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(54) **DEVICE AND PROCEDURE FOR JOINING HOLLOW ORGANS**

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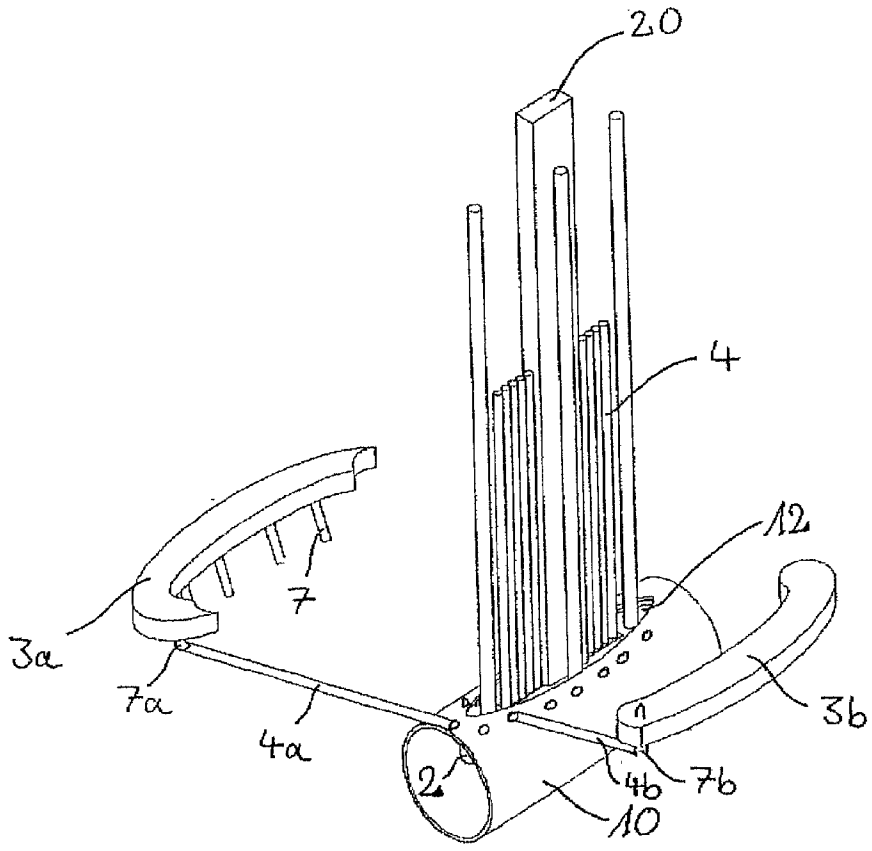
(57) **ABSTRACT**

The invention relates to a device for joining hollow organs with an elongated holder and a needle carrier which is positioned at one end of the holder, where the needle seat extends radially, forming an overhang projecting beyond the periphery of the holder, as well as with a plurality of needles which are disposed standing vertically on the project overhang of the needle seat, surrounding the holder.



