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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
8 January 2004 (08.01.2004)

PCT

(10) International Publication Number
WO 2004/002573 A1

(51) International Patent Classification[7]: A61N 1/362

(21) International Application Number: PCT/US2003/018111

(22) International Filing Date: 9 June 2003 (09.06.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10/184,481 26 June 2002 (26.06.2002) US

(71) Applicant: **KRITON MEDICAL, INC.** [US/US]; 3351 Executive Way, Miramar, FL 33025 (US).

(72) Inventors: **YU, Long, Sheng**; 10214 NW 54 Place, Coral Springs, FL 33076 (US). **PIFERI, Peter**; 6040 SW 13th Street, Plantation, FL 33317 (US). **PARNIS, Steven, M.**; 19200 Space Center Blvd., Unit 28, Houston, TX 77058 (US).

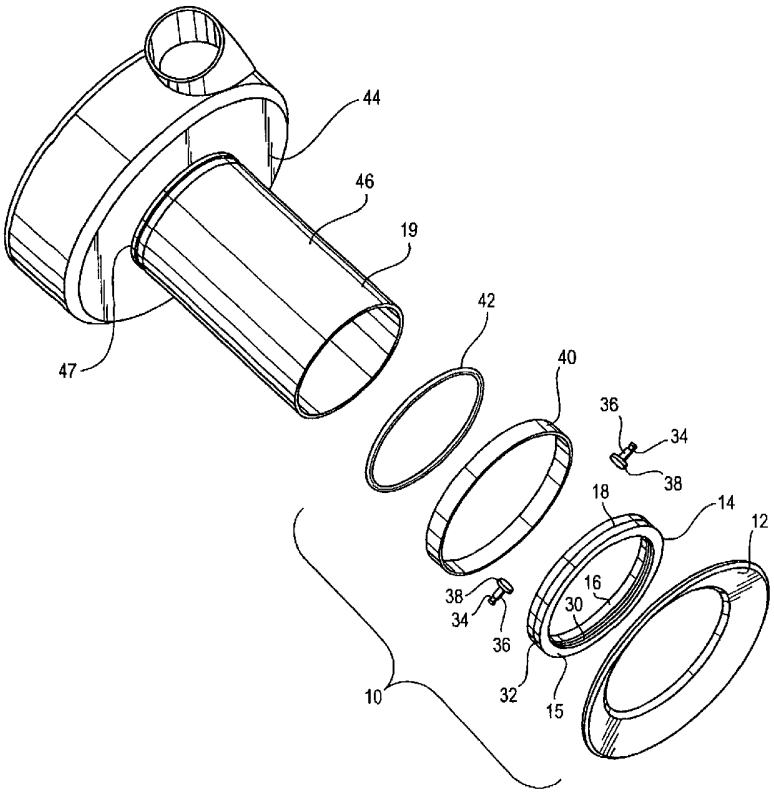
(74) Agent: **GERSTMAN, George, H.**; Seyfarth Shaw, Suite 4300, 55 East Monroe Street, Chicago, IL 60606 (US).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: VENTRICULAR CONNECTOR



(57) Abstract: A ventricular apex connector (10) for quick connection and disconnection of an inflow tube (19) of a ventricular assist device, comprising a sewing ring (12), a cylindrical ring (14), a spring ring (40) and a sealing O-ring (42) is provided. The cylindrical ring (14) defines two openings, diametrically opposed to each other, in its walls. Gripping pins (34), comprising rods (36) with gripping pads (38), are placed in the openings in the cylindrical ring (14) so that the gripping pads (38) are at rest within the inner circumference of the cylindrical ring (14) and the rods (36) of the gripping pads (38), which extend out of the outer wall (18) of the cylindrical ring (14), are welded to the spring ring (40). The gripping pins (34) are thus biased towards each other by the force of the spring ring (40). When the spring ring (40) is squeezed, at points away from the gripping pin (34) connection points, the deformation of the spring ring (40) causes the gripping pads (38) to be pulled out towards the inner wall (16) of the cylindrical ring (14). An inflow tube (19) of a heart pump may then be inserted into the ventricular apex connector (10), and upon the release of the spring ring (40), the inflow tube (19) is sealedly held within the ventricle of the heart. In an embodiment, the inflow tube (19) may include an inner sleeve that is slidably and retractably mounted therein. The inflow tube may have a bend at an end.

WO 2004/002573 A1

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

VENTRICULAR CONNECTOR

FIELD OF THE INVENTION

The present invention concerns a connector to allow an inflow tube of a blood pump to be securely fastened to the heart.

BACKGROUND OF THE INVENTION

Clinical application of ventricular assist devices to support patients with end-stage heart disease as a bridge to cardiac transplantation or as an end stage therapeutic modality has become an accepted clinical practice in cardiovascular medicine. It is estimated that greater than 35,000 persons suffering from end stage cardiac failure are candidates for cardiac support therapy.

Currently, several ventricular assist devices are used clinically, and several more are undergoing development. In most of these devices, blood enters the device via an inflow tube, which is placed within the ventricular cavity. A sewing ring is usually attached to the ventricular apex of the heart and an inflow tube of a blood pump is inserted through the sewing ring and into the ventricle. The blood pump is then secured to the sewing ring by placing a ligature, or tie, around the inflow tube of the pump and the sewing ring and tightening them together. A nylon band can also be placed around the sewing ring collar and tightened down on the inflow tube. By this method an adequate seal can be made and the pump and inflow tube are held in place. However, this method makes it very difficult to change the orientation of the inflow tube, or if necessary, to remove the inflow tube from the ventricle. Additionally, placing and tightening a nylon band and ligatures around the inflow tube can be difficult and comprises extra steps in the implant process.

