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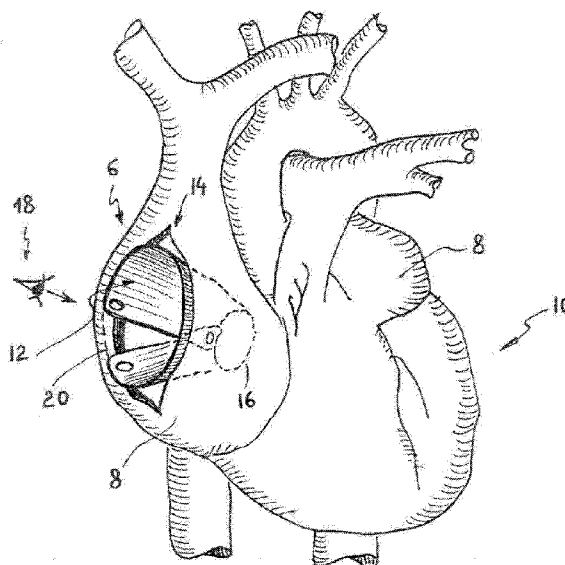
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(54) Title: SURGICAL RETRACTOR



(57) Abstract: Surgical retractor (6), designed in particular for minimally invasive operations, comprising an elastic plate (12) rolled up about an axis so as to form the side wall of a substantially truncated cone shape, the narrowest cross section (16) of the truncated cone constituting the distal part of this retractor, when the retractor is in place, and delimiting an operating field, the widest cross section (20) of the truncated cone forming the proximal part, through which instruments can be introduced, said plate (12) being able to be rolled up into a substantially cylindrical shape with a diameter smaller than or equal to the narrowest cross section of its truncated cone shape.

WO 2007/017294 A1

SURGICAL RETRACTOR

Field of the invention

The invention relates to surgical retractors, in particular to retractors used in the field of
5 minimally invasive surgery, for example for operations in the cardiac field.

Retractors are instruments intended to clear the operating field by spreading apart the edges of an incision or of a natural orifice. Thus, in conventional cardiac surgery, the operating surgeon has a relatively wide operating field, resulting from the fact that a sternotomy has been performed. The situation is very different in the case of minimally invasive surgery: the access routes are small incisions made in particular between the ribs; the operating surgeon does not generally have a direct view of the operating field, but instead has a view through an endoscope; the instruments have to be operated remotely within a very small space and are therefore very different to handle.

Background of the invention

Conventional retractors are known in this field which have the form of spatulate hooks.

This type of retractor is also used in
5 minimally invasive surgery.

In the case of intrathoracic surgery performed without a sternotomy, it is necessary to exert traction from the outside, either by an operating surgeon holding the retractor via a handle, or by fastening it to the
10 surrounding tissues, which includes the rib cage, or by threads passing through the rib cage.

There are also retractors that can be described as peripheral retractors, which are used for example in eye surgery (see US 6,083,155).

15 However, this type of retractor can be used only in operations in which there is no problem of access and in which the operating field is not deep. Pneumatic retractors formed by an inflatable cuff are also known from US 5,342,385. This type of retractor,
20 which is of considerable size, poses problems of deflation if torn by a cutting instrument.

Retractors specifically designed for spinal surgery are also known from US 2004/116954 and from WO 2004/021899. These retractors comprise, mounted at the
25 end of a cylindrical tube, a truncated cone part in the shape of a funnel (widening toward the distal part). This is a relatively complex device which has to be deployed with force. Moreover, this type of retractor does not permit direct viewing of the operating field,
30 and the « keyhole » view produced is advantageous only if the eye of the camera is near the incision, which is

not always the case.

Summary of the invention

5 It has been sought to produce a retractor of small size which is easy to introduce into the inside of a patient's body, requires a reduced number of steps for putting it into place, and permits easy access and also a clear view of an operating field, either directly or by way of an endoscope.

10 The subject of the invention is a surgical retractor essentially consisting of an elastic plate rolled up about an axis so as to form the side wall of a substantially truncated cone shape, the narrowest cross section of the truncated cone constituting the distal
15 part of this retractor, when the retractor is in place, and delimiting an operating field, the widest cross section of the truncated cone forming the proximal part, through which instruments can be introduced. Said plate is able to be rolled up into a substantially cylindrical
20 shape with a diameter smaller than or equal to the narrowest cross section of its truncated cone shape.

The apparently very simple design of this retractor is the result of an extensive study of the ergonomic requirements of surgeons in the field of
25 minimally invasive surgery. In particular, the manœuvres required for putting it into place afford a considerable saving in terms of time. In addition, the reduced stress that it exerts on the wall of the incised organs means that it is especially indicated for operations on hollow
30 organs such as the heart, the intestines, etc. Moreover, even if the incision is of a small size, the operating

surgeon has, compared to the prior art, twice the view of the operating field, that is to say by direct viewing through the incisions combined with a view by way of an endoscope.

5 According to an advantageous embodiment, the retractor comprises connecting means that are able to keep the side wall of the truncated cone rolled up at a defined diameter. These connecting means can in particular comprise a button and a buttonhole. The
10 advantage of these elements lies in avoiding distortion at the moment of deployment or during the course of the operation.

 According to one embodiment, in the absence of stress, the elastic plate that constitutes the side wall
15 of the truncated cone shape spontaneously adopts a substantially flat shape.

 According to another embodiment, in the absence of stress, the elastic plate that constitutes the side wall of the truncated cone shape spontaneously
20 adopts a truncated cone shape.

 The plate preferably has a shape substantially in the form of a truncated crescent, the inner curve of this crescent, in the form of an arc of a circle, having a length corresponding to the maximum perimeter of the
25 narrowest cross section of the truncated cone, and, instead of the horns of the crescent, it comprises two sides which are substantially parallel to one another, their length corresponding to the height of the truncated cone.

The surgical retractor of the invention preferably comprises protuberances arranged on the flanks of the wall of the truncated cone.

It advantageously comprises, at the proximal
5 end, grip means facilitating its manipulation.

These grip means are preferably able to cooperate with gripper means mounted on the end of positioning tools of elongate shape, said positioning tools allowing the plate to be rolled up and to be
10 maintained in the rolled-up state.

According to an advantageous embodiment, these positioning tools comprise connecting means with which it is possible to secure them together so as to facilitate their manipulation, particularly with the
15 retractor maintained in the rolled-up position.

