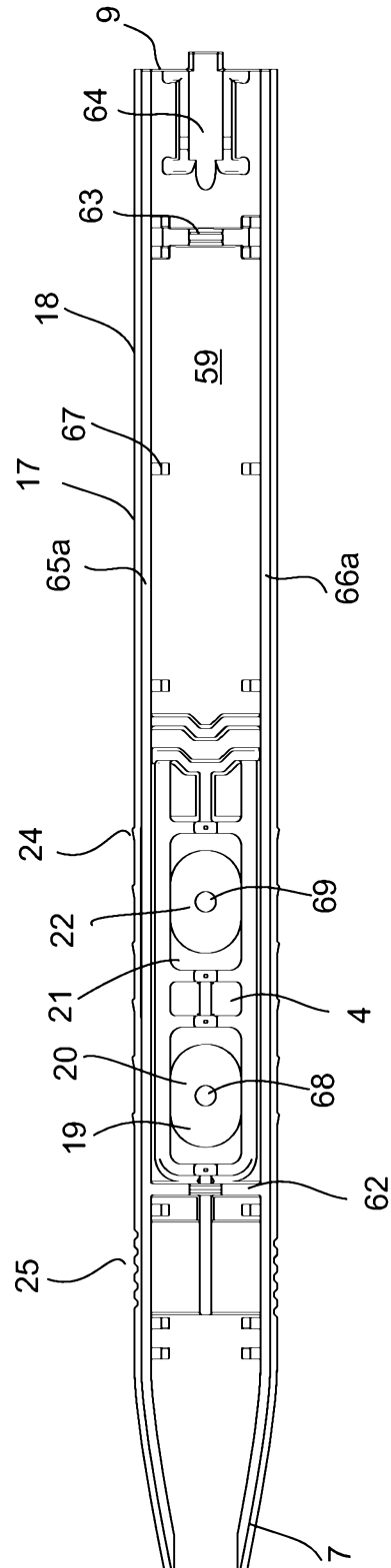
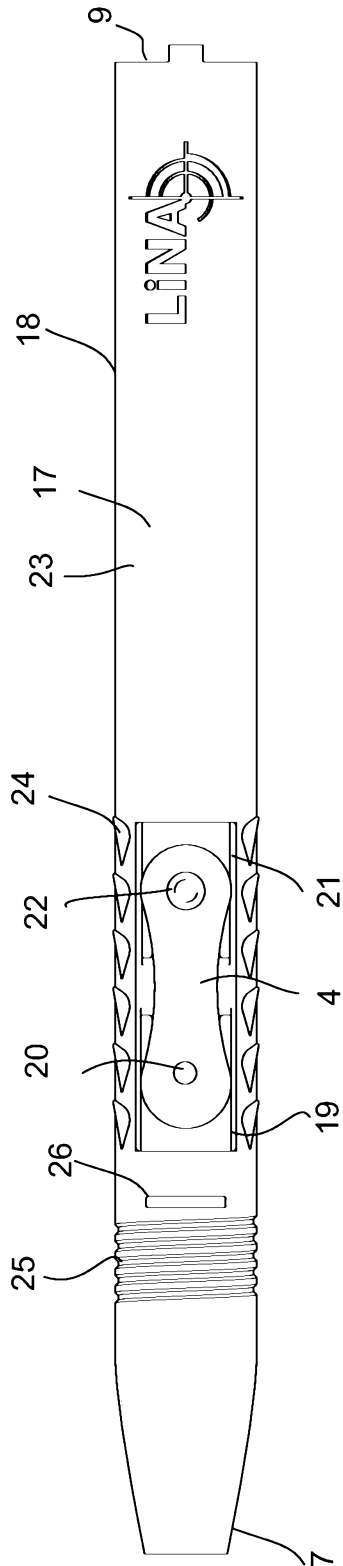
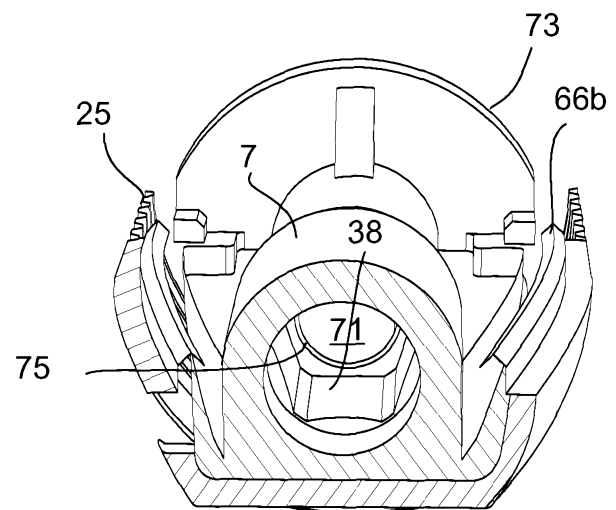