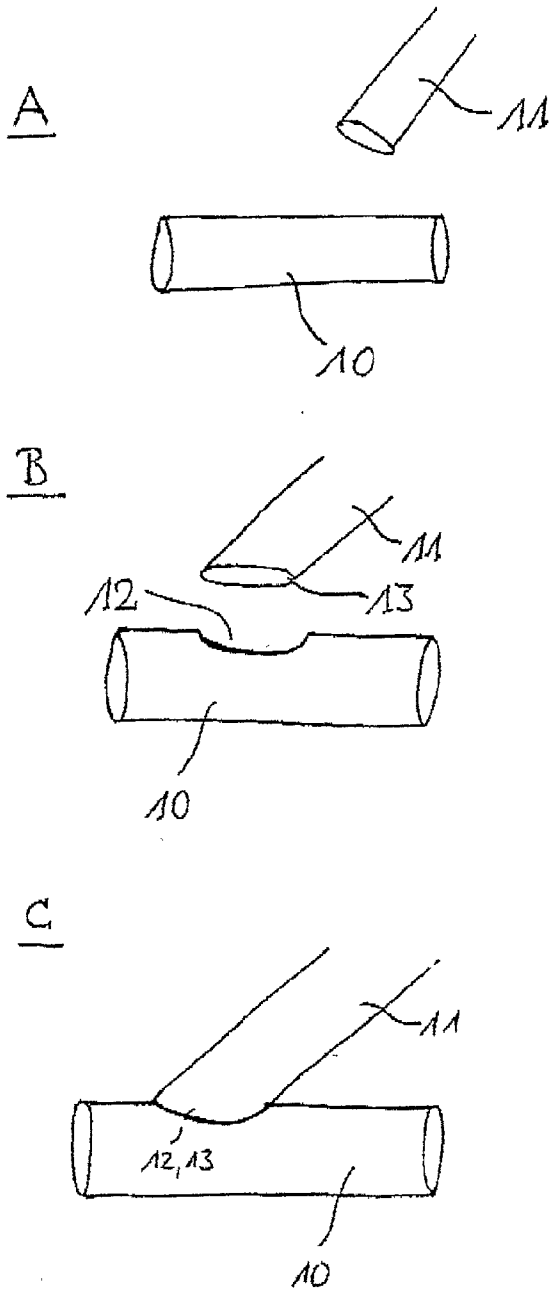


Fig. 1

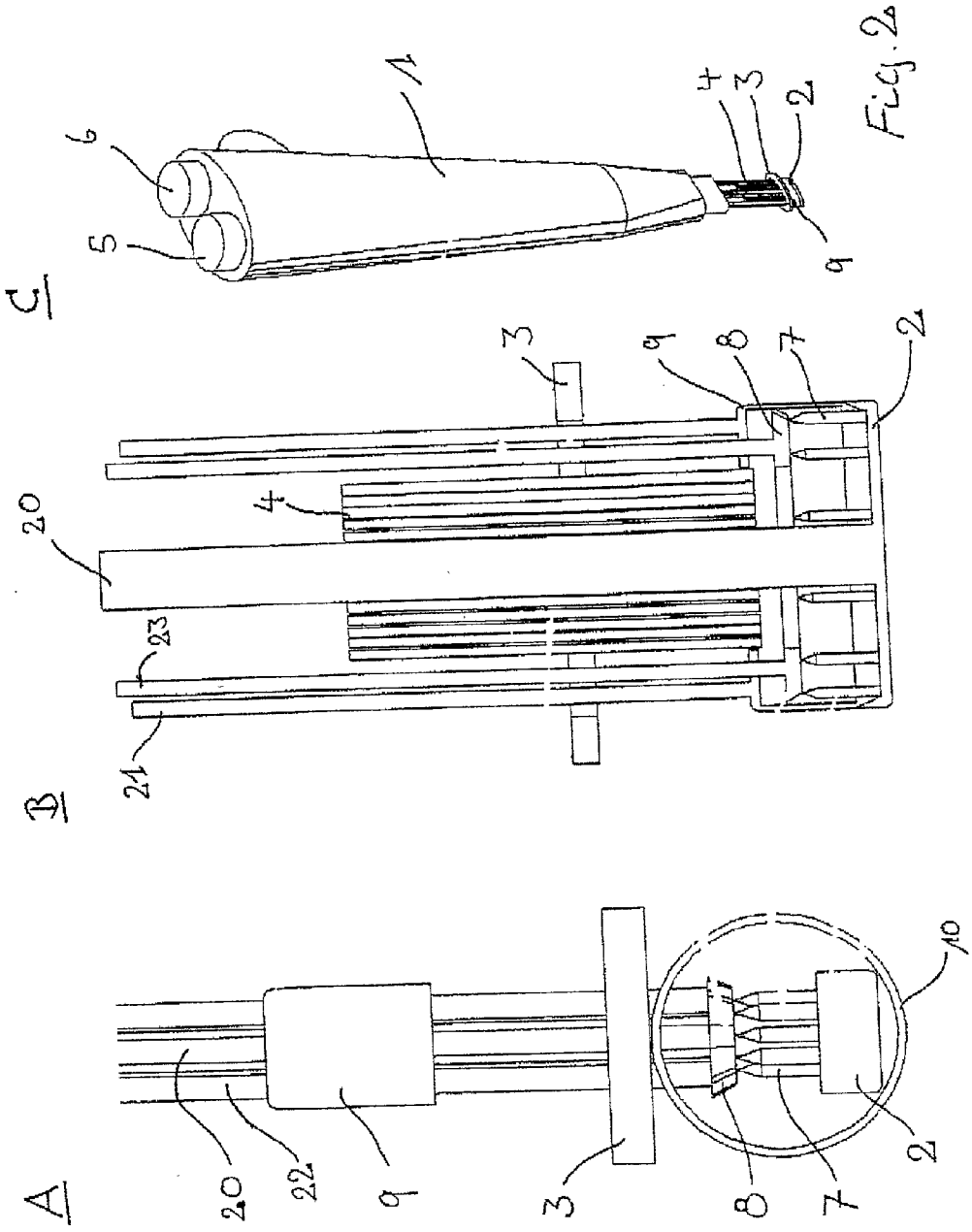


Fig. 2a

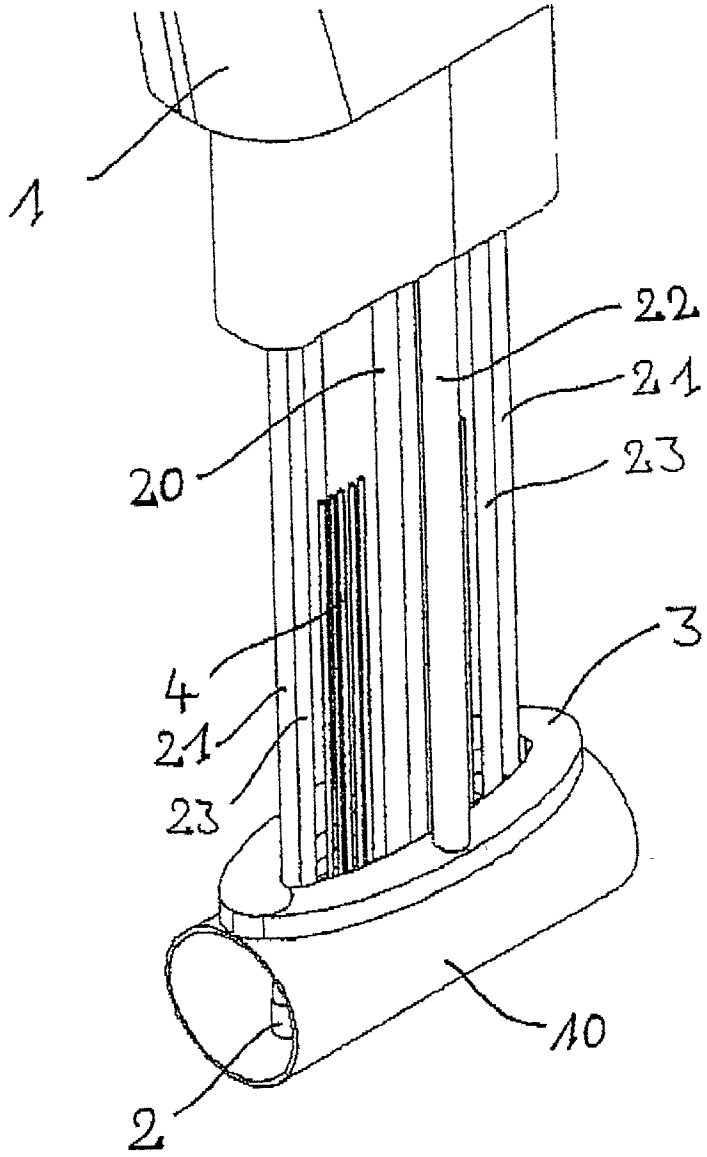


Fig. 3

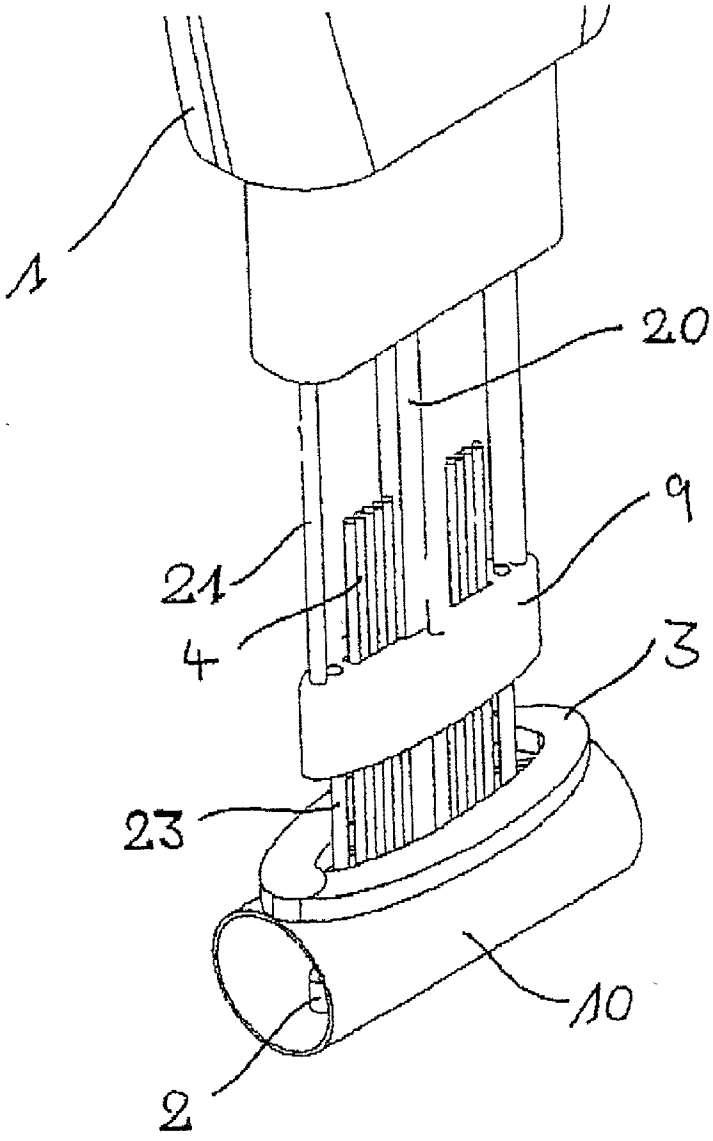


Fig. 4

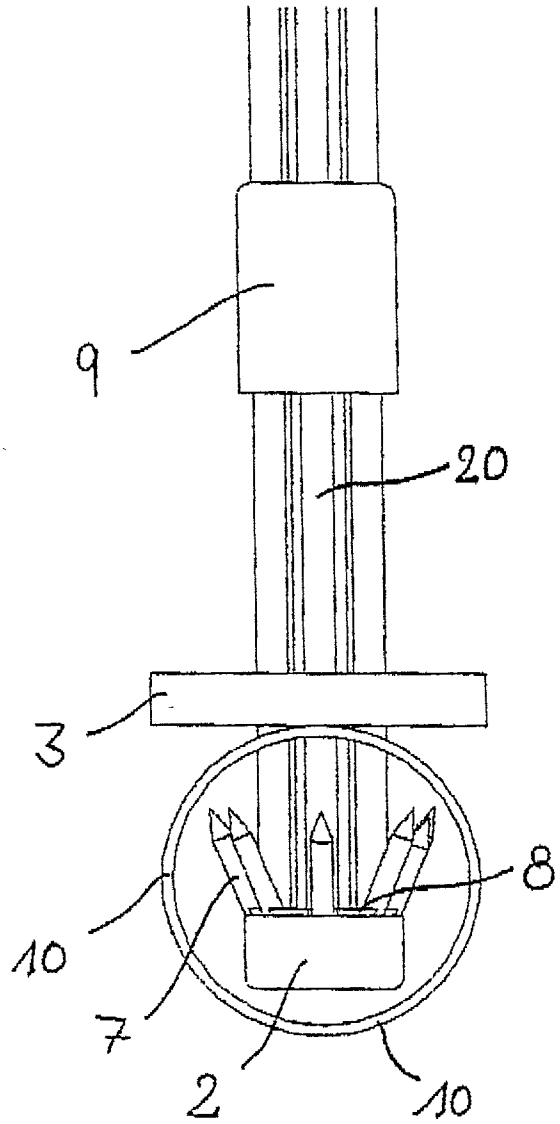


Fig. 5

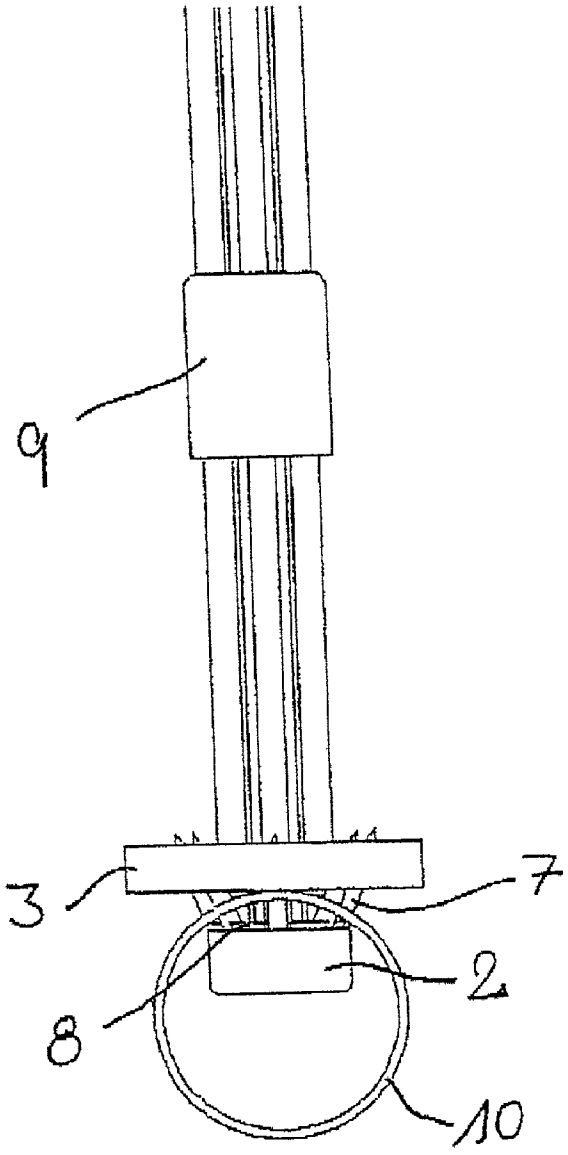
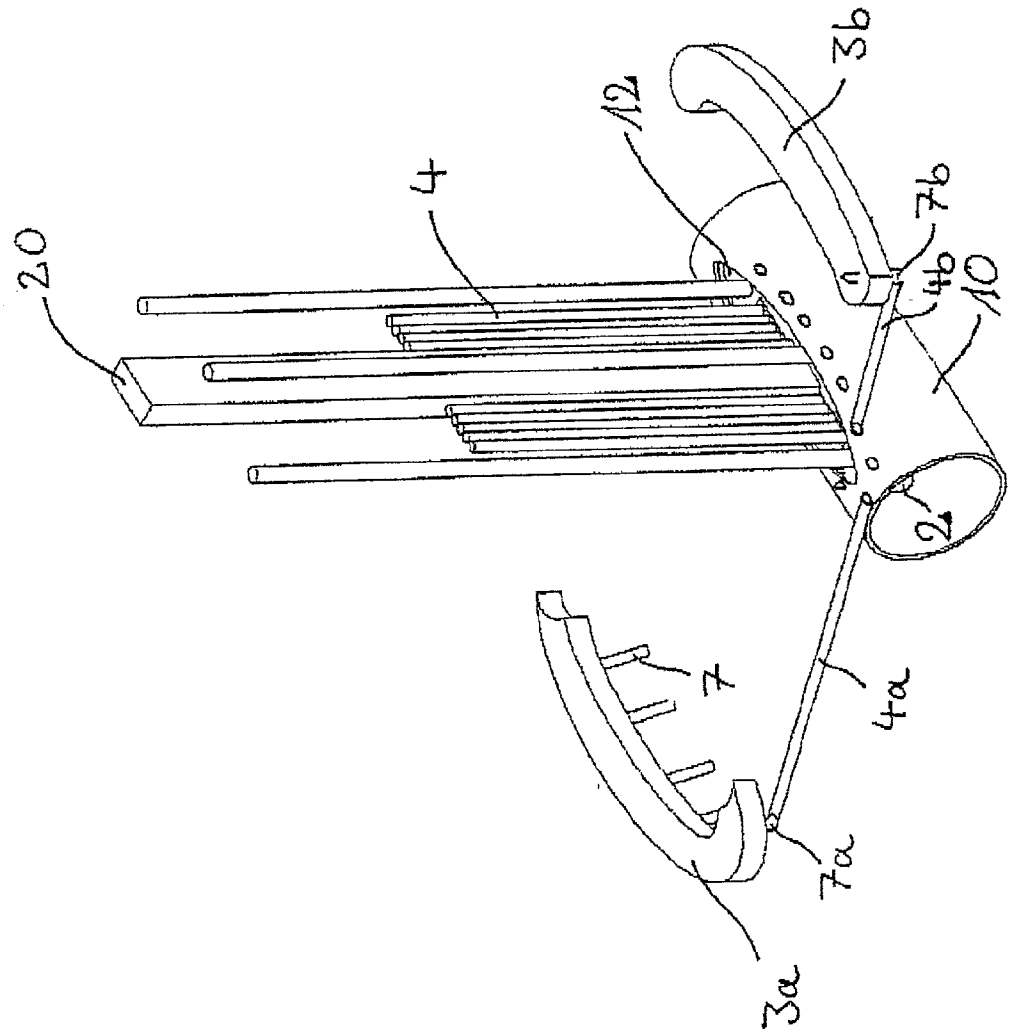