The inner face of the surgical retractor according to the invention is preferably transparent. In this case, according to an advantageous embodiment, the outer face of the plate comprises conductive elements
20 that are able to be connected to a generator so as to produce localized tissue necrosis, such as that produced in the elimination of atrial fibrillation.

The plate can also be made of a frosted material, which can be metal or plastic, in order to
25 avoid interference from reflections during use.

The proximal end of the plate advantageously comprises fixation points for means for holding the retractor in the course of an operation. These holding means can, for example, be a support formed by suture
30 threads, etc.

Brief description of the figures

These features, and other features of the invention, will become clear from the following detailed description of particular embodiments of the invention, reference being made to the figures in the drawings, in which:

Fig. 1 is a schematic and cut-away perspective view of a standard intrathoracic operation performed by a minimally invasive technique.

Fig. 2 is a perspective view of a retractor according to the invention positioned in an atrium of the heart.

Fig. 3 is a plan view of a retractor according to the invention spread out flat.

Fig. 4 is a plan view of another embodiment of a retractor according to the invention spread out flat.

Figures 5 and 6 are perspective views of instruments for manipulating a retractor according to the invention, keeping the retractor respectively deployed and rolled up in a compact form for introduction.

Figures 7, 8 and 9 are perspective views of the retractor from Fig. 4 at different stages of its manipulation.

Fig. 10 is a schematic perspective view of another embodiment of the retractor.

Fig. 11 is a schematic perspective view of the retractor from Fig. 10 in position in an atrium.

The figures are not drawn to scale. Generally, similar elements are designated by similar reference labels in the figures. The present invention will be

described in the context of specific embodiments that have been chosen as non-limiting illustrations.

Detailed description of the figures

5 Fig. 1 shows the conditions in which minimally invasive intrathoracic surgery is performed: the instruments 2 are introduced inside the thorax via small incisions, without cutting the ribs 3 or sternum 4.

 Fig. 2 shows the retractor 6 of the invention
10 positioned for an operation on an atrium 8 of the heart. As the walls of the heart 10 are relatively thin and have little muscle in the area of the atrium 8, it would be awkward to place conventional retractors there which are anchored to the rib cage 3. As will be seen, the
15 retractor 6 basically comprises a plate 12, made of an elastic material, rolled up so as to form the side wall of a truncated cone. The distal part of this truncated cone is driven through an incision 14 into the interior of the atrium 8. The narrowest cross section 16 of the
20 truncated cone thus delimits the operating field, while the conicity of the wall provides a clear zone for movement of the surgical instruments and for the viewing field of the operating surgeon, which in this case corresponds to the field covered by an endoscope 18
25 placed near the axis of the truncated cone, in the area of its widest cross section 20. To maximize the stereoscopic vision that the operating surgeon may have of the operating field, it is important to widely retract the tissues freed by the incision.

30 Fig. 3 shows one embodiment of the retractor 6. In this embodiment, the elastic plate 12, in the

absence of stress, adopts a substantially flat shape. Its shape as a crescent, with the two horns cut away, corresponds substantially to the side wall of a truncated cone and comprises two sides in the shape of arcs of a circle: an inner side 16 with a length corresponding to that of the narrowest cross section of a truncated cone and with radius R_1 , and an outer side 20 with radius R_2 corresponding partially to the circumference of the large cross section of the truncated cone. As can be seen from Fig. 3, the large cross section 20 has part of its circumference cut off by two substantially parallel sides 22 issuing from the ends of the side 16.

At the side corresponding to the narrowest cross section of the truncated cone, the plate 12 is provided with connecting means 24, 26 which cooperate with one another to maintain the retractor in the curved shape when they are engaged in one another.

As shown in Fig. 3, these connecting means are a button 24 and a buttonhole 26 with catch 28, but it goes without saying that other embodiments (clips, snap fasteners, etc.) may be used. Several points of connection may be provided, this making it possible to vary the nominal diameter of the retractor depending on the size of the organ to be operated on, or, as is shown in Figure 4, making it possible to extend the buttonhole so as to obtain a variable cross section.

A series of perforations are formed along the proximal face of the plate. They form anchoring points 29 with which it is possible, if necessary, to tie the retractor to the surrounding tissues.

Grip means 30, in this case openings 30, can be seen near both ends of the side corresponding to the circumference of the large cross section of the truncated cone. Their role will be explained further
5 below.

Protuberances 32, in this case arranged longitudinally, protrude along the length of the plate. They have a secondary role of stiffeners, but their main function is to avoid adherence of the inner walls of the
10 incised organ 14 against the continuous surface of the plate 12. These protuberances can be lengthened and can form fold lines which, if necessary, transform the operating field into a polygonal surface.

Fig. 4 shows another embodiment of the retractor according to the invention. In this
15 embodiment, a very long buttonhole 27 is used, also provided with catch means 28, permitting automatic adaptation of the diameter to the length of the incision and to the diameter of the distal operating field. In
20 addition, it is thereby possible to considerably reduce the diameter of the retractor in the rolled-up state.

Figures 5 and 6 permit a better understanding of the role of the grip means 30 and of the way in which the retractor is fitted in place. To insert the
25 retractor 6 inside the rib cage 3, 4, the operating surgeon has two positioning instruments 34 of elongate shape. Each of these instruments is provided, at its distal end, with gripper means 36 (in this case a button-shaped head 36) that are able to cooperate with
30 the grip means 30 of the retractor.

By manipulating the two instruments 34, the

operating surgeon is able to roll the plate 12 up (see Fig. 4). The roll thus formed, of small diameter, can easily be inserted into the thorax 3, 4 through an incision and positioned in the atrium 8. The instruments 5 34 are specifically designed to be easily bent and therefore adapt to different angles of intervention.

To avoid the plate 12 accidentally unrolling, and to permit their manipulation by just one hand, the positioning tools 34 are provided with a securing clip 10 38. The presence of this securing clip 38 facilitates the work of the operating team, as the retractor can be passed from hand to hand during the operation without risk of its unrolling, thus saving precious time for the surgeon and the patient.

15 As soon as the positioning tools 34 are disconnected, the inherent elasticity of the plate 12 forces the retractor to open out and adopt the required truncated cone shape.

Figures 7, 8 and 9 show another way of 20 introducing the retractor into place. Rather than using the positioning instruments 34 described above, the operating surgeon in this case uses conventional locking tweezers (or forceps) 40.

In Fig. 7, the operating surgeon rolls the 25 plate up and locks the retractor in a roughly truncated cone position with the aid of the connecting means.