Presently, there are some connection devices that use multiple screw type connectors, for ventricular assist devices on the outflow side. On the inflow side, the ligature tie method and devices have generally been used as well as some screw type connection devices. With total artificial hearts, various screw type devices, twist-lock devices, and snap on connectors have been used. All of these connectors have the disadvantage of requiring the use of two hands to install. Further, in the area where these devices must be installed, space is very limited and installation of these devices is difficult.

It is therefore an object of the present invention to provide an easy to use quick connect and disconnect device for connecting a tube to a patient's heart.

It is another object of the present invention to provide a device that provides a seal in the connection of a tube to a heart and allows for easy rotation of the orientation of a tube of a blood pump, after insertion into a heart.

It is a further object of the present invention to provide an adapter sleeve for attachment to a tube of a blood pump in order to accommodate different sized hearts and pumps.

Other objects and advantages of the present invention will become apparent as the description proceeds.

SUMMARY OF THE INVENTION

In accordance with the present invention, a connector for connecting an inflow tube of a ventricular assist device to a heart is provided. The connector comprises a first member for attachment to a heart, a gripping member adapted for receiving the inflow tube, the gripping member being adapted for coupling to the first member. A second member is provided, for enabling hand manipulation of the gripping member, to permit an operator to open the gripping member to enable the inflow tube to be received and gripped by the gripping member.

In the illustrative embodiment, the connector of the present invention is designed to be attached to the ventricular apex of a heart. The first member is a sewing ring adapted to be sewed to the heart. The gripping member comprises a cylindrical ring defining two openings in its wall, diametrically opposed to each other, through which gripping rods are disposed. A gripping head, which comprises a titanium metal pad having grip teeth to assist in holding, is coupled to each gripping rod such that the gripping head is disposed within the area defined by the cylindrical ring.

In the illustrative embodiment the second member is a spring ring, composed of titanium, which surrounds the cylindrical ring in a concentric ring relationship. The gripping rods are attached to the spring ring and the gripping heads are, as a result, biased towards each other and the center of the area defined by the cylindrical ring, when the spring ring is in a first, at rest, position. The gripping rods, which are also made of titanium, are attached to the spring ring by welding. When the spring ring is

squeezed, at points away from the points of connection of the gripping pins, the deformation of the spring ring causes the gripping pins to be pulled back allowing an inflow tube of a ventricular assist device to be inserted into the connector. Releasing the spring ring causes the gripping pins to move towards their first position until they engage the inflow tube. Further squeezing of the spring ring causes the release of the gripping pins from the inflow tube to allow the inflow tube to be adjusted, manipulated or withdrawn.

In the illustrative embodiment, an O-ring seal is provided for insertion into a groove in the cylindrical ring. The O-ring may be installed in the cylindrical ring so as to form a leak proof seal between the inflow tube and the ventricle apex connector. In the illustrative embodiment, the inflow tube of the ventricular assist device is provided with a textured surface to facilitate the gripping of the tube by the gripping members.

In an alternate embodiment a ventricular assist device for a heart is provided which comprises a pump portion, an inflow tube protruding from the pump portion and an adapter sleeve of a first predetermined length attached to the inflow tube forming an extended inflow tube having a total length greater than the first predetermined length. The adapter sleeve may include a first end having a coupling in order to attach the adapter sleeve to a ventricular apex of a heart. The adapter sleeve may have the coupling attached to a sewing ring that is attached to the ventricular apex. The adapter sleeve may be formed of a smooth cylinder of titanium. The adapter sleeve may include cylindrical grooves forming perforations on the surface of the sleeve wherein the sleeve may be separated along said grooves. The adapter sleeve may be formed of ceramic. The adapter sleeve may include a gripping member for attaching the extended inflow tube to the ventricular apex.

In a further alternate embodiment an inflow tube includes a bent end, an extendable end and/ or a rotatable end. The inflow tube may include an inner sleeve that is rotatably and slidingly mounted therein in order to allow for the positioning of the tube in variable locations in the assisted organ.

A more detailed explanation of the invention is provided in the following description and claims and is illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of a ventricular apex connector made in accordance with the present invention.

Figure 2 is a perspective view of the cylindrical ring of the ventricular apex connector of Figure 1.

Figure 3 is an exploded view of the ventricular apex connector of Figure 1, in relationship to a blood pump.

Figure 4 is a perspective view of a ventricular apex connector made in accordance with the present invention attached to a blood pump.

Figure 5 is a perspective view of a heart to which a device made in accordance with the present invention has been attached.

Figure 6 is a plan view of an alternate embodiment of the present invention with an adapter sleeve.

Figure 7 is a sectioned view of an alternate embodiment of a flexible inflow tube.

DETAILED DESCRIPTION OF THE ILLUSTRATIVE EMBODIMENT

Referring to the drawings, Figure 1 shows a ventricular apex connector 10 having a sewing ring 12 and a cylindrical ring 14. Sewing ring 12 may be formed of fabric, such as polyester velour or other types of polyester material, expanded polytetrafluoroethylene (EPTFE) or other such fabrics which are well known in the art. Sewing ring 12 is adapted for attachment to the ventricular apex of the heart by surgical stitching, stapling or adhesives.

As can be seen in Figure 2, cylindrical ring 14 comprises a tube 15 having an inner wall 16 and an outer wall 18. Inner wall 16 is of a diameter slightly larger than the outer diameter of an inflow tube 19 of a ventricular assist device 44 (Figure 3) which is to be connected to a heart 52 (Figure 5). Cylindrical ring 14 defines openings 20 and 22 through tube 15. Openings 20 and 22 are defined, in the illustrative embodiment, generally in positions diametrically opposed to each other. It is to be understood, however, that openings 20 and 22 may be defined in numerous other positions, in other than diametric opposed relation to each other, without departing from the novel scope of the present invention. The utility of openings 20 and 22 will be discussed in detail below.