Fig. 6

Fig. 7



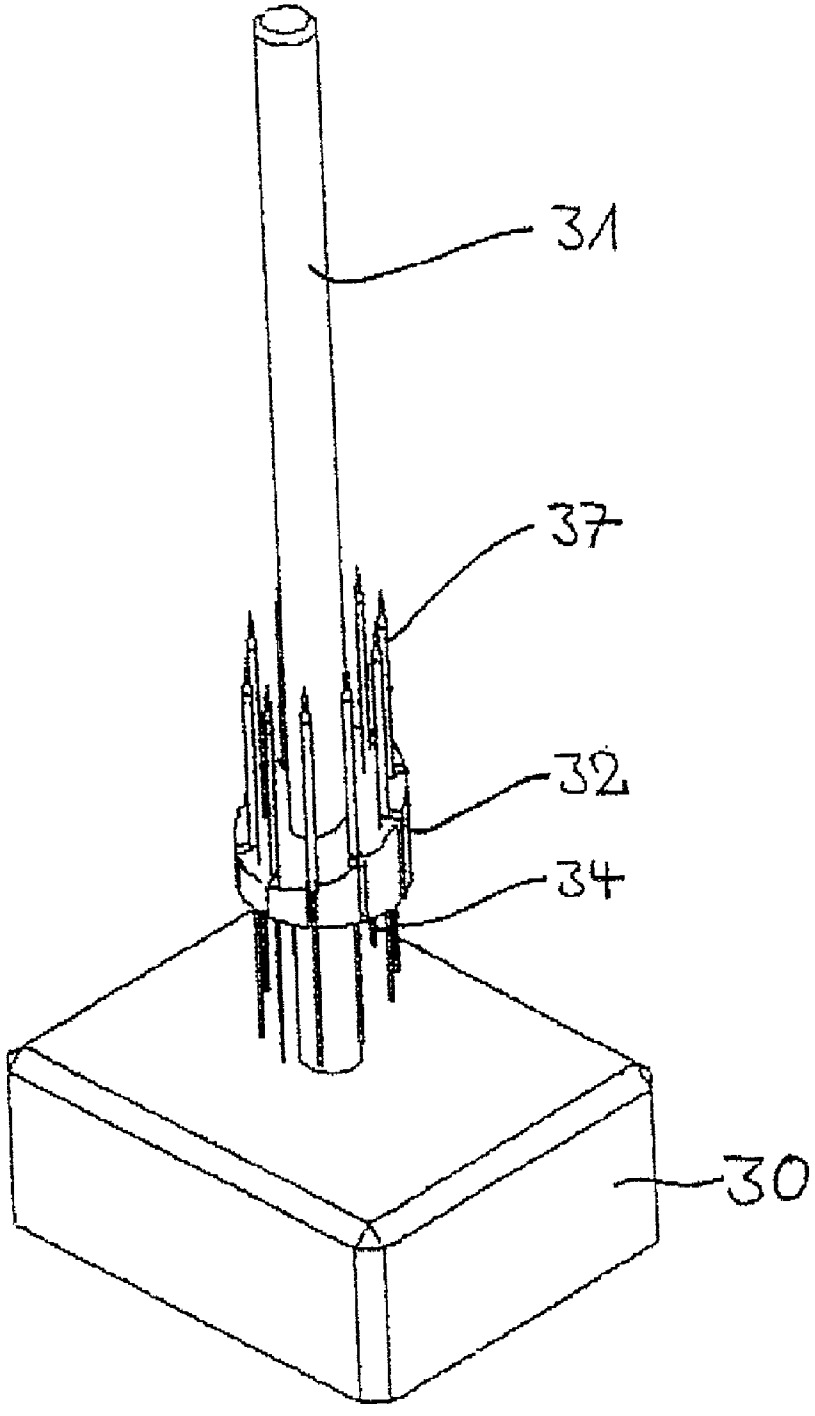


Fig. 8

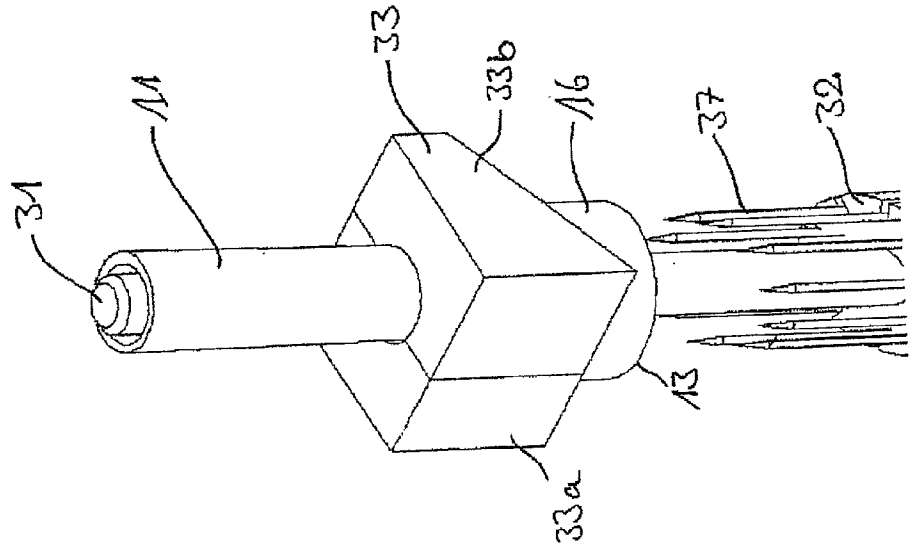


Fig. 11

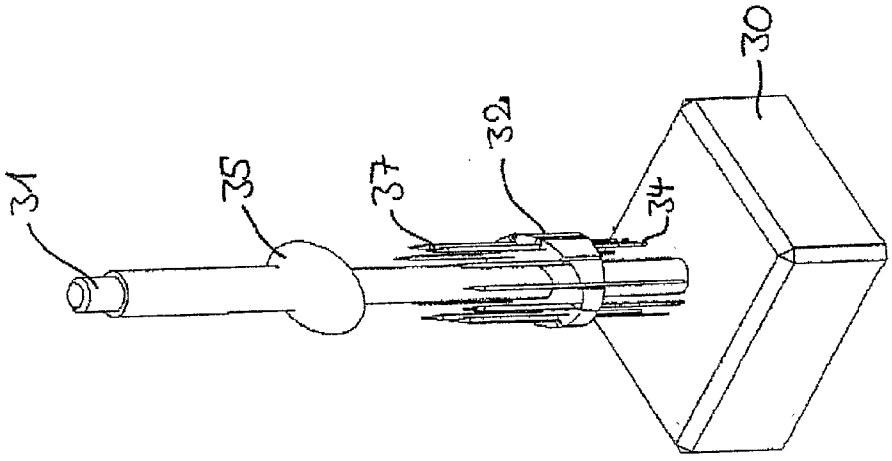


Fig. 9

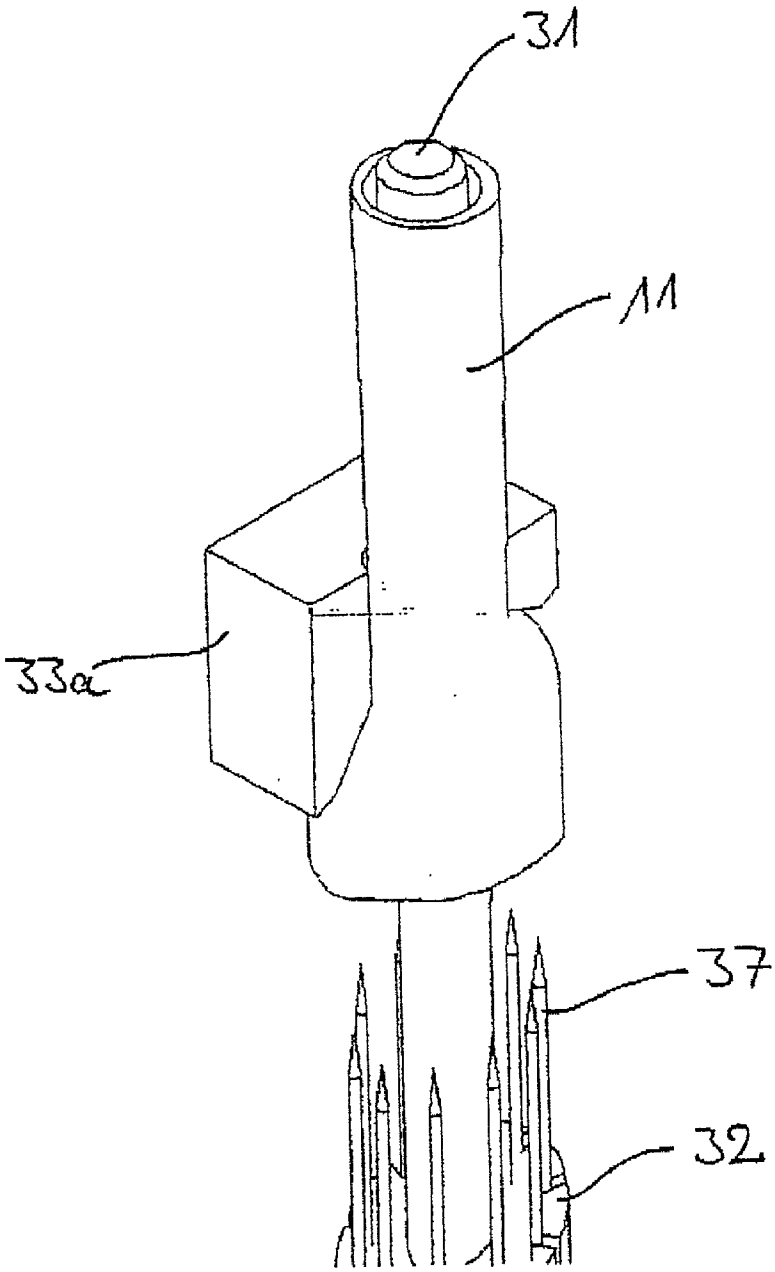


Fig. 10

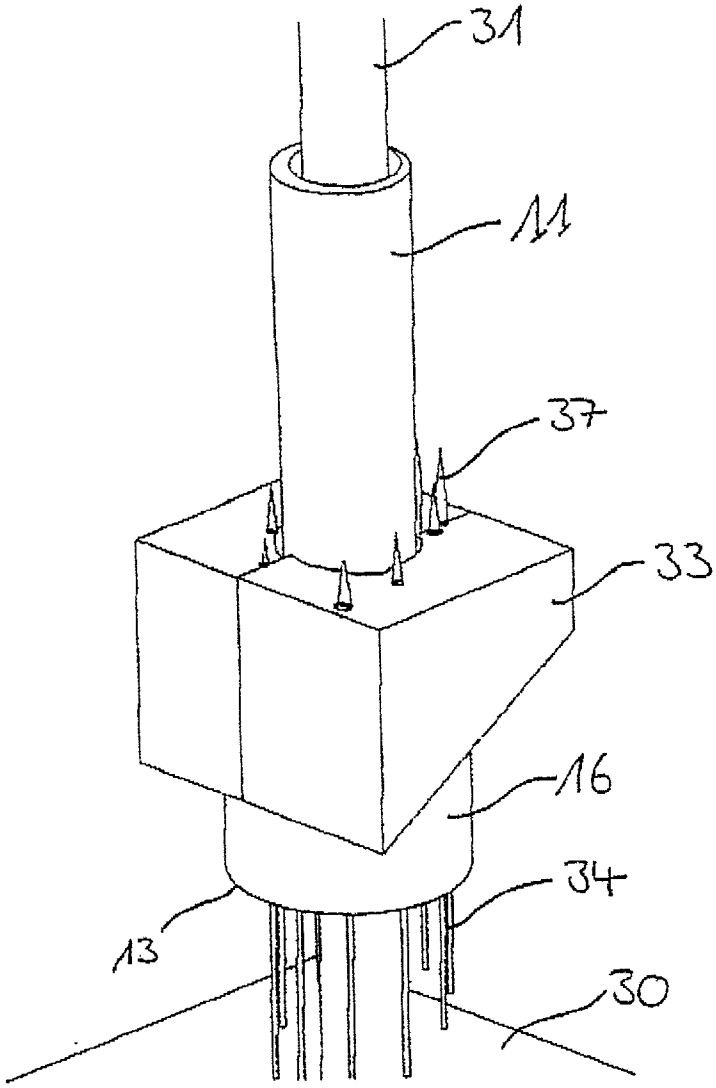