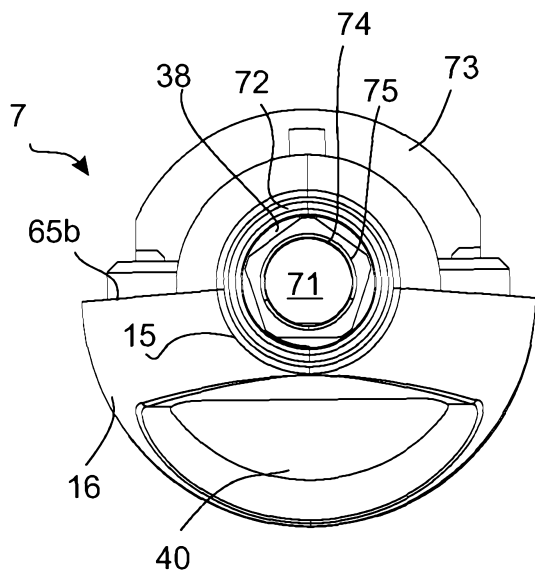
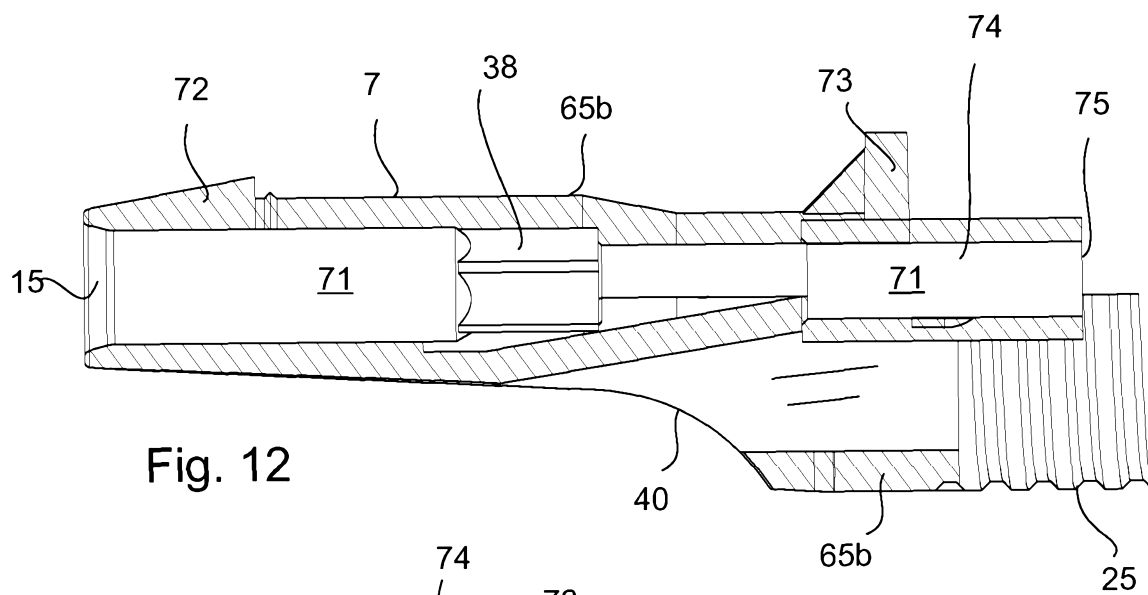
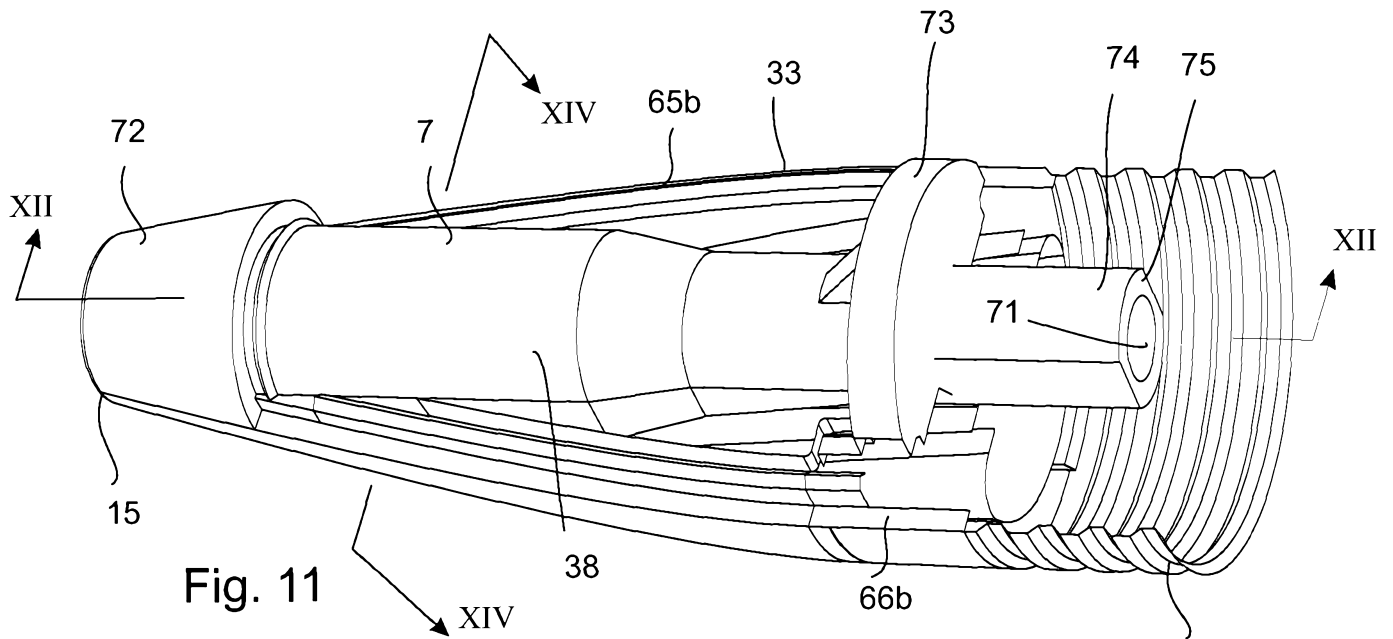