Inner wall 16 of cylindrical ring 14 defines two generally U-shaped cutouts 26, in tube 15, about openings 20 and 22. Inner wall 16 further defines a sealing groove 30, in which an O-ring 42 (Figure 3) is inserted. Outer wall 18 defines a sewing ring groove 32 to facilitate connection of cylindrical ring 14 to sewing ring 12. Sewing ring 12 may be connected to cylindrical ring 14 in any conventional manner, such as screwing or pressure fit. In the illustrative embodiment, cylindrical ring 14 is constructed of titanium, but it is to be understood that cylindrical ring 14 may be made of any other metal, plastic or other rigid material, without departing from the novel scope of the present invention.

Referring again to Figure 1, gripping pins 34, comprising rods 36 and gripping pads 38, extend through openings 20 and 22 of cylindrical ring 14, such that gripping pads 38 fit into cutouts 26. A spring ring 40 (Figure 3), having a diameter larger than the diameter of cylindrical ring 14, is placed concentrically to cylindrical ring 14. Spring ring 40 is preferably constructed of titanium but may be made of any elastic material that maybe temporarily deformed and subsequently returns to its original cylindrical shape. Rods 36 of gripping pins 34 are attached to spring ring 40. In the illustrative embodiment, rods 36 and gripping pins 34 are constructed of titanium, but it is to be understood that various other materials, such as steel, aluminum, or other metal or plastic materials may be used without departing from the novel scope of the present invention. Further, in the illustrative embodiment, gripping rods 36 are welded to spring ring 40. However, it is to be understood that any means of permanent attachment, including the use of adhesives or fasteners such as rivets or screws, may be used to attach gripping pins 34 to spring ring 40. When spring ring 40 and gripping pins 34 are attached together, gripping pins 34 are biased towards each other by spring ring 40.

An O-ring 42 is placed within sealing ring 30, of tube 15, to provide a generally leak proof seal. O-ring 42 is constructed of an elastic sealing material.

In the operation of the illustrative embodiment of a ventricular apex connector 10, when ventricular assist device 44 having inflow tube 46 and an outlet port 45 is to be associated with a heart 52, sewing ring 12 is secured to the ventricular apex 50 of a heart 52, as shown in Figure 5. Spring ring 40 is squeezed, preferably at locations 48 (Figure 1) on the circumference of spring ring 40, causing spring ring 40 to be

deformed such that gripping pins 34 are pulled away from each other, into cutouts 26 of cylindrical ring 14. Inflow tube 46, of ventricular assist device 44, may then be inserted into cylindrical ring 14. When inflow tube 46 has been placed in the desired location within heart 52, spring ring 40 may be released, causing gripping pins 34 to move towards each other until gripping pads 38 contact inflow tube 46, at surface 47. In the illustrative embodiment surface 47 is textured to provided assistance in forming a tight friction fit between gripping pins 34 and the walls of inflow tube 46. Sealing is provided by O-ring 42. Gripping pads 34 hold the inflow tube securely, such that the body of ventricular assist device 44 is pressed tightly against the top of connector 10. Figure 5 further shows that ventricular assist device 44 is in communication with heart 52, through a collapsible conduit 47 which communicates between outlet port 46 and the aorta 54 by means of a sutured connection 56.

If repositioning (such as for a change of orientation) or removal of inflow tube 46 is desired, spring ring 40 may be squeezed, again, at points 48, so that inflow tube 46 is released by gripping pins 34. Upon completion of removal of inflow tube 46, or its repositioning, spring ring 40 may again be released.

It can be seen that a novel device has been provided that allows for the quick installation of a flow tube to the heart, or other organ. The illustrated embodiment of the present invention enables the connection of an inflow tube using one hand. The present invention provides a seal so that leaking does not occur and enables the quick removal of the inflow tube and permits the easy change of orientation of the inflow tube.

Figure 6 discloses and alternate embodiment of the present invention. A ventricular assist device 144 is provided having an inflow tube 146 and mounted thereon is a cylindrically-shaped adapter sleeve 160. A sewing ring 112 is provided that is adapted for attachment to the ventricular apex of the heart by surgical stitching, stapling or adhesives and is attached to a first end 161 of the sleeve adapter 160 via a bayonet type coupling. Other means of attaching the sleeve 160 to the sewing ring 112 may also be provided such as by threaded interior and exterior surfaces, fasteners or adhesives. The sewing ring 112 in an embodiment may be formed of fabric having a hard center portion of metal or polymer material to which the sleeve 160 is secured.