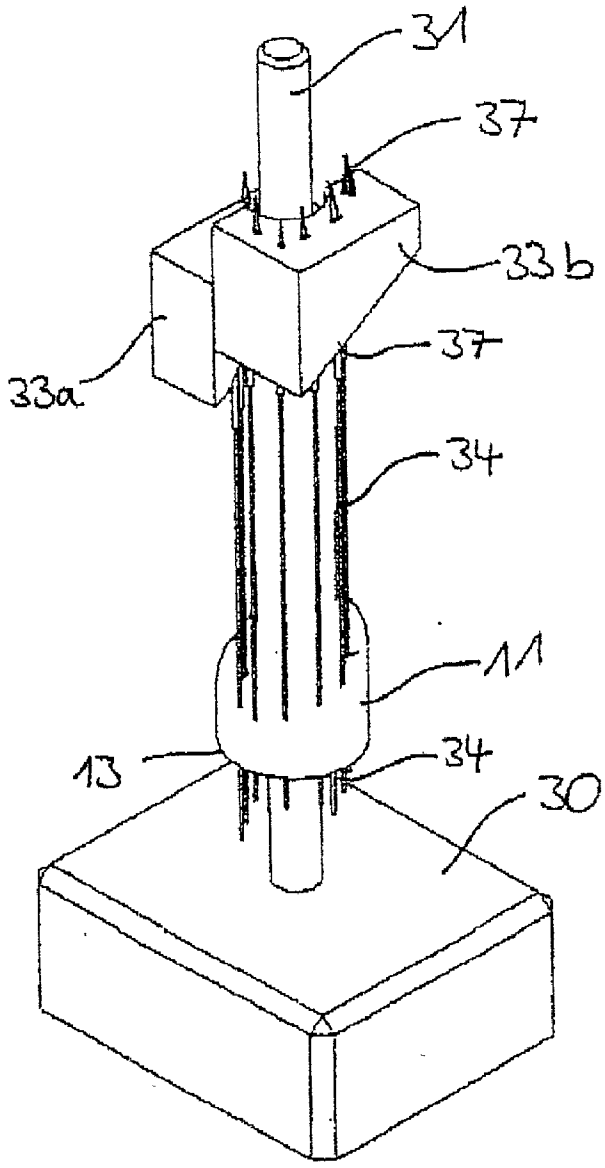


Fig. 12



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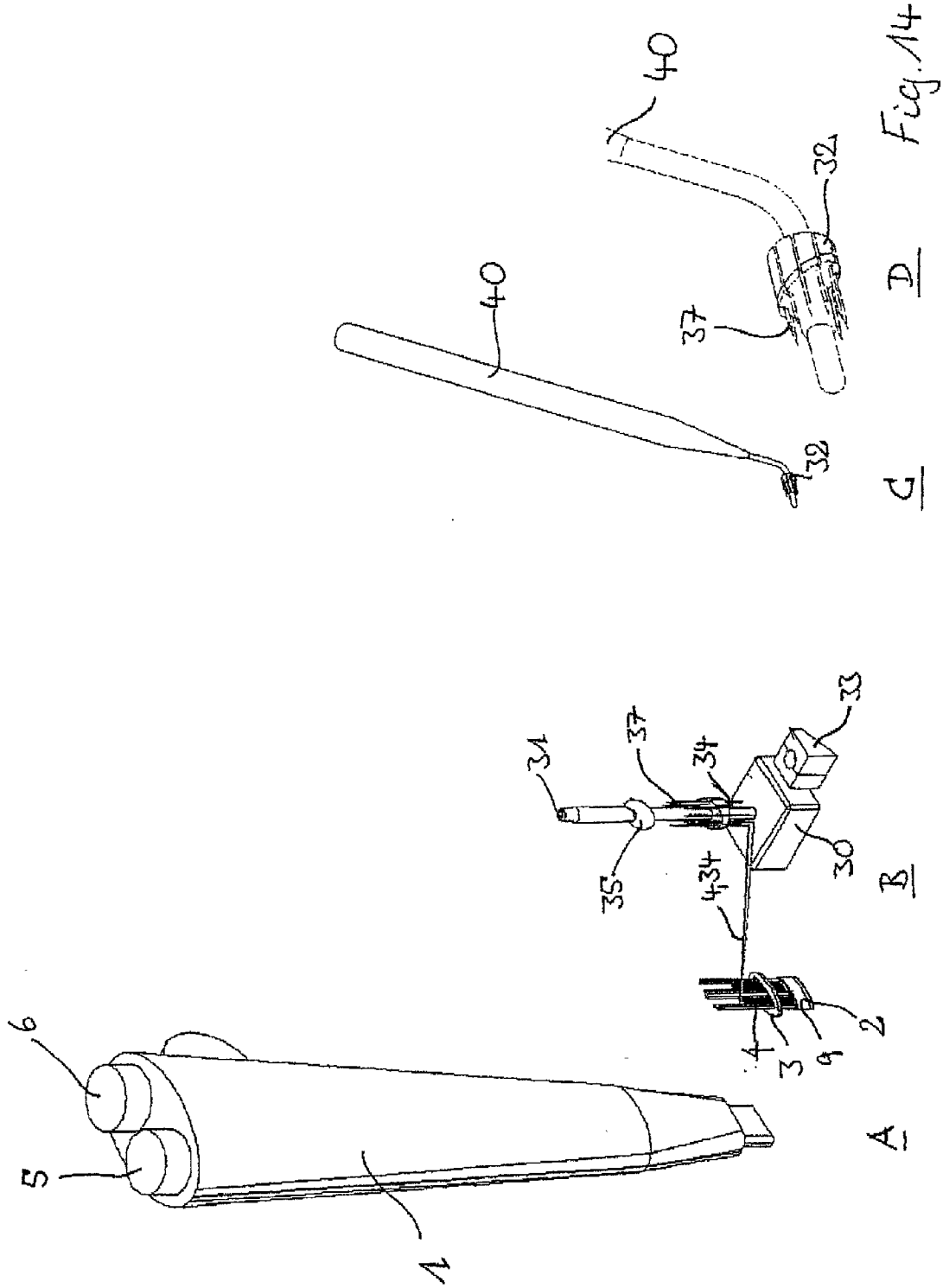
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Fig. 14
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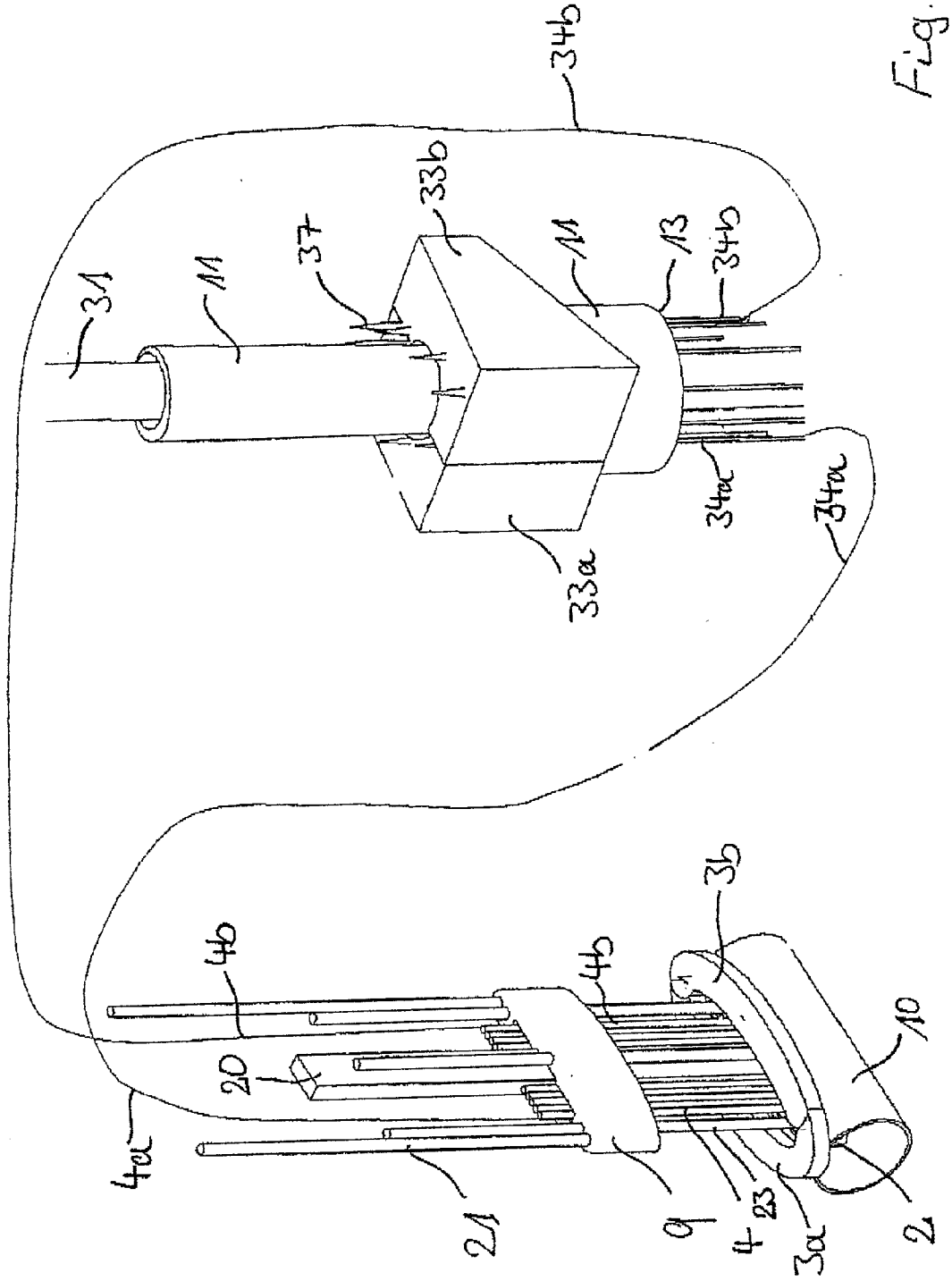