Fig. 7



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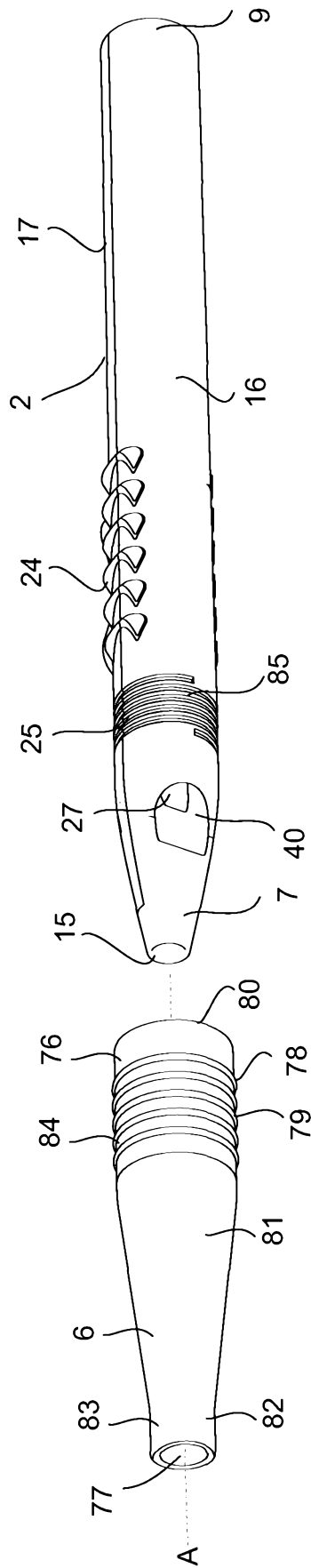