The adapter sleeve 160 may be formed of metal such as titanium. As

discussed above the sleeve 160 is attached to the ventricular apex of the heart via the sewing ring 112. The adapter sleeve 160 may also be attached to the inflow tube 146 by mechanical means such as a bayonet type coupling, interference fit, threaded coupling or with fasteners. The attachment means may include an adjustable member to cause the sleeve 160 to extend or retract from the end of the inflow tube 146. The adapter sleeve 160 allows for the inflow tube 146 to be manufactured having a consistent length regardless of its application. For example, the width of the wall of the ventricle of the heart may vary by 8 mm to18 mm from patient to patient. By use of the adapter sleeve 160, no modification of the inflow tube 146 is necessary. Having different sized adapter sleeves 160 available allows for variation in its attachment to the ventricular apex. For example, by extending the adapter sleeve 160, the device 144 and inflow tube 146 may be oriented at an angle offset from a perpendicular position with respect to the surface of the ventricle in order to maximize fluid flow. Such modification of the assist device 144 could be accomplished ahead of time or during the surgical implantation of the device, where the surgeon has multiple sizes of adapter sleeves 160 available depending on the thickness of the ventricular wall and also the space between the heart and other organs that is available for the assist device 144. The adapter sleeve 160 may have a first predetermined length from 15 mm. to 35 mm. The sleeve 160 is attached to the inflow tube and forms an extended inflow tube assembly having a total length greater than the first predetermined length of the sleeve 160. For example, in a preferred embodiment the total length of the extended inflow tube is 15 mm or less. The adapter sleeve 160 may also function as a receiver or extender. In such a way the adapter sleeve 160 may insure that the inflow tube 146 combined with the adapter sleeve 160 is the proper length to avoid in growth, stagnant blood or obstruction from other areas of the heart.

As well, the adapter sleeve 160 may include in an embodiment a crowned top having apertures 171 forming troughs 173 and crests 175 so that blood flow is not impeded if the end of the sleeve 160 abuts against a tissue or opposite wall of the heart. Other embodiments may include holes formed near the upper edge of the sleeve 180. As well, such a crowned top or holes may provide on the inflow tube 146 or 46 of the previous embodiments not having an adapter sleeve or at end 252 of the

embodiment of figure 7. The number, width and depth of the crests may vary in accordance with the desired blood flow rate.

In an alternate embodiment, the sleeve 160 may be attached directly to the ventricular apex of the heart. In a further alternate embodiment the sleeve 160 may have cylindrical grooves or perforations axially spaced along the sleeve 160 to allow for each axial section to be peeled away in order to shorten the length of the sleeve 160. Such a sleeve 160 could be formed of a ceramic material that can be manipulated and separated without special tools. In this way, only a single sleeve need be present during an implantation procedure and upon determination of the proper size of the sleeve, modification may be effected on the spot. In another alternate embodiment, the adapter sleeve 160 may be combined with the above discussed gripping member or spring ring 40.

Turning to Figure 7, an alternate embodiment of the invention is depicted. An inflow tube 246 is provided having a first end 251 and a second end 252. The inflow tube may be formed of a metal such as titanium. The tube 246 includes an inner sleeve 255 that may be formed of metal such as titanium. The inner sleeve 255 is attached to the tube 246 via fastener 256 such as an O-ring that allows for the inner sleeve 255 to be rotatably and slidingly secured within the inner diameter of the tube 246. In an embodiment the tube is formed having a bend at its first end 252 which may be attached to the heart by a sewing ring, for example.

The first end 252 is inserted into the ventricle of the heart, or other assisted organ. The tube 246 may be rotated so that during an operation the insertion and attachment of the bent end 252 of the tube 246 to the heart can be accomplished more easily and also so that modifications may be made to the orientation of the tube in order to increase the flow rate. A surgeon may desire to locate the inflow tube at a location on the left ventricle, for example, where the highest rate of blood flow will occur. Once the inflow tube 246 is positioned with the inner sleeve 255 extended and rotated to its preferred position the assembly may be locked in position with a locking mechanism 258 such as a screw or other fastener. For example, in an embodiment a screw 258 may be tightened with a finger or screw driver in order to apply sufficient pressure against the wall of the inner sleeve 255 so that it is frictionally secured within the tube 246. As well, since each patient's assisted organ may be of slightly

different size and shape, the flexible inflow tube 246 allows for accommodation of such variances when mounting the pump which is attached at the second end 251 of the inflow tube 246.

Although illustrative embodiments of the invention have been shown and described, it is to be understood that various modifications and substitutions may be made by those skilled in the art without departing from the novel spirit and scope of the invention.

WHAT IS CLAIMED:

1. A connector for connecting an inflow tube of a ventricular assist device to a heart, which comprises:

a first member for attachment to a heart;

a gripping member adapted for receiving said inflow tube, said gripping member being adapted for coupling to said first member;

a second member for enabling hand manipulation of said gripping member, to permit an operator to open the gripping member to enable said inflow tube to be received and gripped by said gripping member.

2. The connector of claim 1, wherein said first member is adapted to be attached to the ventricular apex of a heart.

3. The connector of claim 1, wherein said first member is a sewing ring adapted to be sewn to a heart.

4. The connector of claim 1, wherein said gripping member comprises a cylindrical ring defining at least one opening, a gripping rod disposed in said opening, and a gripping head coupled, within the area defined by said cylindrical ring, to said gripping rod.

5. The connector of claim 1, wherein said second member comprises a spring ring surrounding said gripping member in concentric relationship.

6. The connector of claim 4, wherein said second member comprises a spring ring surrounding said gripping member in concentric relationship, said spring ring being coupled to each gripping rod such that each gripping head is biased towards the center of the area defined by said cylindrical ring when said spring ring is at a first position.

7. The connector of claim 1, wherein said gripping member comprises a cylindrical ring defining two or more openings, a gripping rod disposed through each of said openings, and a gripping head coupled, within the area defined by said cylindrical ring, to each of said gripping rods.

8. The connector of claim 7, wherein said second member comprises a spring ring surrounding said gripping member in concentric relationship, said spring ring being attached to each of said gripping rods, such that said gripping heads are

biased towards the center of said cylindrical ring in a first position, and are pulled towards the inner wall of said cylindrical ring when said spring ring is compressed.

9. The connector of claim 8, wherein said cylindrical ring defines two openings, diametrically opposed to each other, and compression of said spring ring, at points away from the attachment points of said gripping rods, causes said gripping heads to be pulled towards the inner wall of said cylindrical ring.