Fig. 15

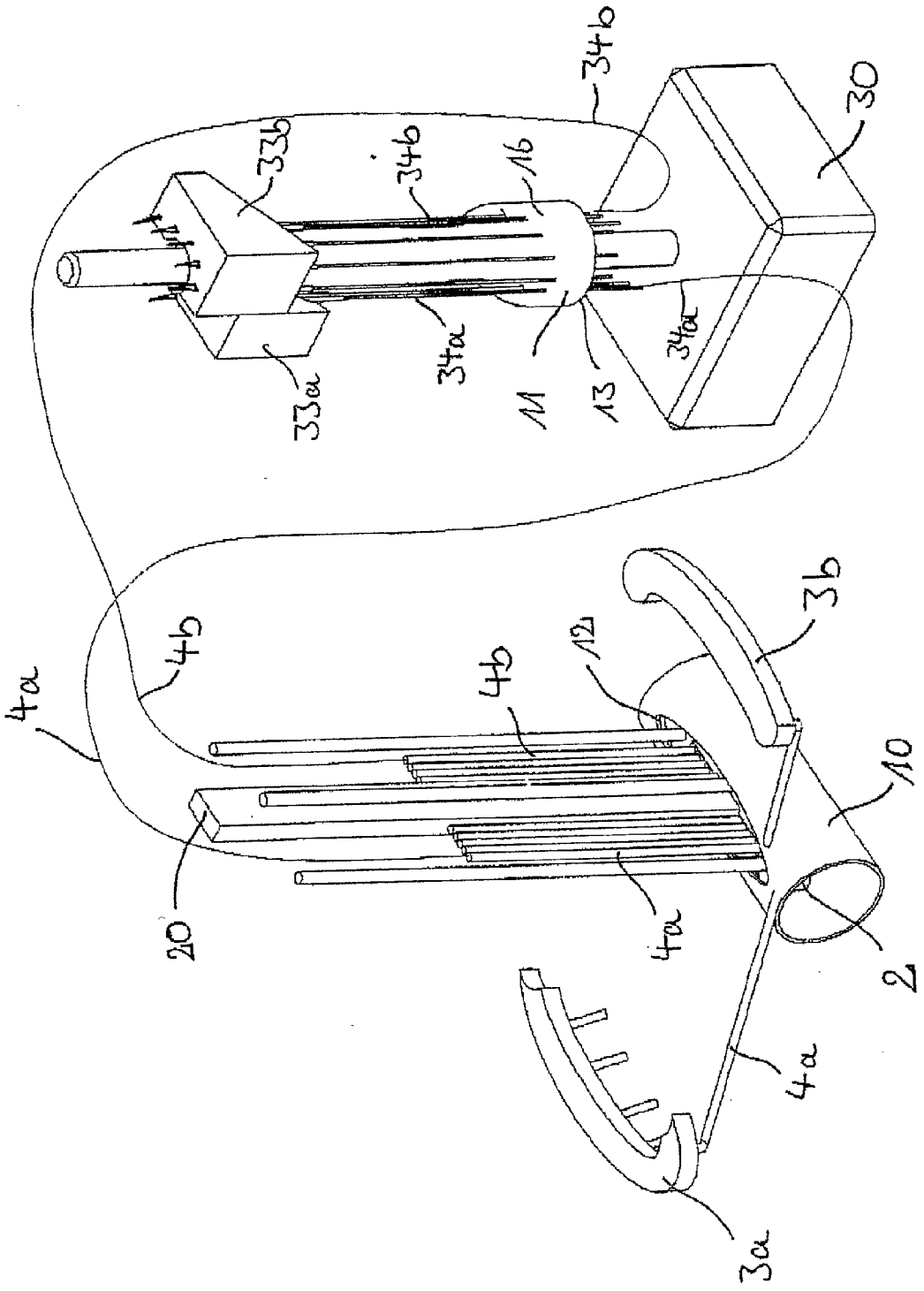


Fig. 16

Fig. 17

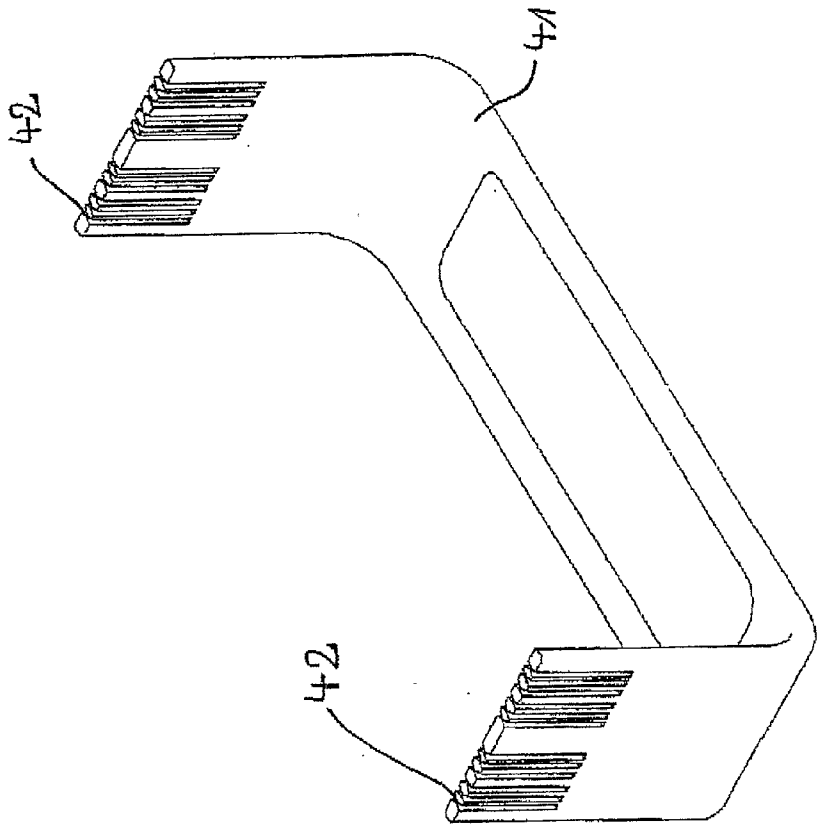


Fig. 18

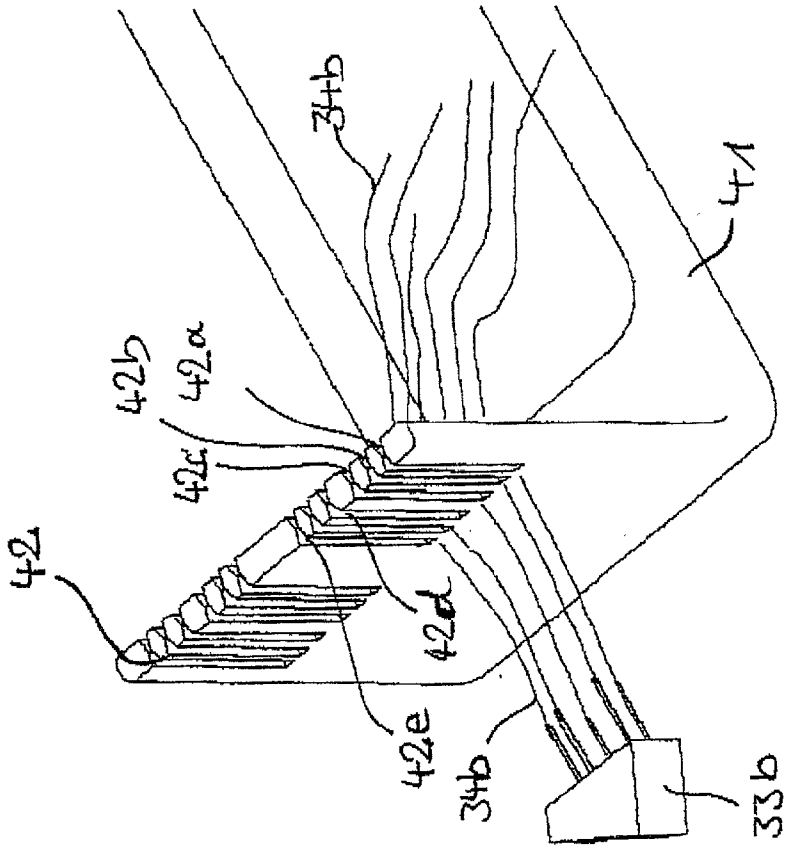


Fig. 19

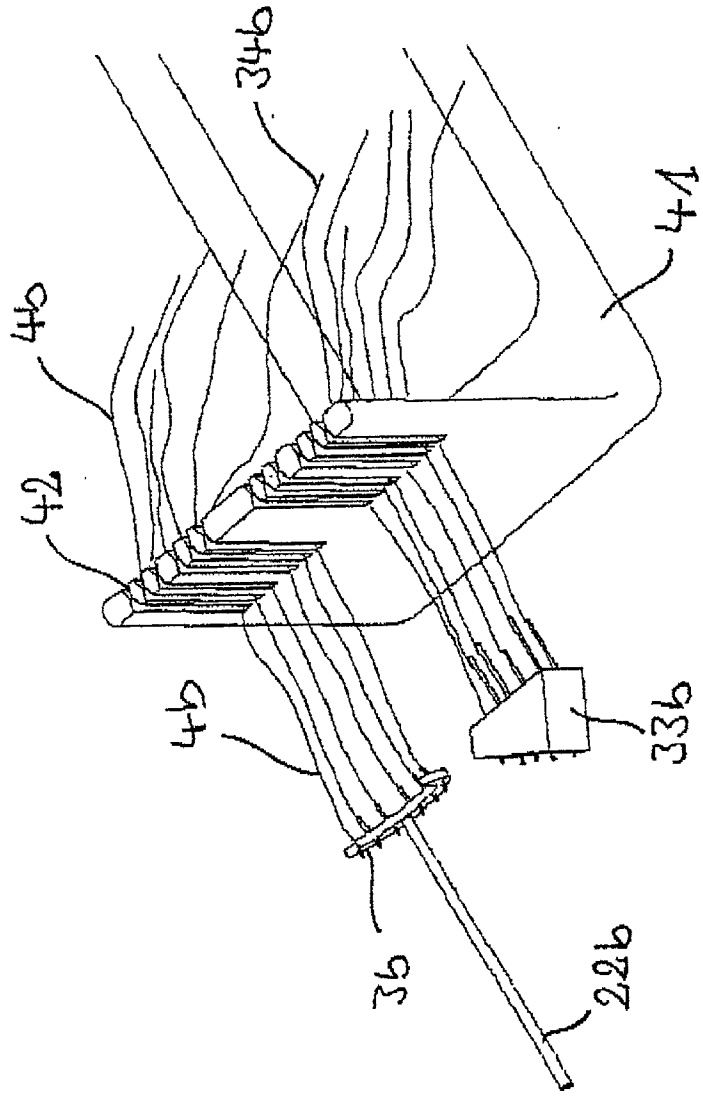
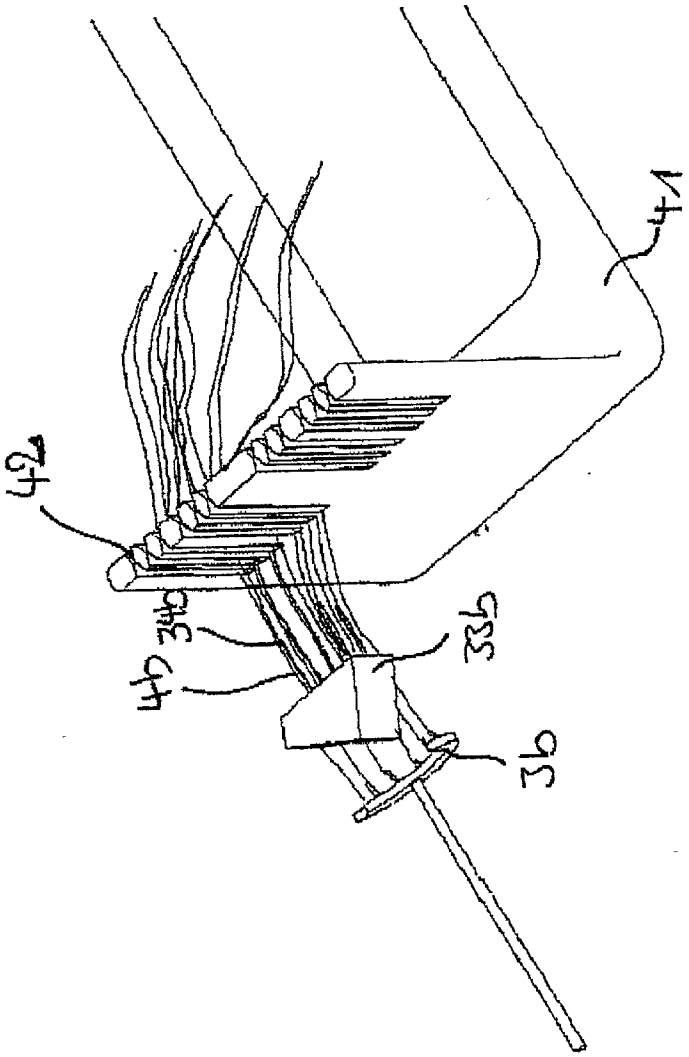