Fig. 15

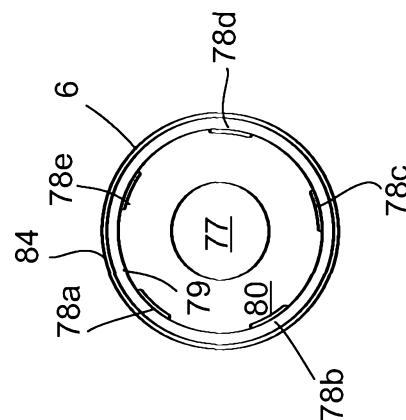


Fig. 16

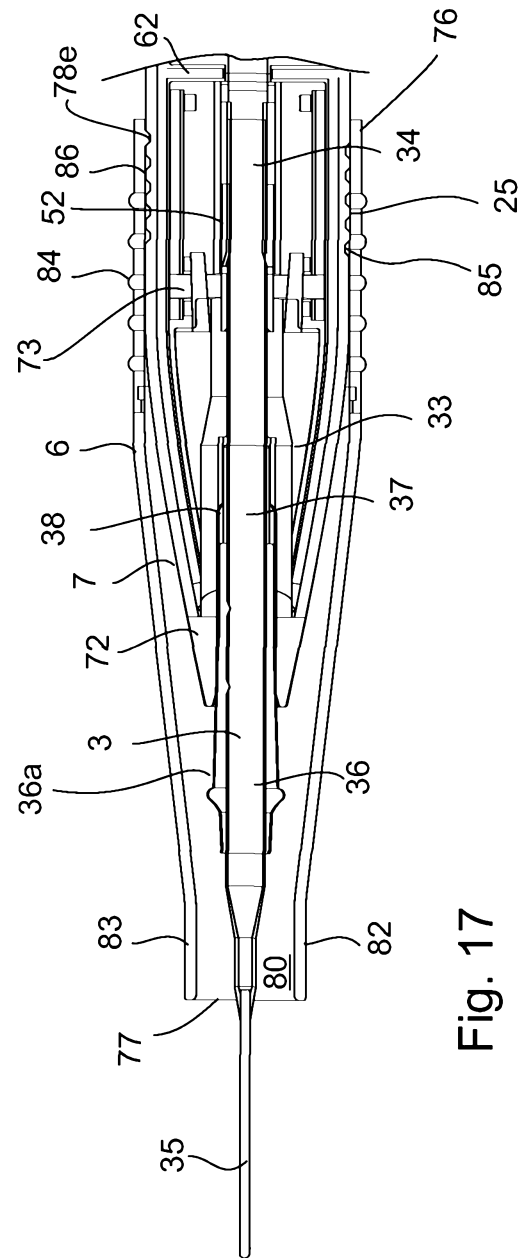


Fig. 17

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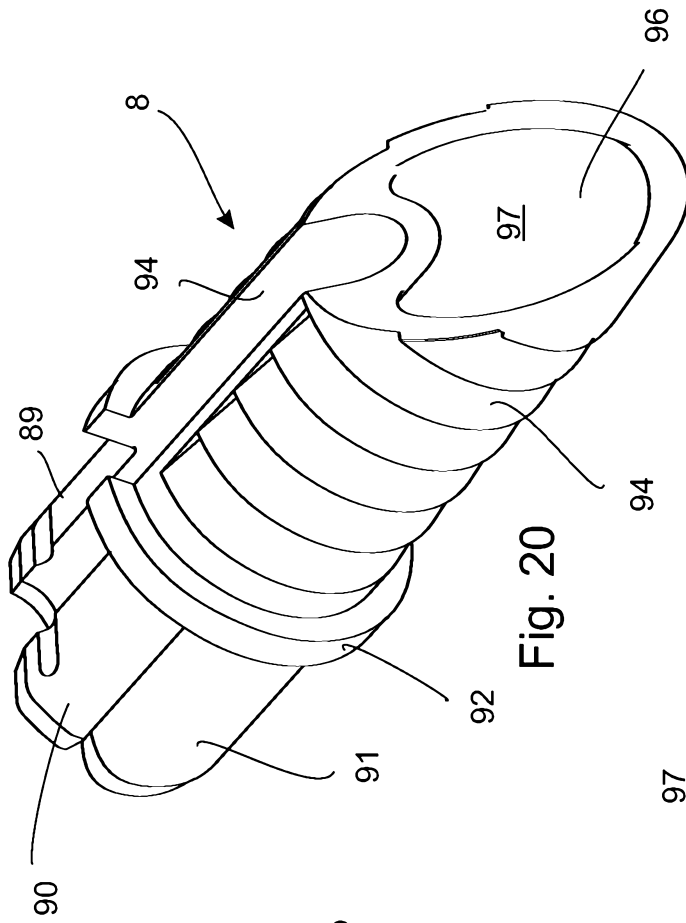
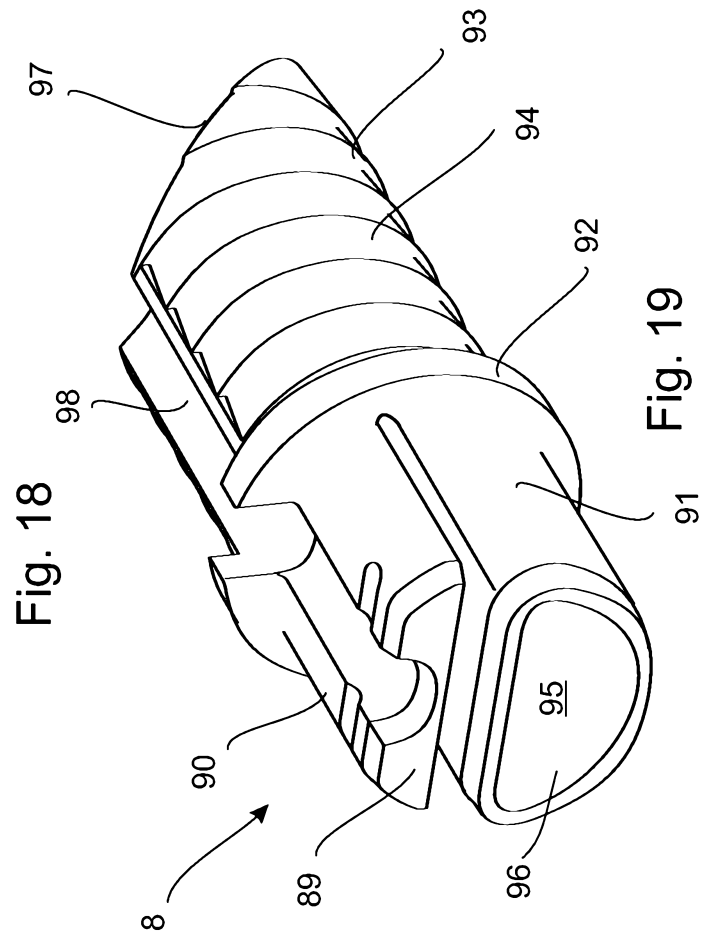
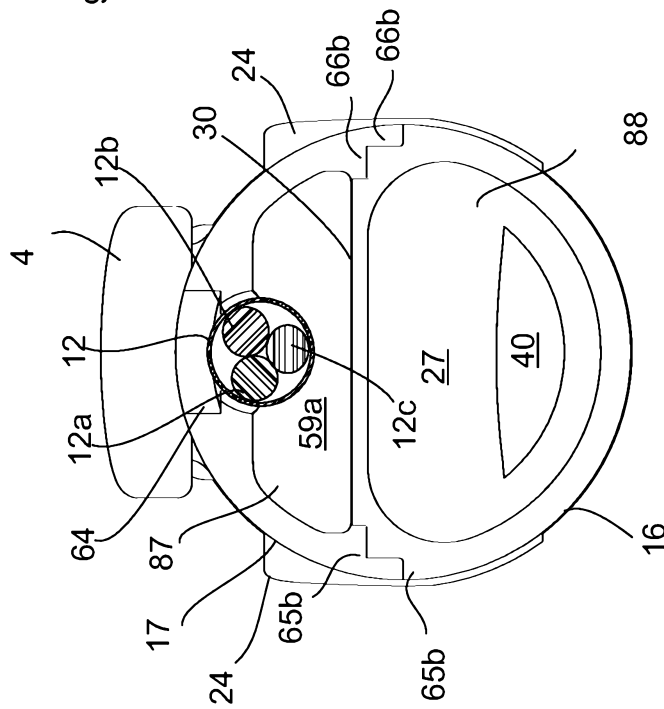