10. A connector for connecting an inflow tube of a ventricular assist device to a heart, which comprises:

a first member for attachment to the ventricular apex of a heart;

a gripping member, adapted for connection to said first member, comprising a cylindrical ring defining two or more openings, gripping rods disposed through each of said openings, and a gripping head coupled, within the area defined by said cylindrical ring, to each gripping rod, said gripping member adapted for receiving said inflow tube;

a second member, comprising a spring ring surrounding said gripping member in concentric relationship, said spring ring being coupled to each gripping rod such that each gripping head is biased towards the center of the area defined by said cylindrical ring when said spring ring is at a first, at rest, position;

said second member enabling hand manipulation of said gripping member, to permit an operator to open the gripping member, by compressing said spring ring, to enable said inflow tube to be received by said gripping member, and gripped by said gripping member when said spring ring is released.

11. The connector of claim 10, wherein said first member is a sewing ring adapted to be sewn to a heart.

12. The connector of claim 10, wherein said cylindrical ring defines two openings, diametrically opposed to each other, and compression of said spring ring, at points away from the attachment points of said gripping rods, causes said gripping heads to be pulled towards the inner wall of said cylindrical ring.

13. The connector of claim 10, wherein said gripping pads are formed of titanium.

14. A method for connecting an inflow tube of a blood pump to the heart, which comprises the steps of:

attaching a first member to a heart;

connecting to said first member a gripping member;

providing a second member for manipulating said gripping member;

operating said second member to open said gripping member to enable the inflow tube to be received and gripped by said gripping member.

15. The method of claim 14, including the step of attaching said first member to the ventricular apex of a heart.

16. The method of claim 14, wherein said first member is a sewing ring adapted to be sewn to a heart.

17. The method of claim 14, including the steps of providing a gripping member which comprises a cylindrical ring defining at least one opening, providing a gripping rod disposed in each defined opening, and providing a gripping head coupled to each gripping rod.

18. The method of claim 14, including the step of providing a second member comprising a spring ring surrounding said gripping member in concentric relationship.

19. The method of claim 17, including the steps of providing a second member comprising a spring ring surrounding said gripping member in concentric relationship, and coupling said spring ring to each gripping rod such that each gripping head is biased towards the center of the area defined by said cylindrical ring when said spring ring is at a first, at rest, position.

20. The method of claim 17, including the steps of providing a second member comprising a spring ring surrounding said gripping member in concentric relationship, and attaching said spring ring to each of said gripping rods, such that said gripping heads are biased towards the center of said cylindrical ring in a first, at rest position, and are pulled towards the inner wall of said cylindrical ring when said spring ring is compressed.

21. The method of claim 20, including the step of providing a cylindrical ring which defines two openings, diametrically opposed to each other, such that compression of said spring ring, at points away from the attachment points of said gripping rods, causes said gripping heads to be pulled towards the inner wall of said cylindrical ring.

22. A method for connecting an inflow tube of a ventricular assist device to a heart, which comprises the steps of:

attaching a first member to the ventricular apex of a heart;

connecting said first member to a gripping member, comprising a cylindrical ring defining two or more openings, gripping rods disposed through each of said openings, and a gripping head coupled to each gripping rod, said gripping member adapted for receiving said inflow tube;

providing a second member, said second member comprising a spring ring surrounding said gripping member in concentric relationship, said spring ring being coupled to each gripping rod such that each gripping head is biased towards the center of the area defined by said cylindrical ring when said spring ring is in a first, at rest, position;

compressing said spring ring, such that each gripping head is drawn towards the walls of said cylindrical ring, enabling said inflow tube to be received through said gripping member and first member into a heart, and releasing said spring ring such that said inflow tube is gripped by each gripping head as said spring ring returns towards its first, at rest, position.

23. The method of claim 22, wherein said first member is a sewing ring.

24. The method of claim 22, including the step of providing a cylindrical ring which defines two openings, diametrically opposed to each other, such that compression of said spring ring, at points away from the attachment points of said gripping rods, causes said gripping heads to be pulled towards the inner wall of said cylindrical ring.

25. The method of claim 22, including the step of attaching an adapter sleeve to said inflow tube.

26. The method of claim 22, wherein the inflow tube includes a bent end.

27. The method of claim 22, wherein the inflow tube includes an extendable end.

28. The method of claim 22, wherein the inflow tube includes a rotatable end.

29. The method of claim 22, further including the steps of mounting the

inflow tube, extending the inflow tube and rotating the inflow tube in order to provide an optimal flow rate.

30. A ventricular assist device for a heart, which comprises:

a pump portion;

an inflow tube protruding from the pump portion; and

an adapter sleeve of a first predetermined length attached to the inflow tube forming an extended inflow tube having a total length greater than the first predetermined length.

31. The adapter sleeve of claim 30 including a first end having a coupling in order to attach the adapter sleeve to a ventricular apex of a heart.

32. The adapter sleeve of claim 31 wherein the coupling attaches to a sewing ring that is attached to the ventricular apex.

33. The adapter sleeve of claim 30 wherein the adapter sleeve is formed of a smooth cylinder of titanium.

34. The adapter sleeve of claim 30 including cylindrical grooves forming perforations on the surface of the sleeve wherein the sleeve may be separated along said grooves.

35. The adapter sleeve of claim 34 wherein the sleeve is formed of ceramic.

36. The adapter sleeve of claim 30 further including a gripping member for attaching the extended inflow tube to the ventricular apex.

37. The ventricular assist device claim 30 wherein the inflow tube includes a bent end.

38. The ventricular assist device of claim 30 wherein the inflow tube includes an extendable end.

39. The ventricular assist device of claim 30 wherein the inflow tube includes a rotatable end.

40. The ventricular assist device of claim 30 wherein the inflow tube includes an inner sleeve that is rotatably and slidingly mounted therein.