Fig. 20



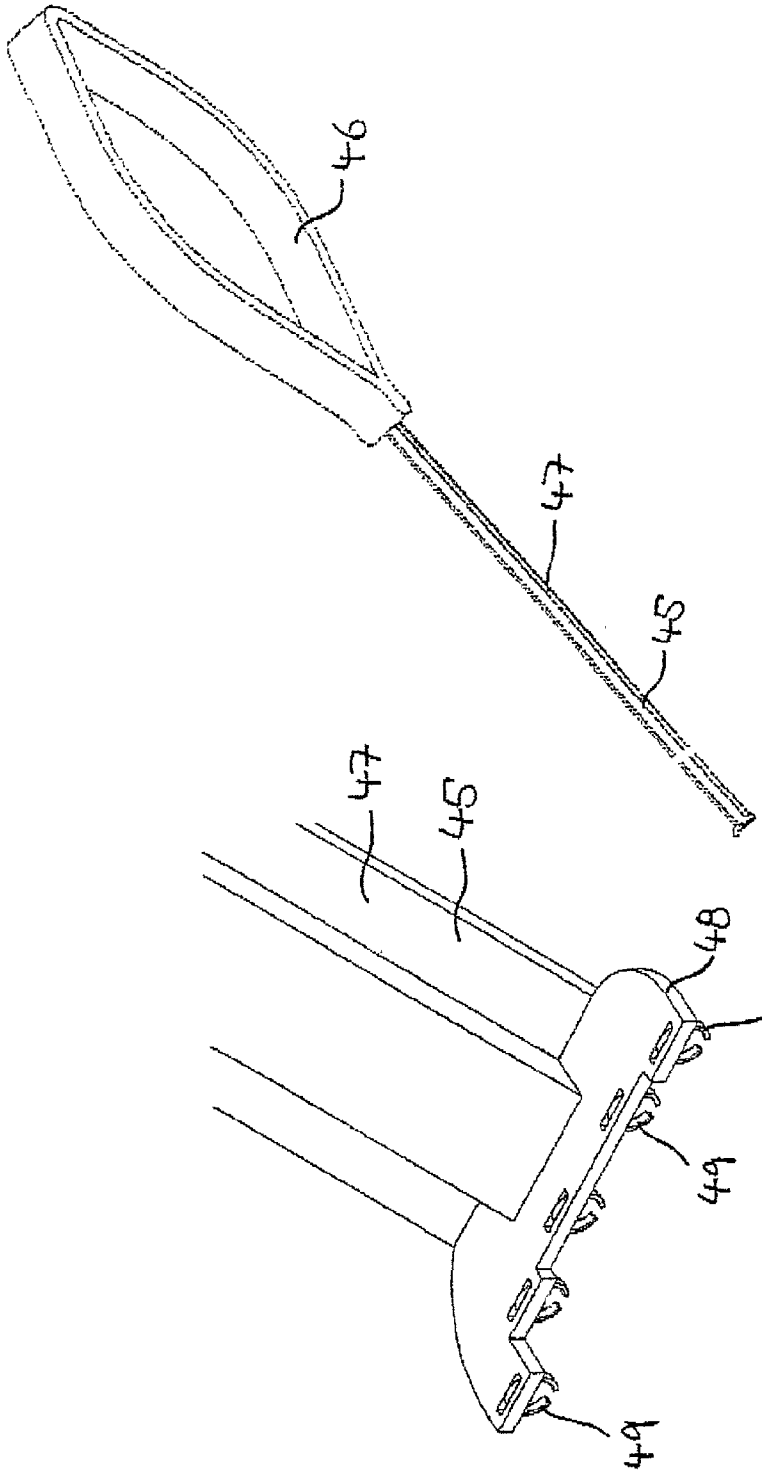
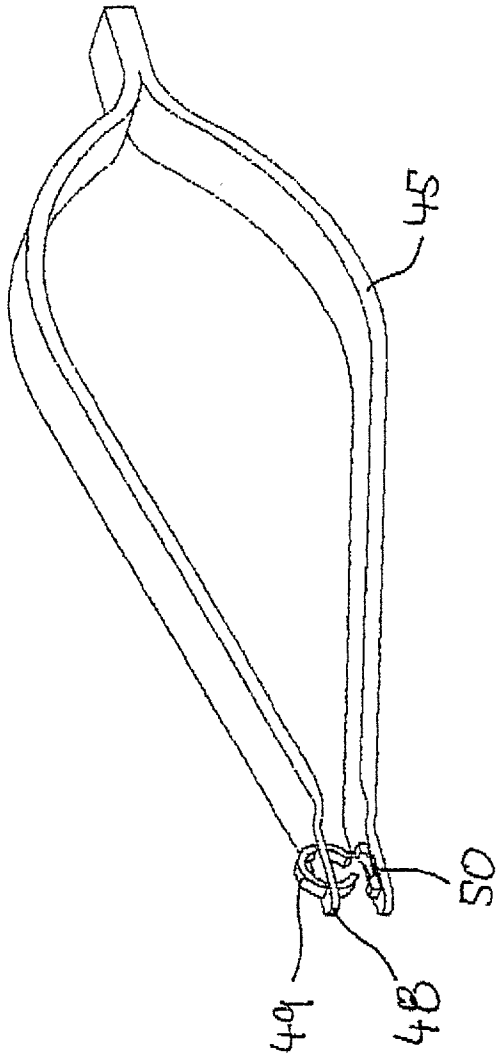


Fig. 21

Fig. 22



DEVICE AND PROCEDURE FOR JOINING HOLLOW ORGANS

[0001] The present invention refers to a device and a procedure for joining hollow organs. With devices and procedures of this kind for attaching blood vessels, the suturing process, for example, can be mechanized and consequently speeded up and simplified. This is of great importance in coronary surgery, in particular for performing operations on the beating heart. Furthermore, through the use of devices and procedures of this kind a repeatable and high-quality suturing process can be carried out, so that the risk of the vessels not being leak-free is minimized or, for example, in coronary surgery that the rear wall of the blood vessel in question is also attached.

[0002] An important area of application for devices and procedures of this kind is the suturing of end-to-side anastomoses in coronary by-pass surgery, i.e. surgically applied unions of hollow organs in which one end of a vessel is sewn laterally to another one. The devices and procedures under the invention can, however, be used for sewing vessels in all other areas of vascular surgery.

[0003] Today, about 70,000 by-pass operations are performed each year in Germany alone. The most difficult discipline are anastomoses on the coronary arteries. They require a great deal of skill and experience on the part of the surgeon, because the blood vessels here are extremely small, with an average arterial diameter of 2 mm and an average vascular diameter of 4 mm, and where the diameter of the other transplants, mammaria for example, is often only 2 mm. In particular, there cannot be any leakage or sewing up of the rear wall of the vessel.

[0004] The manual procedure can be divided up into the following operational steps, where the attachment at the anastomosis suture represents the task which can be taken over by mechanical devices and the appropriate procedures. First of all, a thoracotomy and a sternotomy (opening and separation of the chest wall) are performed. Parallel to this, the transplant (e.g. vein) is obtained and prepared for attachment to the artery with a suitable diagonal end cut. In the next step, an incision is made into the artery as a lengthwise opening. Next the openings of the vein and the artery are joined to each other. This can be simplified and improved by means of a mechanical device. Finally, the thorax is closed up again.

[0005] Under the present art, several types of what are called staplers are currently known, which, like a paper stapler, place a clip instead of a suture. The systems are used primarily for larger vessels or for sealing off open vessels. Leaks in particular are a major problem with end-to-side staplers. Staplers of this kind are known, for example, from U.S. Pat. No. 5,732,872, No. 4,930,674 or No. 5,285,945.

[0006] Coupling systems, such as those described in "Review of Facilitated Approaches to Vascular Anastomosis Surgery," Werker, P. et al., *The Society of Thoracic Surgeons,* 1997, follow another approach to joining vessels. Coupling systems of this kind are used mostly in the intestine, or to join the blood vessels end-to-end.

[0007] A third group of procedures for connecting vessels is based on the conventional suturing technique, which has been mechanized. A system of this kind, for example, is the ArthroSew™ Suturing System from U.S. Surgical Dynamics.

[0008] The disadvantage of all these systems known from the present art is that they often do not provide any possibility for end-to-side anastomosis, or are not suitable for small vessels with a diameter of about 2 mm. In particular, they are often also not suitable for by-pass surgery.

[0009] It is, therefore, the object of the present invention to make available a procedure and a device for joining hollow organs, in particular for applying anastomoses, with which two hollow organs can be joined in a way that is simple, safe and of high quality, as well as being repeatable.

[0010] This task is solved by means of the device in accordance with claim **1** as well as the set in accordance with claim **17** and by means of the procedure in accordance with claim **19**. Advantageous further developments of the device under the invention, the set under the invention and as well as the procedure under the invention are given in the specific dependent claims.

[0011] The fundamental operating principle of the device under the invention and the procedure under the invention is based on simultaneously punching several needles with sutures through a vessel, where there are similarly needles at the other end of the suture, which are simultaneously punched through a second vessel. By pulling the ends of the two sutures tight, placing the ends of the sutures in the rest plate and tying the ends of the sutures together, the two vessels are then securely attached to each other.