In Fig. 8, the operating surgeon forces the plate to roll up until he obtains a cylindrical roll of small diameter. He locks the retractor in this position 30 with the aid of locking tweezers 40. He finally introduces the retractor into place (Fig. 9) via its

distal section.

It will be noted that the substantially flat shape of the elastic plate 12 allows it to be stored flat, in a way that saves space in particular, and
5 avoids any creep in cases where the plate is made of materials sensitive to this phenomenon. The retractor can be made of plastic materials, such as PET or PTFE, and also of a biocompatible metal such as stainless steel, titanium alloys, etc.

10 The retractor, like the positioning instruments 34, is offered in different standard dimensions and can either be reusable or intended to be disposed of after one use.

The advantages associated with the flat
15 opened-out shape do not, however, mean that a retractor according to the present invention cannot, in the absence of stress, have a truncated cone shape at rest. However, even when produced in such a shape, it is preferable to provide it with connecting means, so that
20 the pressure of the incised tissues does not cause distortion during the operation.

The retractor can be made of an opaque, translucent or transparent material. However, regardless of the material used, it is important that the inner
25 wall reduces as far as possible any reflections that might disturb the operating surgeon. To this end, this wall may be frosted.

The use of a transparent wall allows the operating surgeon to visually monitor the state of the
30 wall. The surgical procedures are often combination procedures, and several manœuvres are often performed in

succession. The repair of a mitral valve is also often accompanied by ablation of atrial fibrillation (Cox-Maze procedure). The latter involves isolating certain nerve junctions responsible for uncontrolled movements of the heart muscle. This isolation is achieved by producing necrosis of certain areas extending along a line encircling the pulmonary veins and the mitral valve. This operation is performed by locally burning the tissues by passage of an electric current or by radiofrequency, or even ultrasound or cryogenics. The electrical applications can be unipolar or bipolar. The presence of a retractor such as the one according to the invention represents *a priori* an inconvenience since its wall is interposed between the zones to be treated and the tools necessary for producing the necrosis. It has therefore been proposed to place on the actual wall of the retractor the elements 42 needed for producing such necrosis, as is shown in Fig. 10.

The retractor function is thus combined with that of a support for one or more electrodes 42 (or antennas, or even cryogenic conduits) arranged in a suitable configuration (in this case following the pathway of the lines of necrosis) and integrally joined to the wall of the retractor. Once introduced into the atrium, the retractor is positioned in such a way that the electrode or electrodes 42 are arranged in line with the zones that are to be treated (origin of the pulmonary veins 43 as shown in Fig. 11) and the required energy is administered via these electrodes or conduits 42 with the aid of an external generator, which is known to a person skilled in the art and is connected to the

electrodes or to the conduit. Once this procedure has been carried out, the retractor 6 is disconnected and repositioned, if necessary, so as to fulfil strictly its role of retractor for the second procedure (such as a mitral valve repair).

In practice, the electrodes 42 are formed from wires or printed circuits coated with or embedded in a sheet of plastic material from which connecting means 44 emerge. These electrodes 42 can also be supported by a sheet of adhesive material applied to the retractor.

The different procedures involved in using the retractor 6 according to the invention can therefore be summarized as follows:

- providing a plate of elastic material that is able to adopt a substantially truncated cone shape;
- bringing said plate into its truncated cone shape;
- gripping said plate via its end of large diameter, which forms its proximal part, and rolling it up in such a way as to form a cylinder of small diameter;
- passing the retractor through the incision, with the distal part, corresponding to its narrowest diameter, towards the front;
- allowing the retractor to unroll in such a way that it readopts its truncated cone shape.

It will be obvious to a person skilled in the art that the present invention is not limited to what has been described above. The invention lies also in each of the novel characteristics and in the combination of these various characteristics.

CLAIMS

1. - Surgical retractor, characterized in that it essentially consists of an elastic plate (12) rolled up about an axis so as to form the side wall of a substantially truncated cone shape, the narrowest cross section (16) of the truncated cone constituting the distal part of this retractor, when the retractor is in place, and delimiting an operating field, the widest cross section (20) of the truncated cone forming the proximal part, through which instruments can be introduced, said plate (12) being able to be rolled up into a substantially cylindrical shape with a diameter smaller than or equal to the narrowest cross section of its truncated cone shape.

2. - Surgical retractor according to Claim 1, characterized in that it comprises connecting means (24, 26) that are able to keep the side wall of the truncated cone rolled up at a defined and fixed diameter.

3. - Surgical retractor according to Claim 2, characterized in that these connecting means (24, 26) comprise a button (24) and a buttonhole (26, 27).

4. - Surgical retractor according to any one of Claims 1 to 3, characterized in that, in the absence of stress, the elastic plate (12) that constitutes the side wall of the truncated cone shape spontaneously adopts a substantially flat shape.

5. - Surgical retractor according to any one of Claims 1 to 3, characterized in that, in the absence of stress, the elastic plate (12) that

constitutes the side wall of the truncated cone shape spontaneously adopts a truncated cone shape.

6. - Surgical retractor according to any one of the preceding claims, characterized in that the plate (12) has a shape substantially in the form of a truncated crescent, the inner curve (16) of this crescent, in the form of an arc of a circle, having a length corresponding to the maximum perimeter of the narrowest cross section (16) of the truncated cone delimiting the operating field, two straight sides (22) connecting the ends of these arcs of circles and extending substantially parallel to one another, their length corresponding to the height of the truncated cone.

7. - Surgical retractor according to any one of the preceding claims, characterized in that it comprises protuberances (32) arranged on the wall of the truncated cone.

8. - Surgical retractor according to any one of the preceding claims, characterized in that it comprises, at the proximal end, grip means (30) facilitating its manipulation.

9. - Surgical retractor according to Claim 8, characterized in that the grip means (30) are able to cooperate with gripper means (36) mounted on the end of positioning tools (34) of elongate shape that are introduced through its proximal part, said positioning tools (34) allowing the plate (12) to be rolled up.

10. - Surgical retractor according to either of Claims 8 and 9, characterized in that the positioning tools (34) can be secured together, with the retractor (12) maintained in the rolled-up position.

11. - Surgical retractor according to any one of the preceding claims, characterized in that the plate (12) is transparent.

5 12. - Surgical retractor according to any one of the preceding claims, characterized in that the proximal end of the plate (12) comprises fixation points for means for holding the retractor in the course of an operation.

10 13. - Surgical retractor according to either of Claims 11 and 12, characterized in that the outer face of the plate (12) comprises conductive elements (42) that are able to be connected to a generator so as to produce localized tissue necrosis.