Fig. 21

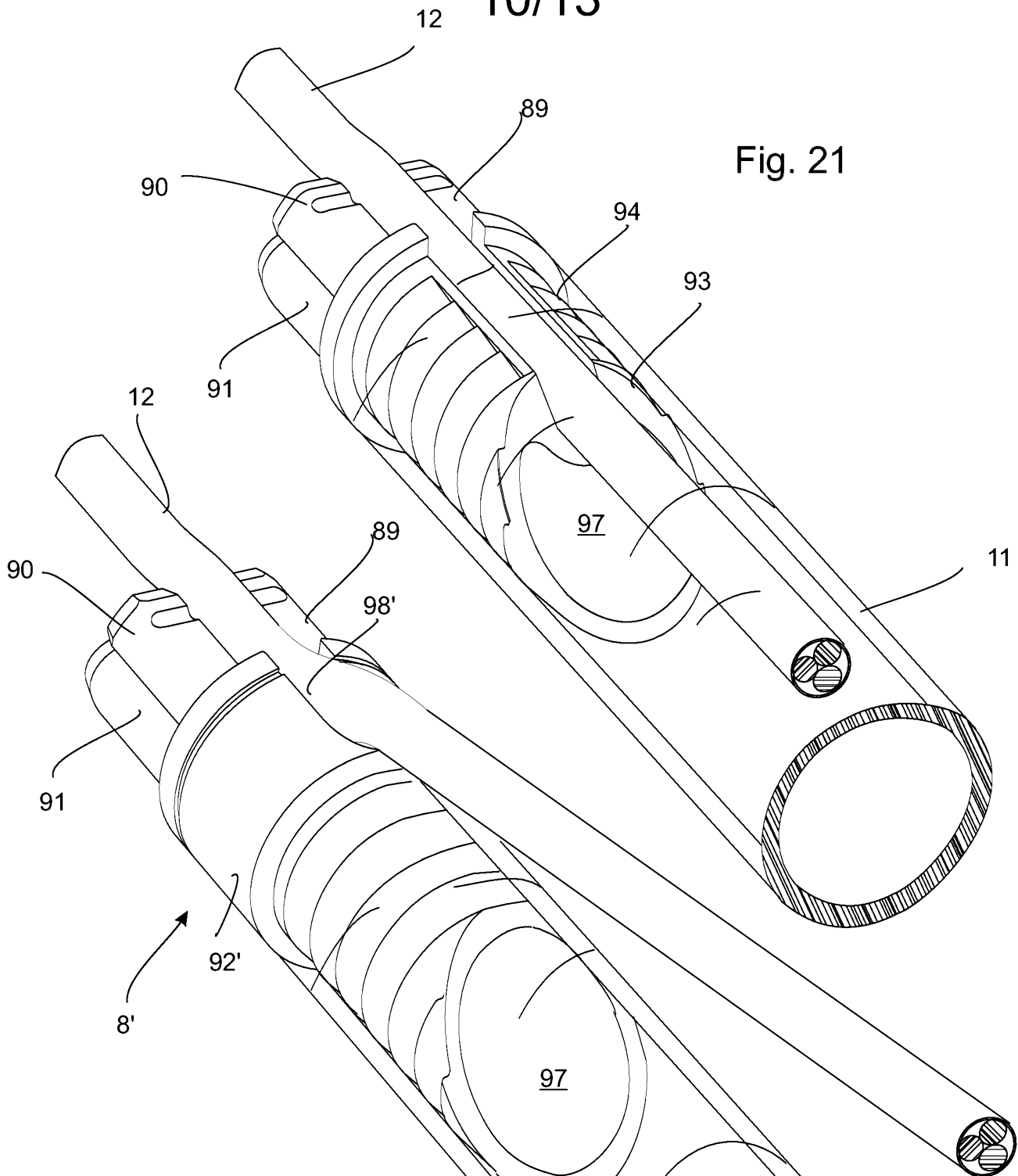
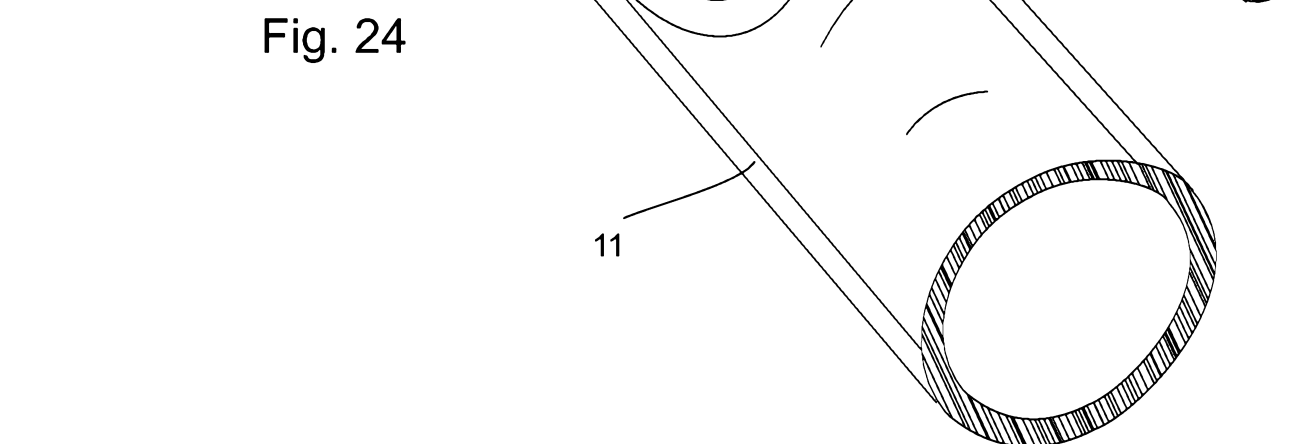