41. A ventricular assist device for a heart, which comprises:

a pump portion;

an inflow tube protruding from the pump portion; and

an adapter sleeve of a first predetermined length attached to the inflow tube forming

an extended inflow tube having a total length greater than the first predetermined length including a first end having a coupling in order to attach the adapter sleeve to a sewing ring that is attached to the ventricular apex of a heart and the adapter sleeve is formed of a smooth cylinder of titanium.

42. The ventricular assist device of claim 41 wherein the inflow tube includes an inner sleeve that is rotatably and slidingly mounted therein.

FIG. 1

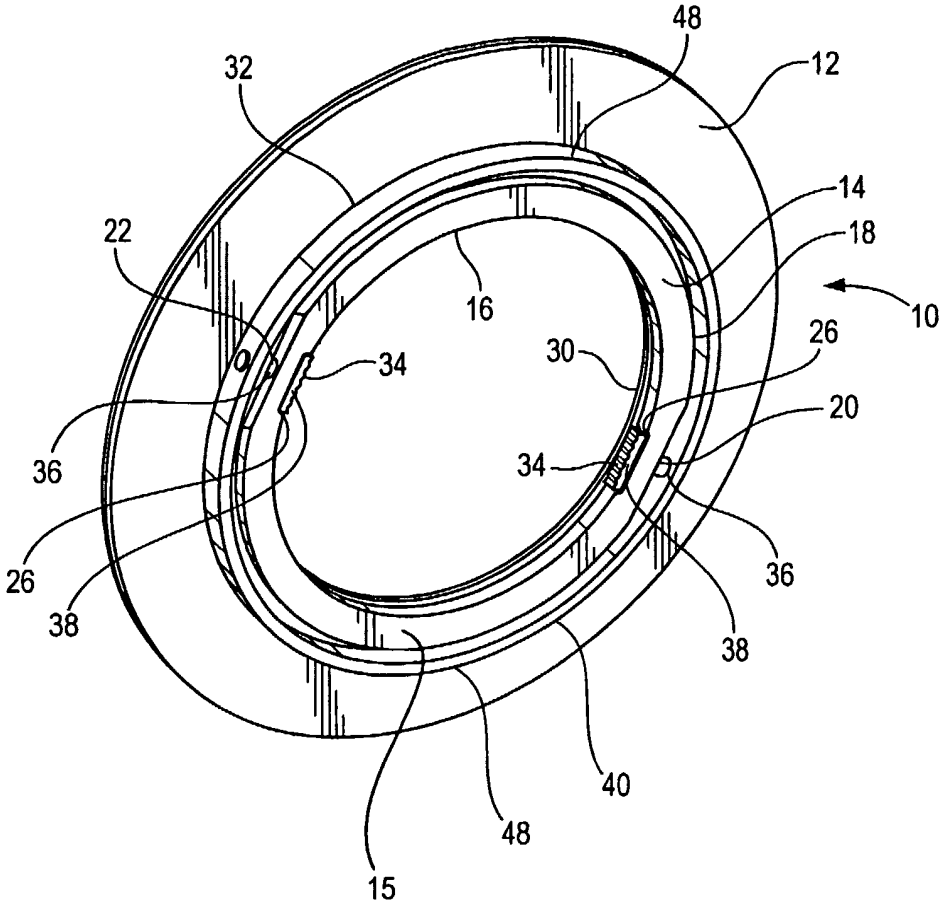