AMENDED CLAIMS
received by the International Bureau on 01 September 2006

1. - Self-expanding surgical retractor, for receiving instruments for performing surgical operations inside hollow organs through an incision performed on the hollow organ walls, characterized in that it essentially consists of an elastic plate (12) rolled up about an axis and comprising connecting means (24, 26) keeping the plate rolled up, said retractor being able to self-expand from a second position to a first position,

in the first position said plate (12) forms the side wall of a substantially truncated cone shape of a defined diameter, exerting a slight stress on the incision of the wall of the incised hollow wall, the connecting means being placed towards the narrowest cross section (16) of the cone shape, said narrowest cross section (16) constituting the distal part of this retractor and delimiting an operating field inside the hollow organ, the widest cross section (20) of the truncated cone forming the proximal part, through which instruments can be introduced, said proximal part providing a clear zone for movement of the surgical instruments and for the viewing field for the operator,

in the second position, said plate (12) is rolled up into a substantially cylindrical shape with a diameter smaller than or equal to the narrowest cross section of its truncated cone shape.

2. - Surgical retractor according to Claim 1, characterized in that these connecting means (24, 26) comprise a button (24) and a buttonhole (26, 27).

3. - Surgical retractor according to either one of Claims 1 or 2, characterized in that the connecting means (24, 26) can be unlocked, the elastic plate (12) that

constitutes the side wall of the truncated cone shape spontaneously adopting, in the absence of stress, a substantially flat shape.

4. - Surgical retractor according to either one of Claims 1 or 2, characterized in that the connecting means (24, 26) can be unlocked, the elastic plate (12) that constitutes the side wall of the truncated cone shape spontaneously adopting, in the absence of stress, a truncated cone shape.

5. - Surgical retractor according to any one of the preceding claims, characterized in that the plate (12) has a shape substantially in the form of a truncated crescent, the inner curve (16) of this crescent, in the form of an arc of a circle, having a length corresponding to the maximum perimeter of the narrowest cross section (16) of the truncated cone delimiting the operating field, two straight sides (22) connecting the ends of these arcs of circles and extending substantially parallel to one another, their length corresponding to the height of the truncated cone.