Fig. 24



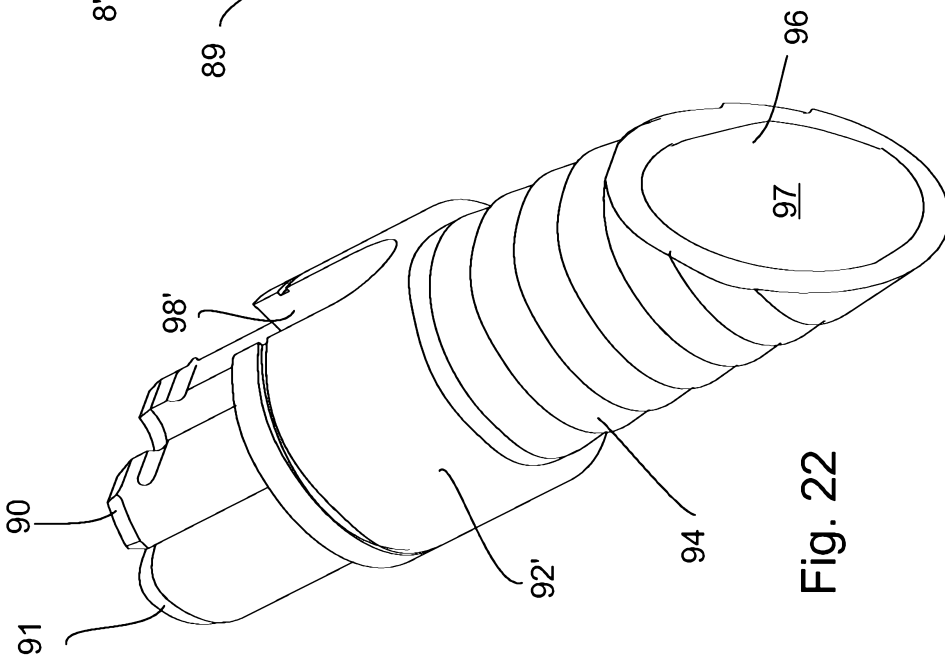


Fig. 22

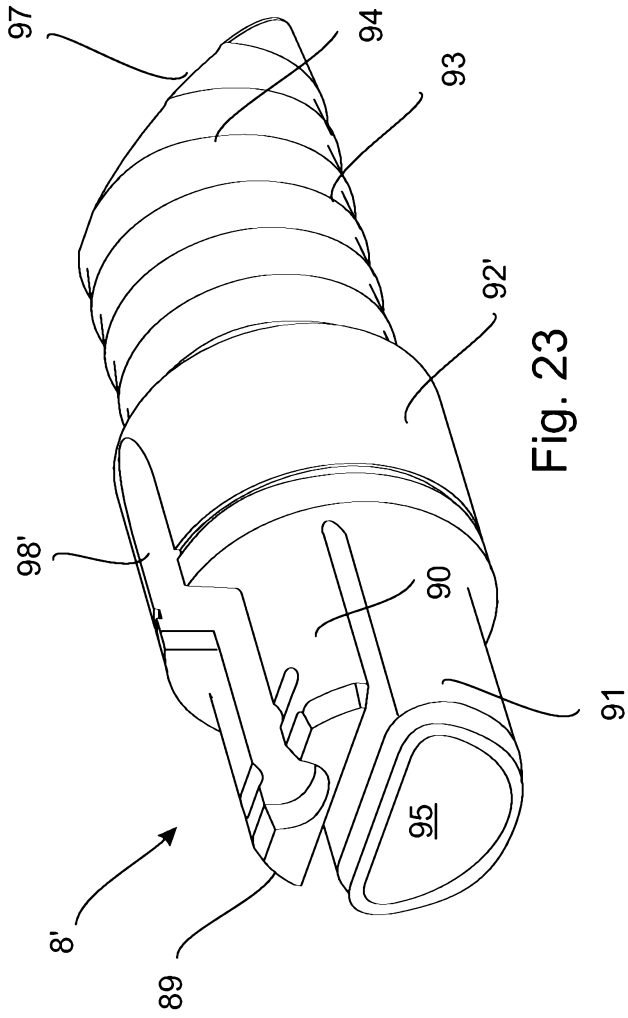


Fig. 23

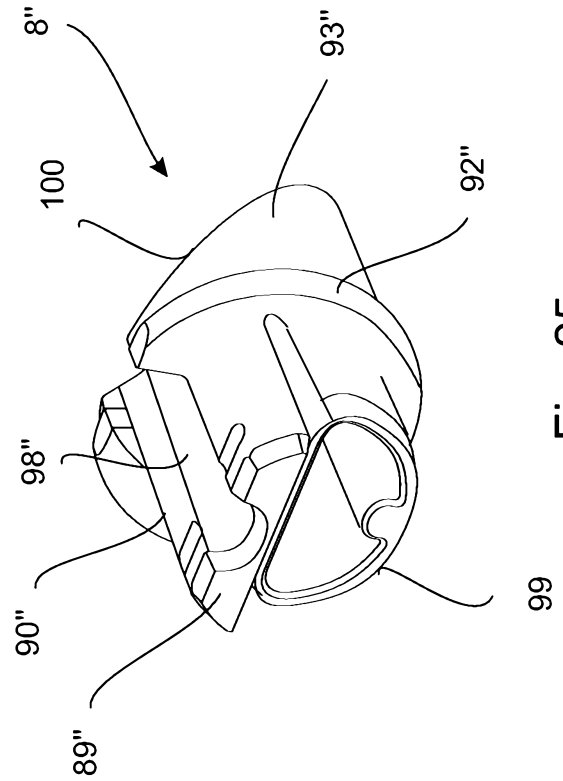


Fig. 25