[0012] This conception of the device and the procedure solves the task of joining hollow organs, specifically the application of anastomoses in a simple, safe and repeatable way. The primary field of application is by-pass surgery on the heart with coronary ischemia, but in addition operations on other organs in the case of stenoses, occlusions, strictures and thromboses, for example, in peripheral arteries.

[0013] In contrast to manual attachment or the conventional procedures, there is no risk of the rear wall of the vessel being sewn or the anastomosis suffering from leakage. With the device under the invention and the procedure under the invention, most operations can not only be performed on the asystolic heart, so that any additional traumatization for the patient as the result of the use of the heart-lung machine is avoided. Specifically, the attachment of very small vessels with a diameter of about 2 mm is possible in safety.

[0014] On the basis of the mechanized suturing process, the quality of the suture is improved, the rear wall is protected, for example, by means of a needle carrier designed as a shoe, and the operation can consequently be carried out in most cases on the beating heart.

[0015] Under the invention, the device for joining hollow organs has several elements, which are

[0016] an elongated holders

[0017] a needle carrier, which is located at one end of the holder, where the needle carrier forming a projecting overhang extends radially beyond the elongated holder, so that a plurality of needles can be disposed in a ring on this projection pointing away from the end of the holder, for example, so that they stand vertical, while their ends are connected to sutures. In this way, the needle carrier is constructed as a shoe, which protects the rear wall of the vessel from the needles

when the holder is inserted into the incision in the vessel. The needles can then be splayed out at a predetermined angle and, with the assistance of a needle seat positioned on the outside of the vessel wall, pushed through the vessel wall along the circumference of the incision.

[0018] If the other side of the sutures is connected with needles in a similar carrier, the second vessel which is to be connected to the first one can be sutured in this way along the periphery of its incision, so that the two openings are joined along their circumference when the sutures are subsequently pulled tight and tied together. With this, both hollow organs are securely joined together with their openings flush and in a sealing manner.

[0019] The holder can be implemented as a table stand, for example, for the end of a transplant, if the transplant is still unattached, or as a handle for example, for the second end of the transplant or for the mammaria. In addition, the holder can be equipped with an insertion aid for the transplant, for example, the vessel undergoing anastomosis. This insertion aid can be an enlargement of the elongated holder, or be mounted in the elongated holder in such a way that after the transplant is pulled over the holder and the insertion aid, this insertion aid is expanded so that the transplant has a larger circumference. In this way the transplant can be expanded to a circumference which extends beyond the periphery of the array of needles, so that by means of axial movement in the direction of the holder, the needles can be then pushed through the vessel wall of the transplant.

[0020] To protect the needles when they are being inserted, or rather to protect the vessel from the needles, a needle cap can be pulled over the needles and the needle tips, which is removed from the needles immediately before the needles are deployed, or before the needles are pushed through the vessel wall. In this way, the vessel is protected for as long as possible from the sharp-pointed needles and injuries resulting from them.

[0021] The needles can be extended in the direction of the lateral vessel wall immediately before being pushed through the vessel wall, while a sleeve is inserted between the needles and the elongated holder and the needles are splayed outwards.

[0022] All the movements of the needle cap or the sleeve, for example, or the two-part seat for pushing the needles through the vessel wall, can be carried out by simply pressing buttons, for example by using a handle which is attached to the holder and has the appropriate controls with mechanical means of movement.

[0023] Once the two openings of the vessels are sutured and the sutures drawn tight, the needle seats with the needles and the sutures attached to them can be placed in a cradle, where as the result of proper design of the carrier and proper placement of the needle seats, the sutures coming from the transplant or from the artery are correctly sorted out automatically. The matching ends of the sutures can then be tied together correctly.

[0024] Tying the sutures together can be done, for example, by means of an auxiliary instrument which takes up the parallel sutures in the holder from the two sides (artery, transplant) and encloses them with clips. The auxiliary instrument can be designed in such a way that several clips can be placed simultaneously, or only one clip is placed at a time. If several clips are placed simultaneously, it is advantageous if the end effector of the auxiliary instrument is designed in such a way that the distance between the clips on the auxiliary instrument is equal to the distance between the sutures in the holder.

[0025] As an alternative to the auxiliary instrument, conventional knots can continue to be made or other procedures such as bonding, thermal forming, etc. can continue to be used. In addition, clips made of nitinol, such as those produced by the Coalescent Surgical Co. Inc., can be used to join the sutures coming from the two hollow organs.

[0026] In addition to straight needles, curved needles are also conceivable.

[0027] For sewing on a mammaria (an artery which is already on the heart and is only being sutured unilaterally), it is conceivable to design the instrument as a minimally invasive surgical instrument and to introduce it into the body through small incisions and to suture without opening the sternum. To do this, the part of the instrument for the artery and the transplant side would be introduced into the body by means of a trocar and handled endoscopically.

[0028] The handles of the tool can also be designed in such a way that they can be manipulated by a robot. In the first step, the procedure for the transplant could continue to be performed by hand and only the procedure for the artery be carried out by the robot. To do this, a flange, which is attached to a robot flange, would be installed for the artery side instead of the hand grip. The movement of the needle cap, the sleeve and the two-part seat are then controlled electrically, hydraulically or pneumatically or by other drives.

[0029] The transplant portion can also be handled by a second robot arm for the suturing of the mammaria. The handle with the needle carrier and the insertion aid would be flanged to a robot. The two-part seat would need to be pushed up manually or by yet another robot arm and pulled out along with the needles. The needle seat (two-part seat) is then put into the cradle by the robot, and the tightening and tying together is done manually.

[0030] In what follows some examples are given of devices and procedures under the invention.

[0031] **FIG. 1** shows an anastomosis being applied;

[0032] **FIG. 2** shows a device under the invention;

[0033] **FIG. 3** shows an artery with a needle carrier inserted

[0034] **FIG. 4** shows a needle carrier inserted with needle cap raised;

[0035] **FIG. 5** shows the arrangement according to **FIG. 4** in cross section;

[0036] **FIG. 6** shows a cross section through an artery with a needle carrier inserted, penetrating the vessel wall;

[0037] **FIG. 7** shows an artery with a vessel wall sutured;

[0038] **FIG. 8** shows another device under the invention;

[0039] **FIG. 9** shows the device from **FIG. 8** with the vessel expanded;

[0040] **FIG. 10** shows the device according to **FIG. 9** with the vein pulled down over it;

[0041] **FIG. 11** shows the device according to **FIG. 10** with the needle carrier;

[0042] **FIG. 12** shows the device according to **FIG. 11** with a sutured vessel wall;

[0043] **FIG. 13** shows the device according to **FIG. 12** with the needle seats removed;

[0044] **FIG. 14** shows a set under the invention;

[0045] **FIG. 15** shows the schematic of a set under the invention during suturing of a vessel;

[0046] **FIG. 16** shows the set according to **FIG. 15** with the needle seats removed;

[0047] **FIG. 17** shows a needle seat cradle;

[0048] **FIG. 18** shows a section of the needle seat cradle from **FIG. 17** with the needle seat in place;

[0049] **FIG. 19** shows the cradle according to **FIG. 18** with two needle seats in place;

[0050] **FIG. 20** shows the cradle according to **FIG. 19** with needle seats placed one over the other;

[0051] **FIG. 21** shows a device for clipping the ends of sutures; and

[0052] **FIG. 22** shows another device for clipping sutures.

[0053] **FIG. 1** shows schematically the attachment of end-to-end anastomoses. **FIG. 1A** shows an artery **10** and a vein **11**. The vein **11** is a transplant which is to be joined to the artery **10**. Here, as in all the following illustrations, similar components are identified with similar reference numbers. In **FIG. 1B** an incision **12** has been made in the artery **10**. The end of the vein **11** has been cut on the diagonal so that a suitable opening **13** results, whose diameter approximately matches the diameter of the opening **12**. **FIG. 1C** shows how the two openings **12** and **13** of artery **10** and vein **11** are joined to each other and sutured, so that now an end-to-end anastomosis has been performed.

[0054] **FIG. 2** show a device under the invention, which can be used when creating anastomoses shown in **FIG. 1**. This device has a handle **1**, at the end of which a shoe **2** is formed as a needle carrier for needles. This shoe **2**, along with the needles disposed vertically on it, is covered by a needle cap **9**. Above the needle cap **9** there is a needle seat **3**, whose function will be explained later. In addition, sections of sutures **4** are shown, which are connected to the ends of the needles.

[0055] **FIG. 2B** shows the lower part of the device from **FIG. 2C** in an enlarged view in a lateral cross section. Again, the shoe **2** can be seen, on which needles **7** are standing vertically in a ring around a holder **20**. These needles **7** are connected to sutures **4** by the ends facing the shoe **2**. Above the points of the needles there is a sleeve **8**, which can be moved along the holder **20** by means of a sleeve linkage **23**. The entire arrangement of needles **7** and sleeve **8** is covered by a needle cap **9**, which can similarly be moved along the holder **20** by means of a linkage **21**, and in its lowered position provides a protective covering for the needles **7** and the sleeve **8**. Above this protective cover **9** there is needle seat **3**, which can similarly be moved along the holder **20** by a suitable mechanism which is not shown here.

[0056] **FIG. 2A** now shows in a cross section rotated by 90° to **FIG. 2B** a needle carrier **2**, which is inserted into an artery **10**. The needle carrier or shoe **2** was inserted into the artery **10** through a suitable incision not shown in the cross section and then, as shown in **FIG. 2A**, the needle cap **9** was raised. As a result, the needle points are now exposed inside the artery, but the rear wall of the artery is protected from the needles **7** by the shoe **2**.

[0057] Both the sleeve **8** and the needle cap **9** can be moved up or down by means of their corresponding linkages **23** or **21** through push buttons **5** or **6** on the handle **1**, as shown in **FIG. 2C**.

[0058] **FIG. 3** shows the same arrangement as in **FIG. 2B**, however in an external view of the artery **10**. It can be seen clearly here that the needle seat **3** can be separated into two, where the needle seat **3** can be moved along the holder rod **20** by means of the linkage **22**.

[0059] **FIG. 4** shows a similar view as in **FIG. 3**, where however the position of the individual parts corresponds to that in **FIG. 2A, i.e.** the needle cap **9** has been pulled off the shoe **2** out of the opening in the artery **10** by means of its linkage **21**.

[0060] **FIG. 5** shows the next step during the attachment of the anastomosis, where the sleeve **8** has been pushed between the needles and the holder linkage **20** by means of its linkage, so that the needles are now standing sideways at an angle and are spread out radially. If the shoe **2** is now pulled up, or the needle seat **3** is pushed down, the tips of the needles **7** are pressed through the wall of the artery **10** along the circumference of the incision and they come to a stop in the needle seat **3**. This is shown in **FIG. 6**, where following this position, the needle seat **3** can be withdrawn upward or opened, and the two halves of the needle seat **3***a* and **3***b* can be withdrawn laterally.

[0061] This is shown in **FIG. 7**, where it is can be seen that the needles are being removed together with the halves of the needle seat **3***a* and **3***b*, where they are pulling the sutures, here **4***a* and **4***b*, which are attached to them, through the suture holes.