6. - Surgical retractor according to any one of the preceding claims, characterized in that it comprises protuberances (32) arranged on the wall of the truncated cone.

7. - Surgical retractor according to any one of the preceding claims, characterized in that it comprises, at the proximal end, grip means (30) facilitating its manipulation.

8. - Surgical retractor according to Claim 7, characterized in that the grip means (30) are able to cooperate with gripper means (36) mounted on the end of positioning tools (34) of elongate shape that are introduced through its proximal part, said positioning tools (34) allowing the plate (12) to be rolled up.

9. - Surgical retractor according to either of Claims 7 and 8, characterized in that the positioning tools

(34) can be secured together, with the retractor (12) maintained in the rolled-up position.

10. - Surgical retractor according to any one of the preceding claims, characterized in that the plate (12) is transparent.

11. - Surgical retractor according to any one of the preceding claims, characterized in that the proximal end of the plate (12) comprises fixation points for means for holding the retractor in the course of an operation.

12. - Surgical retractor according to either of one Claims 10 and 11, characterized in that the outer face of the plate (12) comprises conductive elements (42) that are able to be connected to a generator so as to produce localized tissue necrosis.

Statement under Art 19.1 PCT

Claims 1 was amended so as to include the subject-matter of former claim 2. The orientation and way of acting on the tissues of the retractor of the invention was more precisely defined so as to distinguish it from the prior art cited as closest prior art in the Novelty Search Report. The scope of the claim 1 was restricted so as to further distinguish the present retractor from the cited prior art.

Claim 2, now redundant, was deleted.

Former Claims 4 and 5 were amended so as to take into account the inclusion of the feature of former 2 into main claim 1.

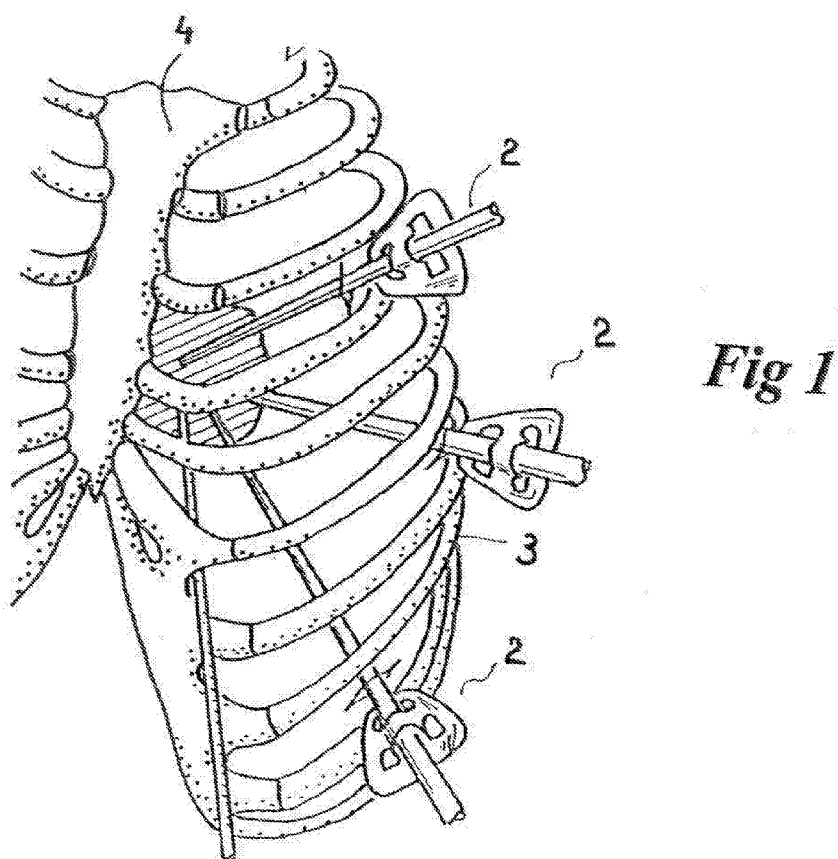
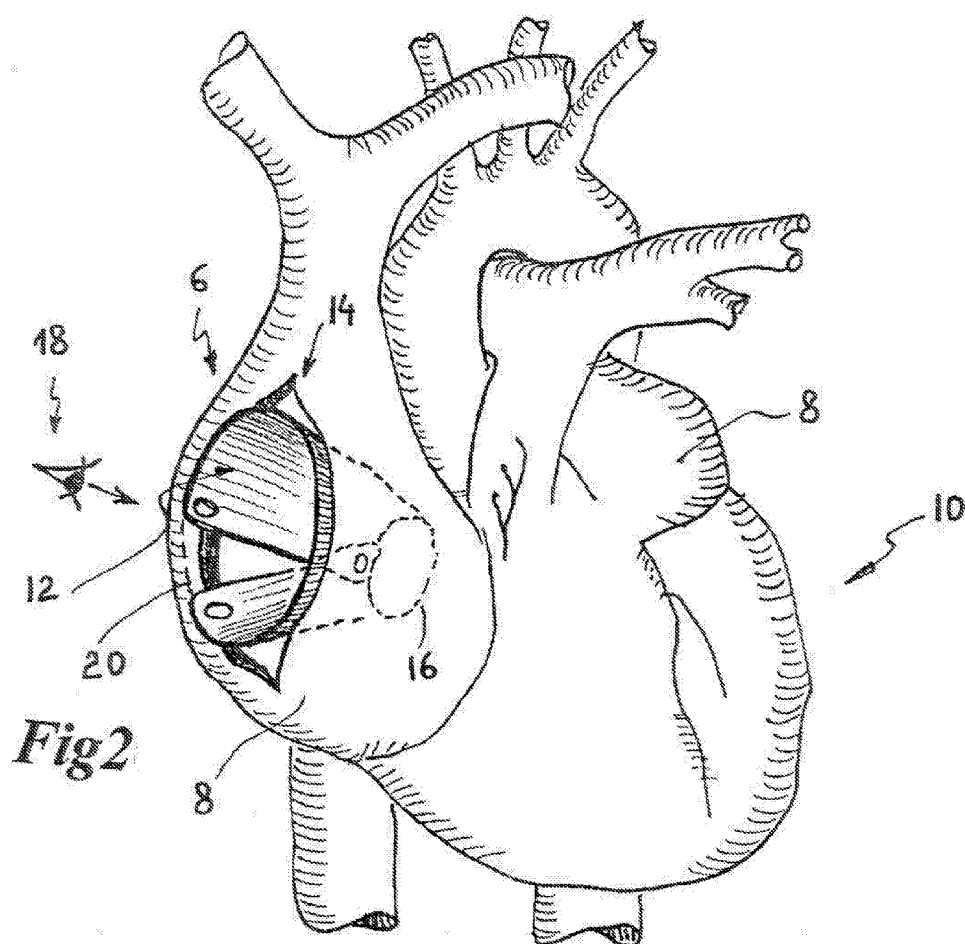