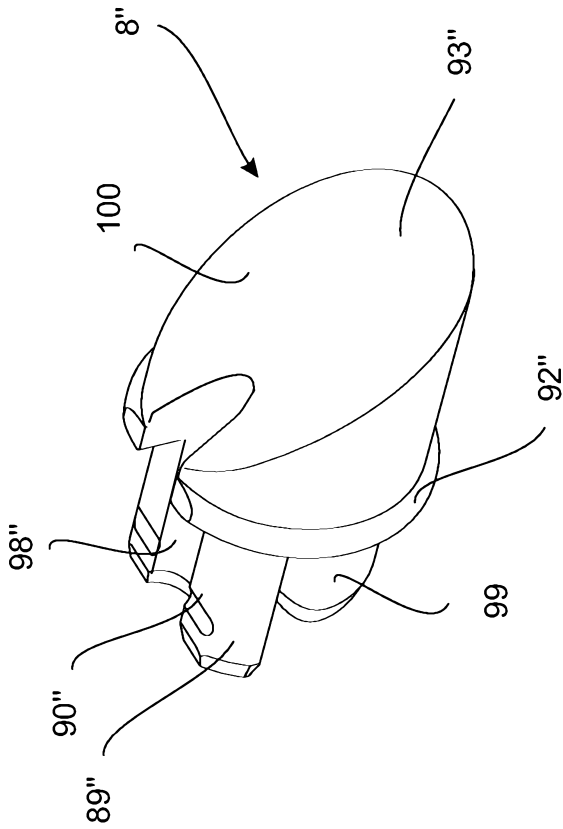


Fig. 26

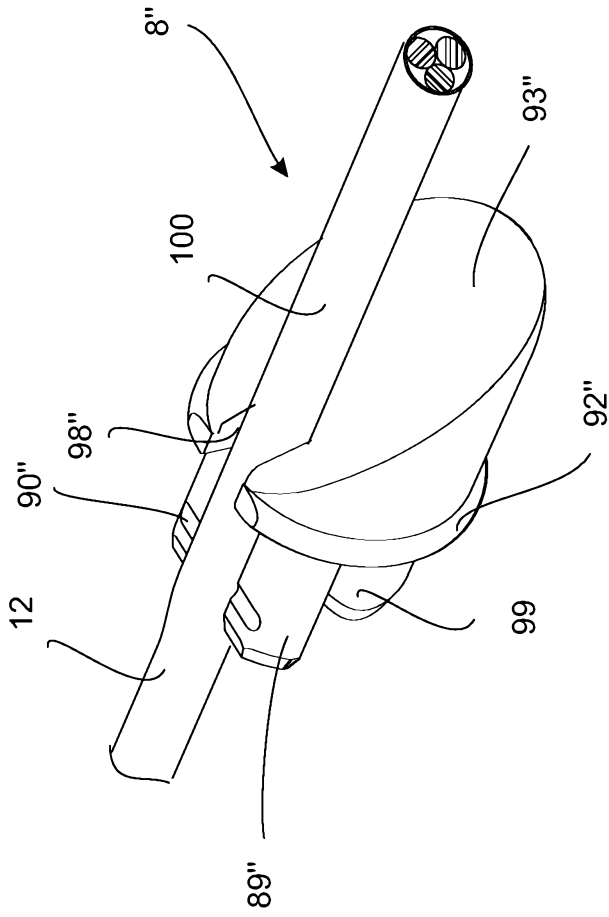


Fig. 27

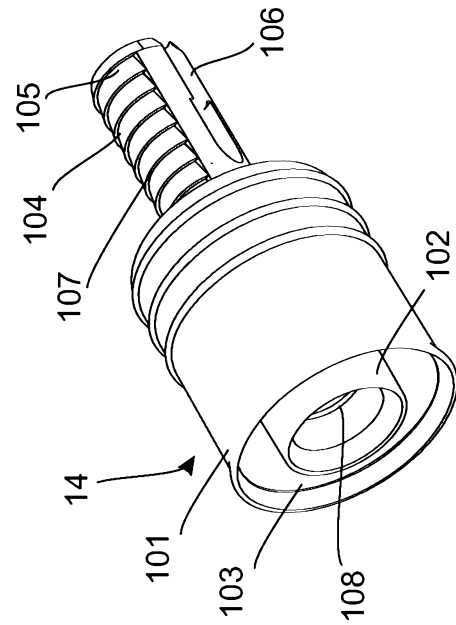


Fig. 28

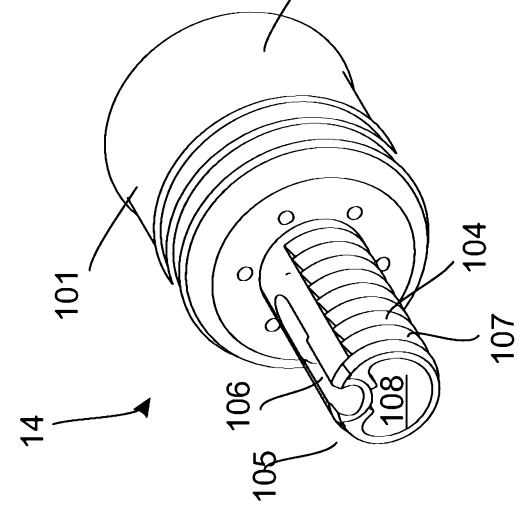