[0062] Not all the sutures which come from the ends of the needles are shown in **FIG. 7** for the sake of clarity. But it must be made quite clear at this point that the end of each needle is provided with its own suture, which runs through the corresponding suture opening into the interior of the artery and then along the holder **20** and out of the incision.

[0063] With this step, the first half of the application of an anastomosis is concluded. Next comes the suturing of the opening of the vessel to be attached, for example, of a vein.

[0064] **FIG. 8** shows a suitable device, where, instead of a handle, a table stand **30** is being used, which has a center rod **31** as well as a needle carrier **32**, in which needles **37** are disposed in a circle around the center rod **31**. These needles **37** are connected at their ends to sutures **34**. It should be noticed that matching the diagonal cut at the opening of the vein, as shown in **FIG. 1**, the needle carrier is sloped in the same way.

[0065] **FIG. 9** shows the device from **FIG. 8**, where an installation aid or insertion aid **35**, which is enlarged in one section, is mounted over the central rod **31**. Alternatively, the insertion aid can be designed just to be dilatable, for example, by suitable inflation.

[0066] **FIG. 10** shows another section from a device in accordance with **FIGS. 8 and 9**, where a vein **11** is now pulled over the insertion aid **35**. The vein is now similarly greatly stretched in the enlarged section of the insertion aid, where the diameter of the vein in the stretched area is greater than the diameter of the needle arrangement with the needles **37**. In **FIG. 10** it can also be seen that one half **33***a* of a two-part needle seat is placed on the vein above the enlarged area.

[0067] In **FIG. 11** the needle seat **33** has been fully assembled from its two halves **33***a* and **33***b*.

[0068] In **FIG. 12** it can be seen that the needles are now being pushed axially along the center rod **31**, or the vein with the seat **33** is being pushed in the direction of the needles, so that the needle points pierce the vein wall from inside the vein and come to a stop in the seat **33**.

[0069] **FIG. 13** shows how the two parts of the needle seat **33***a* and **33***b* are pulled away upwards from the expanded part of the vein, whereby the sutures **34**, which are attached to the ends of the needles **37**, are pulled through the corresponding suture holes in the vein **11**. This pulls the corresponding sutures through the opening **13** of the vein, so that the two openings **12** or **13** of artery **10** or vein **11** respectively can now be joined to each other.

[0070] For this, **FIGS. 14A and 14B** once more show a holder corresponding to **FIG. 2** with a handle **1**, and in **FIG. 14B** the overall arrangement of shoe **2** with needles and sutures **4** and the table stand **30** with needles **37** and sutures **34**. As can be seen, the open ends of the sutures in both arrangements are attached to each other in each case. After the wall of both the artery and the vein have been pierced, the sutures **4** or **34** consequently run from outside the vein through a suture hole in the vein into the interior of the vein, from there into the interior of the artery and out again through a hole pierced in the wall of the artery.

[0071] **FIG. 14**C, and in a section from it **FIG. 14**D, show an alternative to the table stand **30**. Here the needle holder **32** with the needles **37** is attached to a handle **40**, where the handle ends in a tip over which the vein can be pulled in a suitable way. Installation aids or insertion aids, as described above, can be attached here.

[0072] **FIG. 15** shows the drawing in **FIG. 14B** in enlarged form. The sutures are shown in two examples **4***a*, **4***b* or **34***a*, **34***b* respectively. Otherwise the drawings correspond to the illustrations in **FIG. 4** or **12** respectively.

[0073] **FIG. 16** shows the illustration with the divided seat **3***a*, **3***b* or **33***a*, **33***b* respectively pulled back, where again only two sutures **4***a*, **34***a* or **4***b*, **34***b* respectively are shown as examples. Otherwise the illustration in **FIG. 16** corresponds to the illustrations from **FIG. 7** and **FIG. 13**.

[0074] **FIG. 17** shows a cradle **31** for the split needle seat from **FIG. 16**. This cradle **41** has slit-like openings **42**, the distance between which matches the distance between the sutures which come from the divided seats **3***a*, **3***b* or **33***a*, **33***b* respectively.

[0075] **FIG. 18** shows how one seat **33***b* is placed into the cradle **41**. The slit-like openings **42** here are designated by the reference numbers **42***a* through **42***e*, where only suture **34***b* which is running through slit **42***e*, is given a reference number.

[0076] **FIG. 19** shows how one half **3***b* of a needle seat and one half **33***b* of an additional needle seat are placed next to each other in the cradle **41**. In order to tie the ends of the respective sutures together correctly, the seat **33***b* is laid in a suitable way over the seat **3***b* (**FIG. 20**). As a result, the two ends of the same suture, shown for example as **4***b* and **34***b*, are automatically located in each of the slits **42**.

[0077] The ends of the sutures can be clipped together by means of a auxiliary instrument. **FIG. 21** shows such an instrument, where the entire instrument **45** with grip **46** and shaft **47** is shown in **FIG. 21**B, while **FIG. 21A** brings only the end of the shaft **47**. A clip holder **48**, which can hold up to five clips **49** is positioned at the end of the shaft **47**. With the aid of these clips **49** the specific suture ends can be attached to each other.

[0078] **FIG. 22** shows another auxiliary instrument **45**, which, however, has a clip holder for only one clip **49**. Instead, the instrument **45** from **FIG. 22** has a tong-like anvil **50**, so that two ends of the same suture can be clipped together in a simple fashion with this instrument **45**.

[0079] It must be noted in the case of the procedures under the invention that before the ends of the sutures are clipped together the sutures from the artery side and the transplant side are pulled tight, so that the opening in the vein lies completely and in a sealing manner on the incision in the artery. Then the sutures can be clipped together in this tightly approximated position.

[0080] As an alternative to an auxiliary instrument, such as the one shown in **FIGS. 20 and 21**, the ends of the sutures can, of course, be knotted in the conventional manner or other procedures such as adhesive bonding, thermal forming and similar methods can be employed. Clips made of nitinol (Coalescent Surgical Co., Inc.) can also be used.

[0081] In a further example, the instruments and devices presented could be designed as minimally invasive surgical instruments, so that it is not necessary to open the chest wall and the instrument is introduced into the body through small incisions, for example using a trocar.

[0082] In additional examples the handles **1** can also be designed in such a way that they can be manipulated by a robot. In this way, extensive automation of the suturing procedure would be possible.

[0083] In summary, it can be said that through the device under the invention, or through sets under the invention having two or more of such devices, at least one in each case for the artery side and one for the vein side, it is possible to join hollow organs together in a simple and safe manner.

What is claimed is:

1. Device with a lengthy holder for joining hollow organs,

a needle carrier, which is located at one end of the holder, where the needle seat forming an overhanging projection projects radially beyond the periphery of the holder, and

a plurality of needles which are disposed surrounding the holder standing vertical on the overhanging projection of the needle seat.

2. Device in accordance with the preceding claim, characterized by a device to deploy the needles at a predetermined angle to the axial direction of the holder in a radial direction.

3. Device in accordance with the preceding claim, characterized in that the device for deploying the needles in a radial direction is a sleeve which surrounds the holder and is movable in such a way between the needles and the holder that the needles are inclined outwards.

4. Device in accordance with one of the preceding claims, characterized in that adjacent to the holder and above the points of the needles an insertion aid is located for one of the hollow organs to be joined, extending radially beyond the particular needle adjacent to it or expandable in such a way that it extends radially beyond the particular needle adjacent to it.

5. Device in accordance with one of the preceding claims, characterized in that the insertion aid has radial notches or holes aligned in a straight line with the individual needles to permit passage of the individual needles.

6. Device in accordance with one of the preceding claims, characterized by a needle cap which covers the needles detachably.

7. Device in accordance with one of the preceding claims, characterized by a needle seat positionable above the needle points and surrounding the holder, which can be pushed onto the needle points or onto which the needle points can be pushed.

8. Device under one of the two preceding claims, characterized in that the needle cap and/or the needle seat can be separated and/or opened up along its periphery.

9. Device in accordance with the preceding claim, characterized in that the needle cap and/or the needle seat is can be divided into two parts along its periphery.

10. Device in accordance with one of the preceding claims, characterized by a retraction device to remove the needle cap from the needles and/or a motion device to move the sleeve between the needles and the holder and/or a pressure device to press the needle seat onto the needle points or the needle points onto the needle seat.

11. Device in accordance with the preceding claim, characterized in that the holder has controls to move the retraction device, the motion device and/or the pressure device.

12. Device in accordance with the preceding claim, characterized in that the controls have push buttons which are located at the opposite end of the handle to the needle holder.

13. Device in accordance with one of the preceding claims characterized in that a foot is located on the holder below the shoe.

14. Device in accordance with one of the preceding claims, characterized by a separate needle seat cradle for one or two needle seat.

15. Device in accordance with one of the preceding claims, characterized by a separate connecting device for attaching the ends of a suture.

16. Device in accordance with one of the preceding claims, characterized in that the specific ends of a suture can be joined by means of a clip using the connecting device.

17. Set with at least two devices in accordance with one of the preceding claims.

18. Set in accordance with the preceding claim, characterized in that in each case one end of a needle of one device is connected by a suture with one end of a needle of the other device.

19. Procedure to join a first opening in a hollow organ with a second opening in a second hollow organ,

characterized in that

a first array of needles is inserted into the first opening,

a second array of needles with the ends of the needles in front is inserted into the second opening,

where the end of each needle in the first array is connected to the end of a needle in the second array by means of a suture,

the needles of each array for each array are pushed jointly through the wall of the particular hollow organ along its opening with the needle points in front in each case, and subsequently the sutures are pulled tight and the two ends of each suture are tied together.

20. Procedure in accordance with the preceding claim, characterized in that the needles of one or both arrays are disposed in a ring.

21. Procedure in accordance with one of the two preceding claims, characterized in that the needles of at least one of the arrays, after being inserted into the opening of the hollow organ, are splayed out from each other with their points in a radial direction.

22. Procedure in accordance with one of the three preceding claims, characterized in that the opening of at least one hollow organ is expanded such that it can be slipped over one of the arrays of needles.

23. Procedure in accordance with one of the claims 19 to 22, characterized in that in order to push the needle points of at least one array through the wall of the hollow organ, a needle seat is pressed against the wall and the needle points on the side opposite the needle points, and/or the needle points are pushed against the wall and into a needle seat located on the opposite side to the needle points.

24. Procedure in accordance with one of the preceding claims, characterized in that the needle seat is pushed onto the needle points, or the needle points are pushed onto the needle seat in such a way that the needles remain embedded in the needle seat, and the needle seat is then pulled away from the wall of the hollow organ.

25. Procedure in accordance with one of the claims 19 to 24, characterized in that in conclusion the ends of the sutures are detached from the needles and attached, for example, knotted, clipped, bonded or laser welded.

26. Use of a device, a set and/or a procedure in accordance with one of the preceding claims for joining hollow organs, in the field of vascular surgery for connecting vessels, in particular in by-pass surgery on the heart and for the treatment of stenoses, occlusions, strictures and thromboses in peripheral arteries and in surgery of the gastrointestinal tract.

27. Use in accordance with the preceding claim in minimally invasive and endoscopic surgery.

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