Fig 3

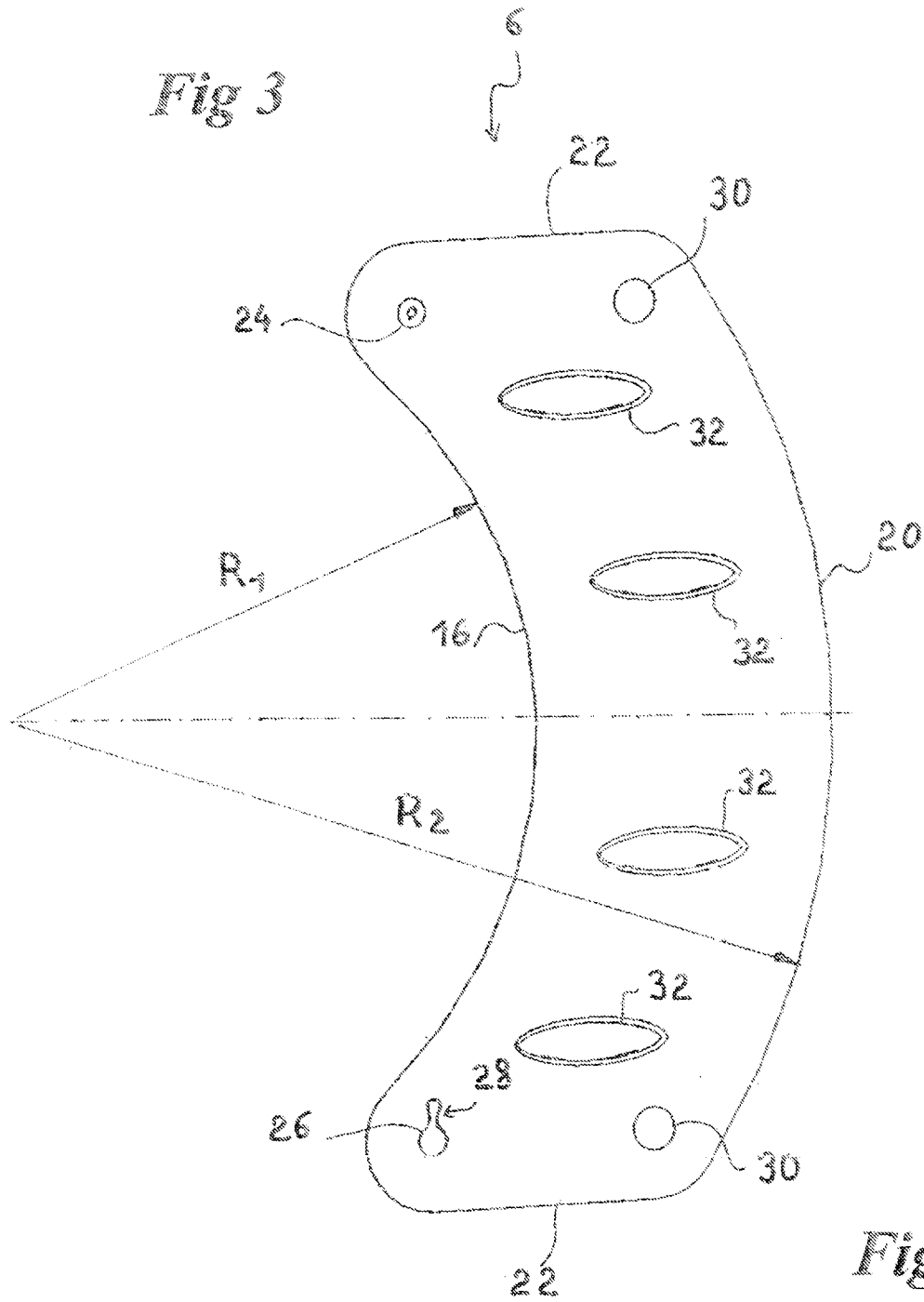
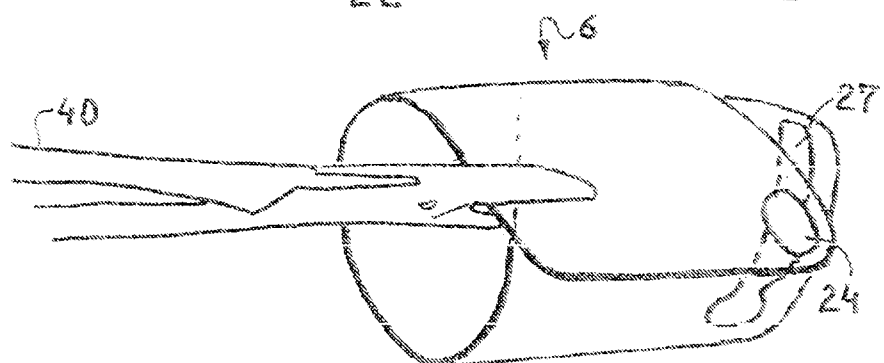
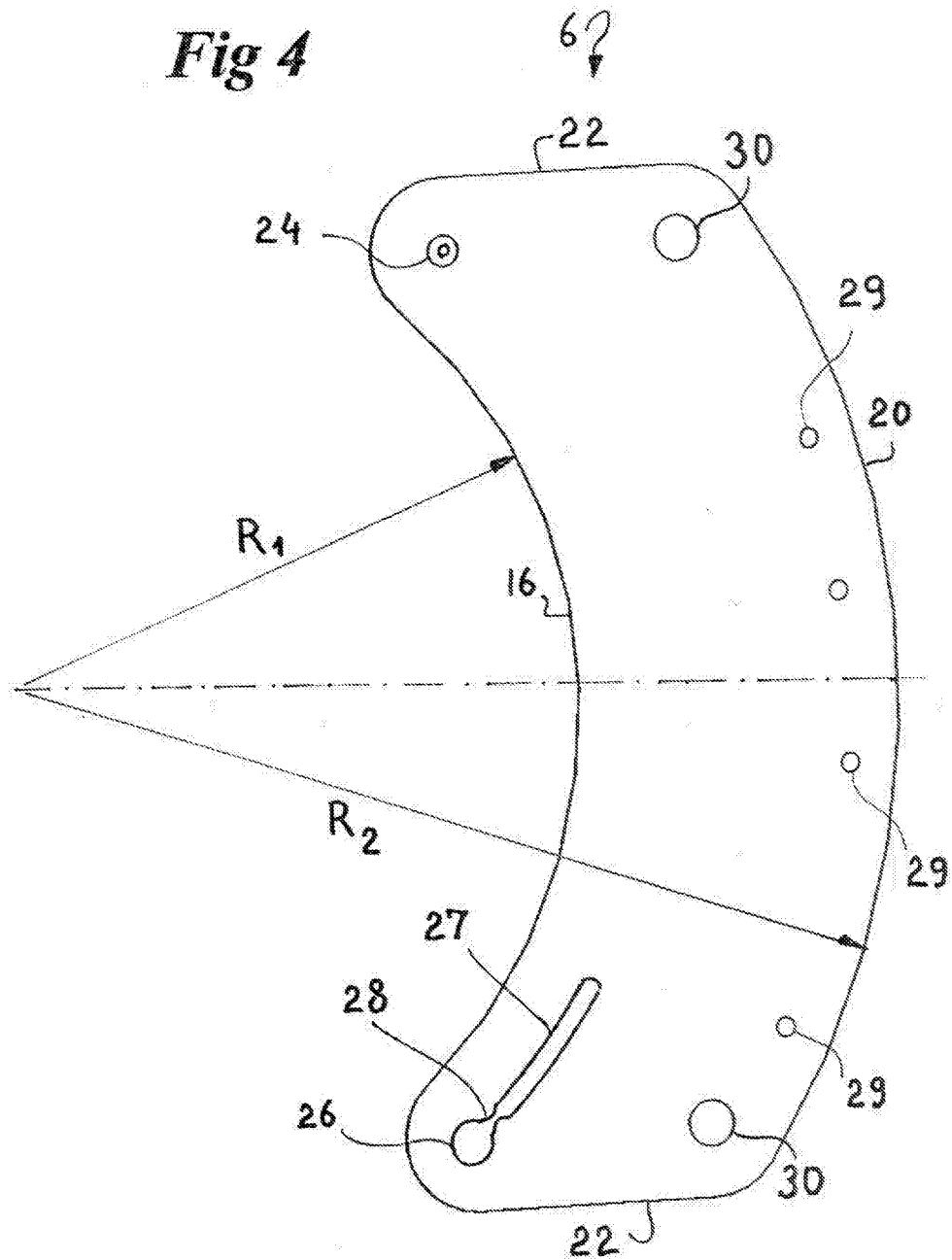