Fig. 29

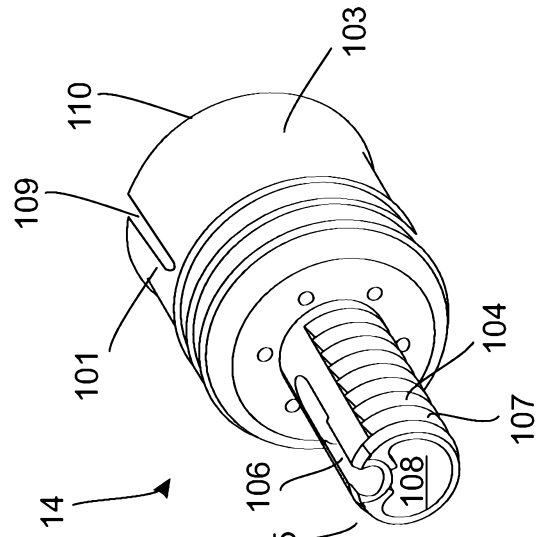


Fig. 30

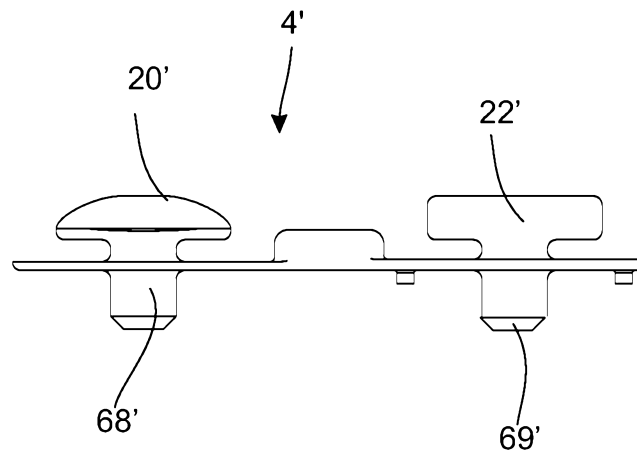


Fig. 31

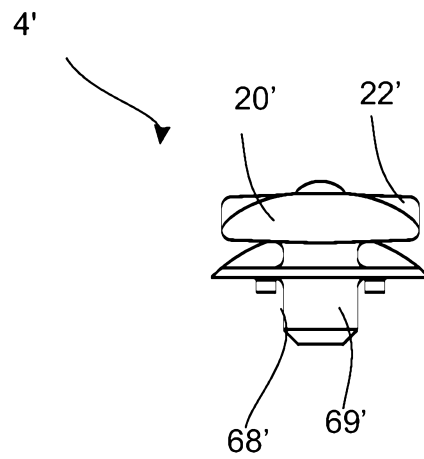


Fig. 32