Fig 9





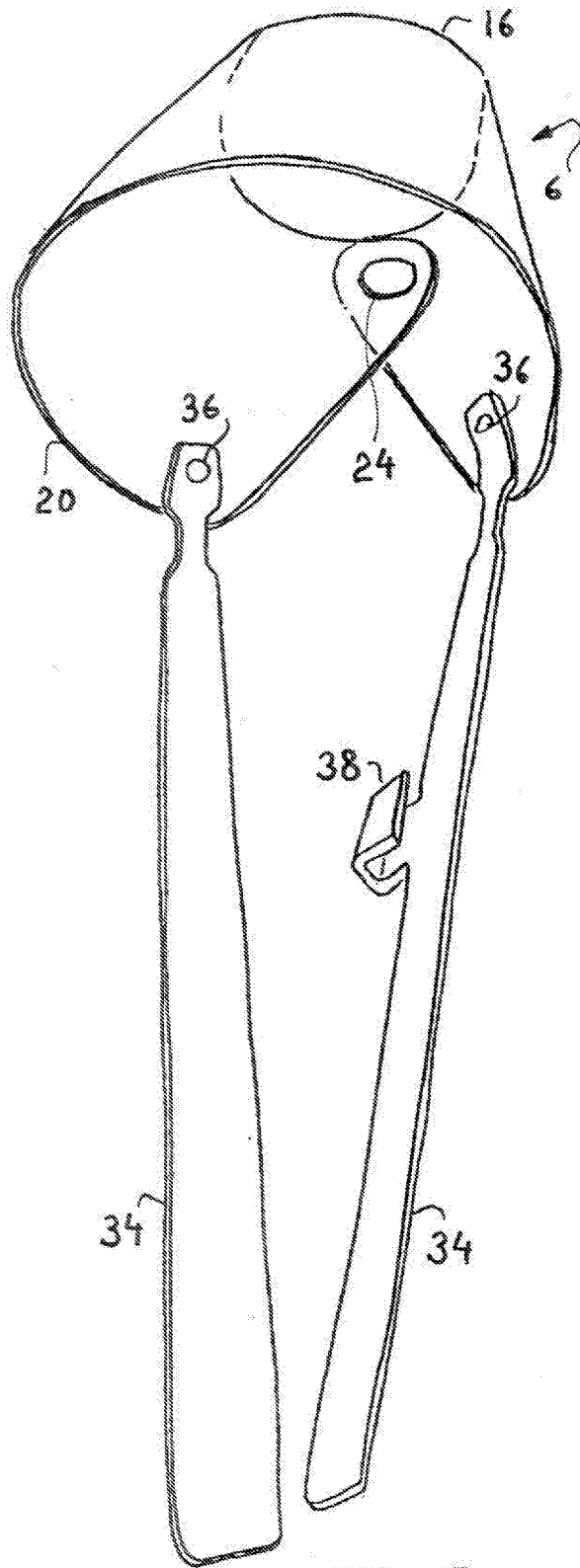


Fig 5

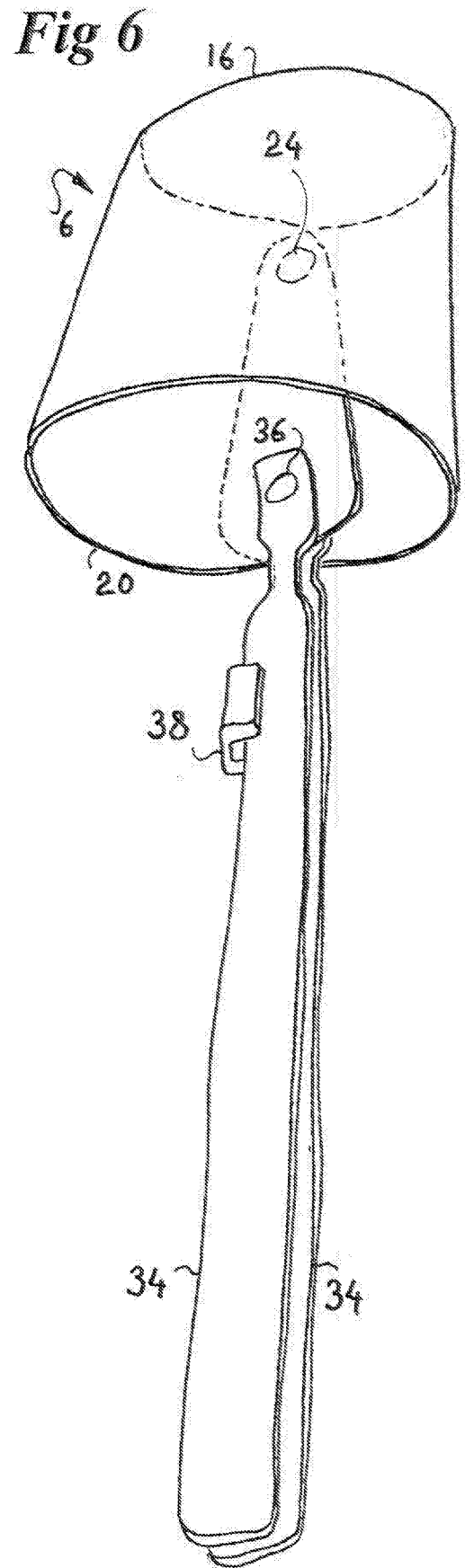


Fig 6

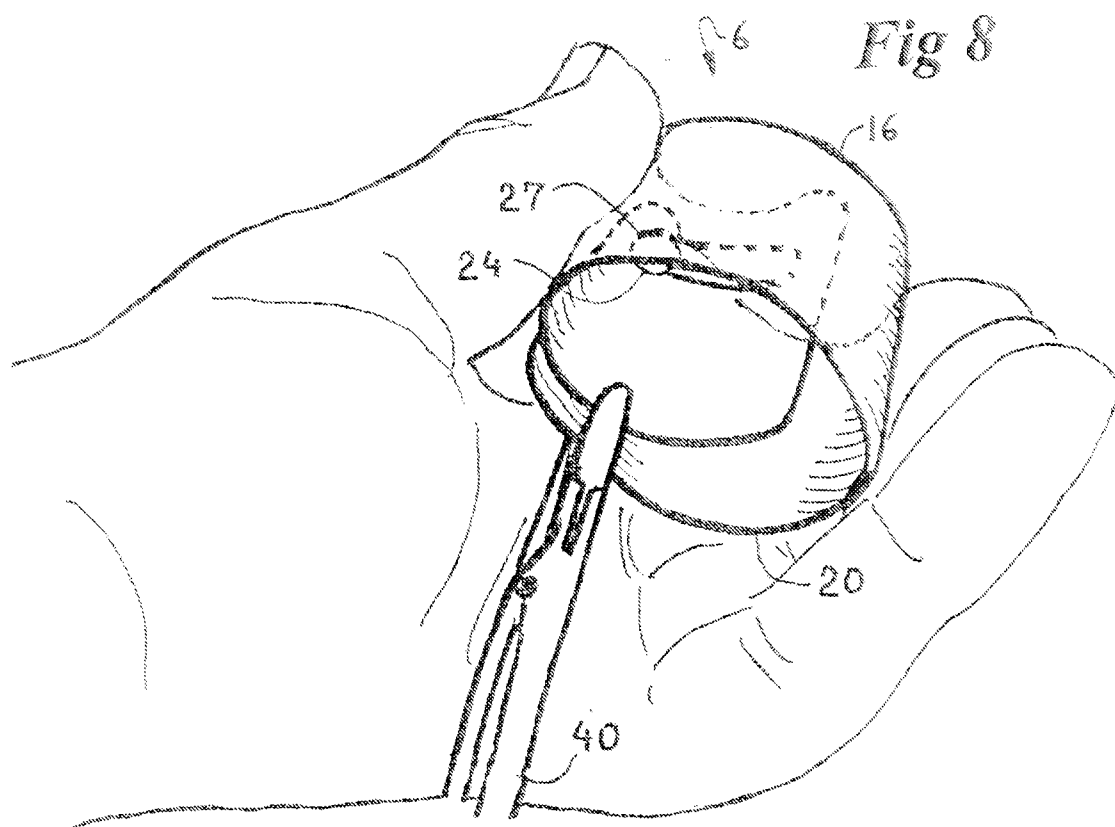
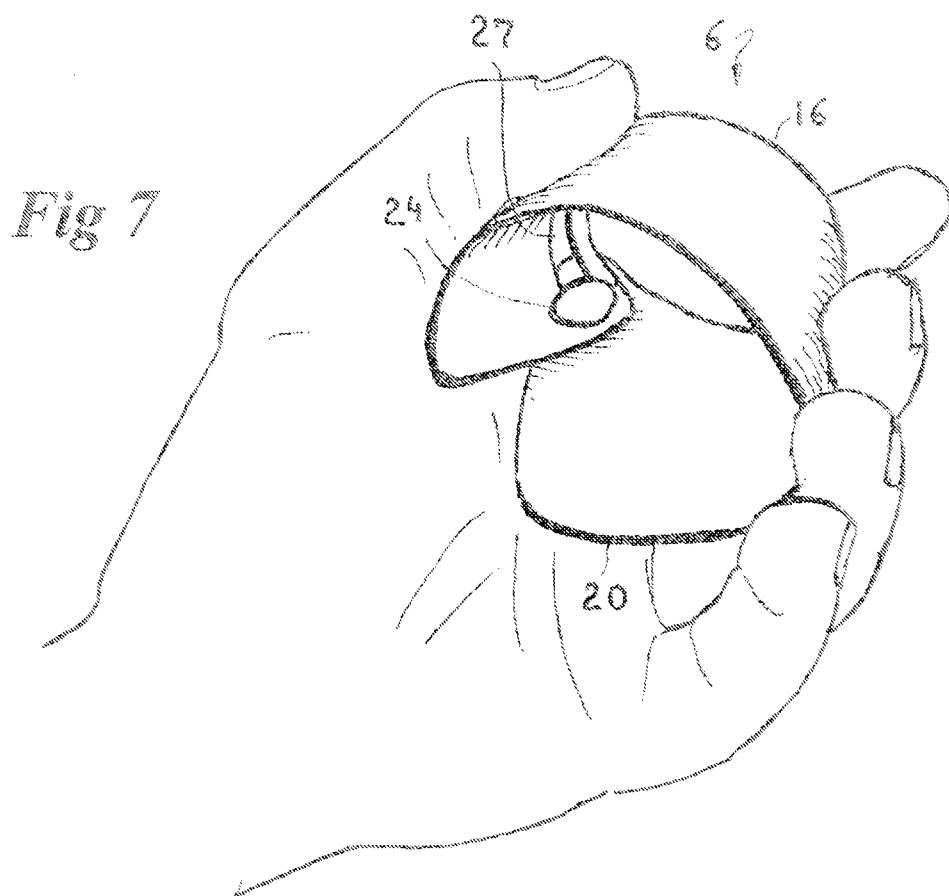


Fig 10

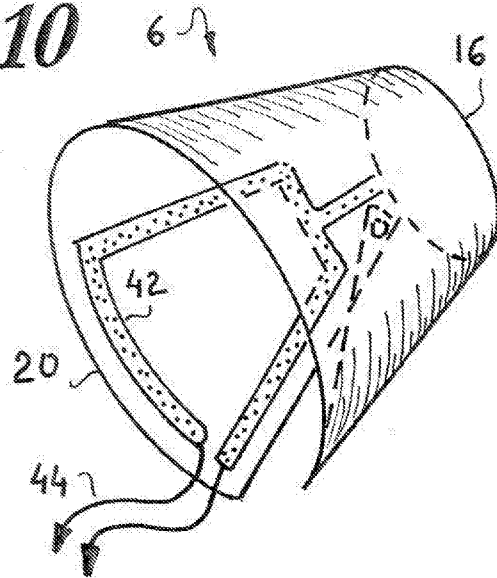
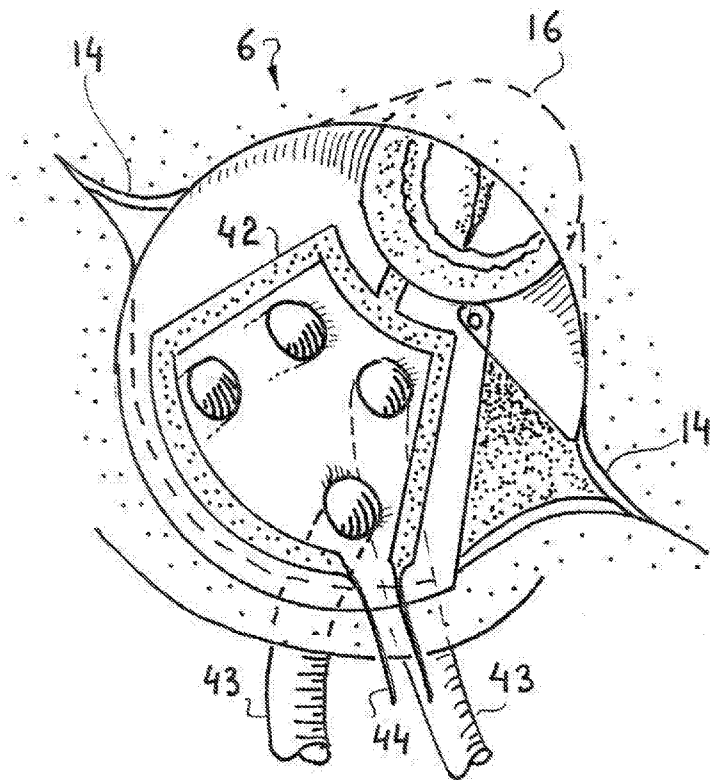


Fig 11



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2006/060618

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B17/34 A61B17/02

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61B

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

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

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004/116954 A1 (PAGLIUCA) 17 June 2004 (2004-06-17) the whole document	1-13
X	WO 2004/021899 A (ENDIUS) 18 March 2004 (2004-03-18) page 13, line 30; figures 2,3,14,16-19	1-13
X	WO 2004/071334 A (ENDIUS) 26 August 2004 (2004-08-26) figures 4,14,20	1-13
A	US 2003/191371 A1 (SMITH) 9 October 2003 (2003-10-09) figures 1-6,12	
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☒ Further documents are listed in the continuation of Box C.

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Date of the actual completion of the international search

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