48
12
32
14
22
18
16
10
26
30
34
20
36
34
36
26
38
38
40
48
15

FIG. 2

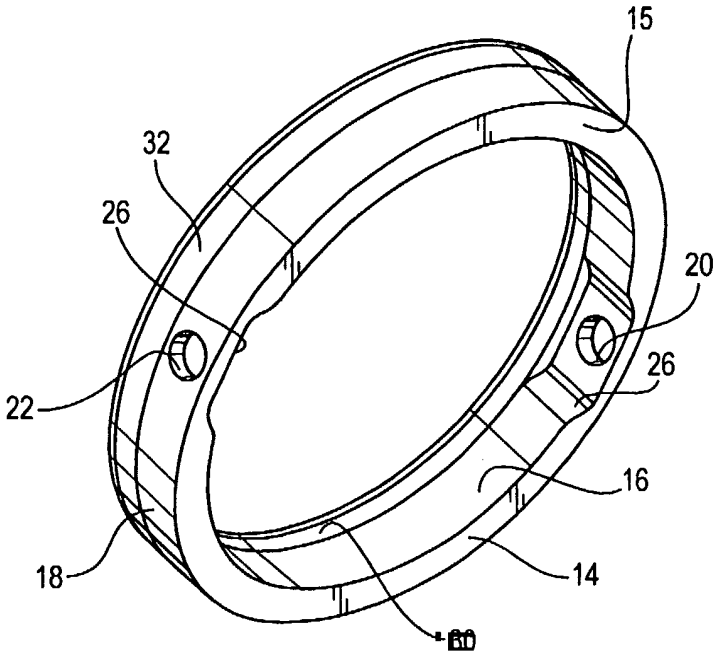

15
32
26
20
22
26
16
18
14
60

FIG. 3

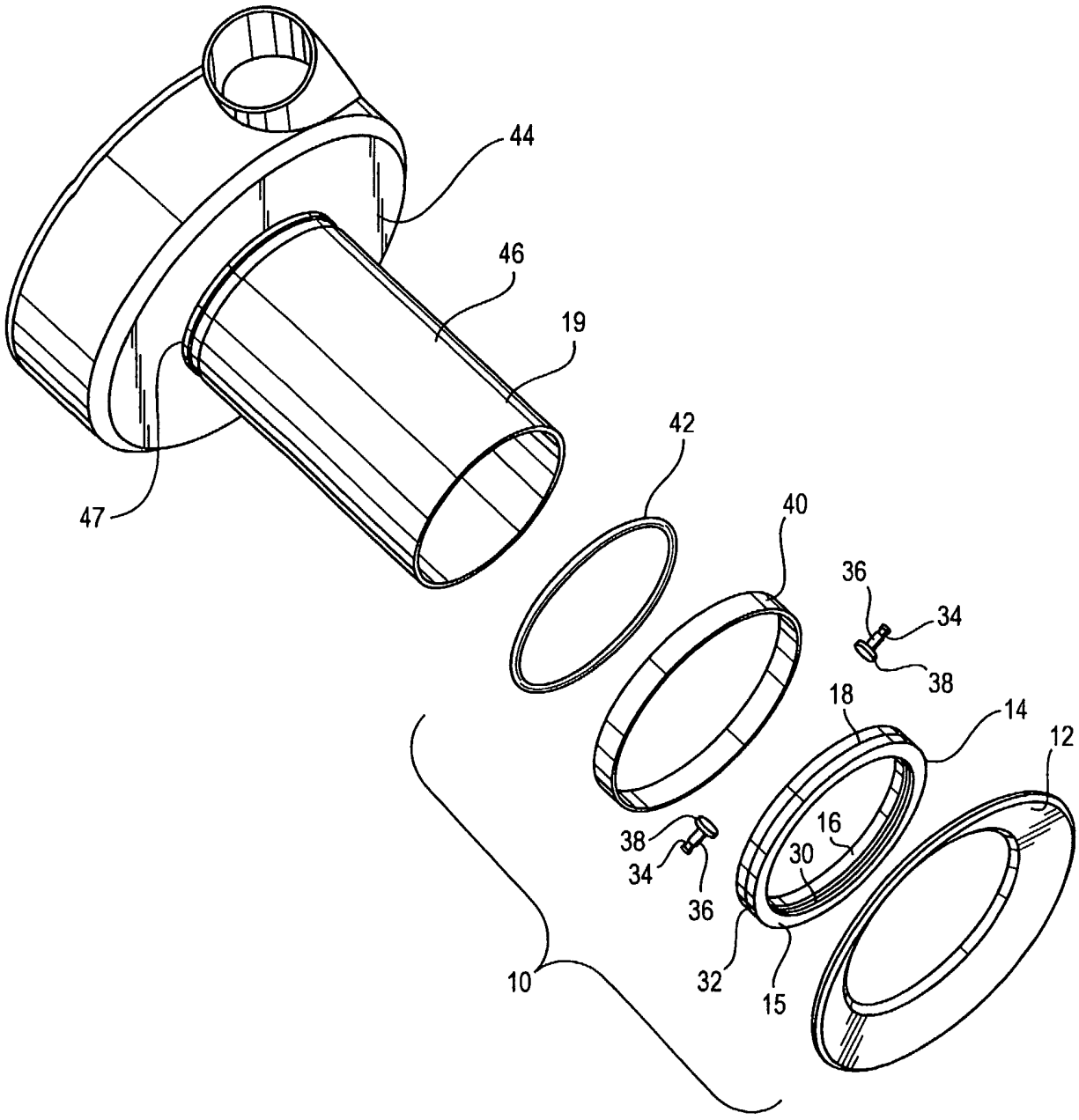


FIG. 4

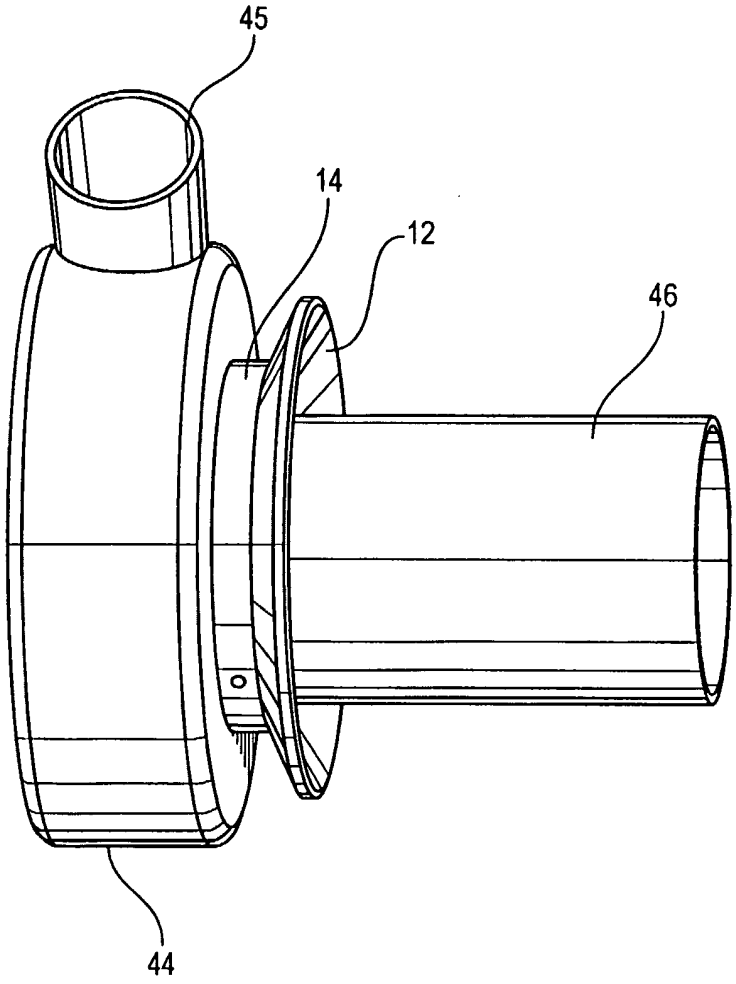


Fig. 5

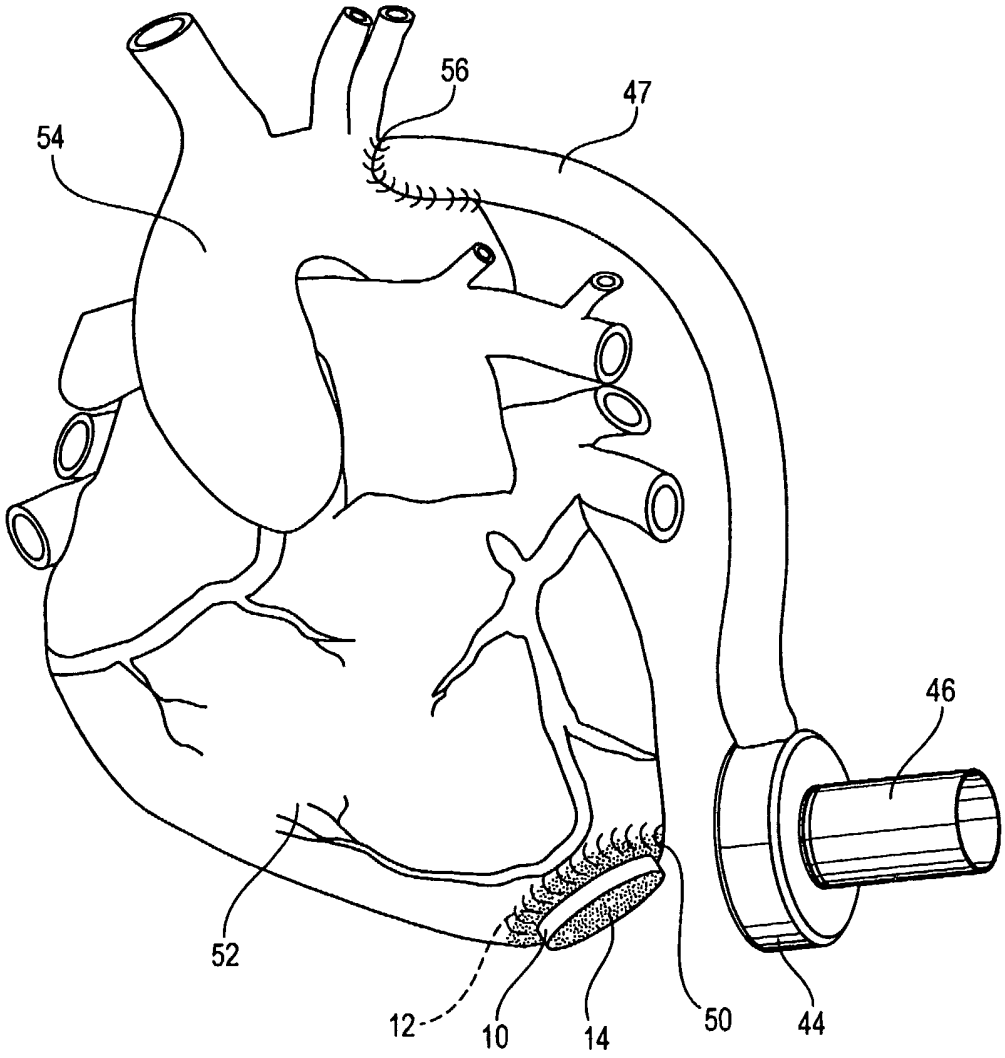


FIG. 6

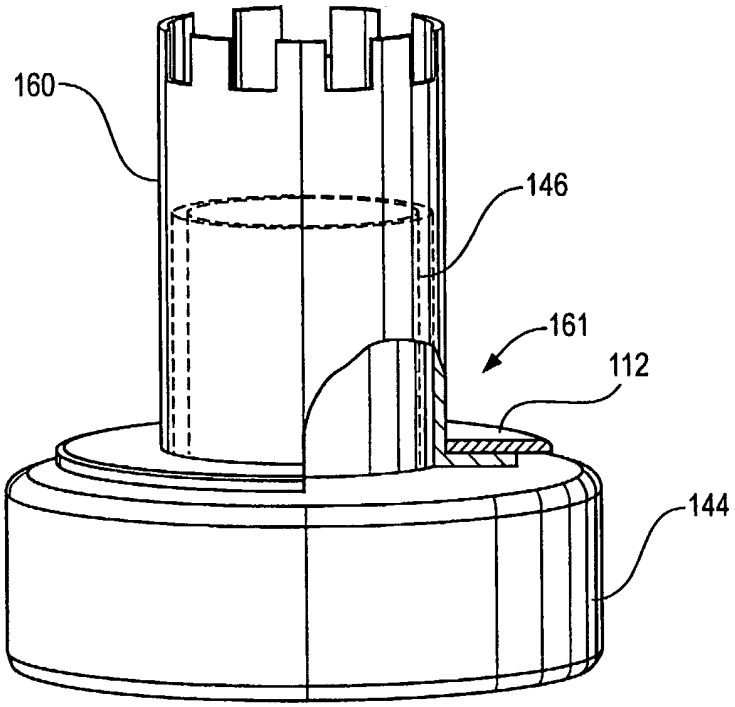
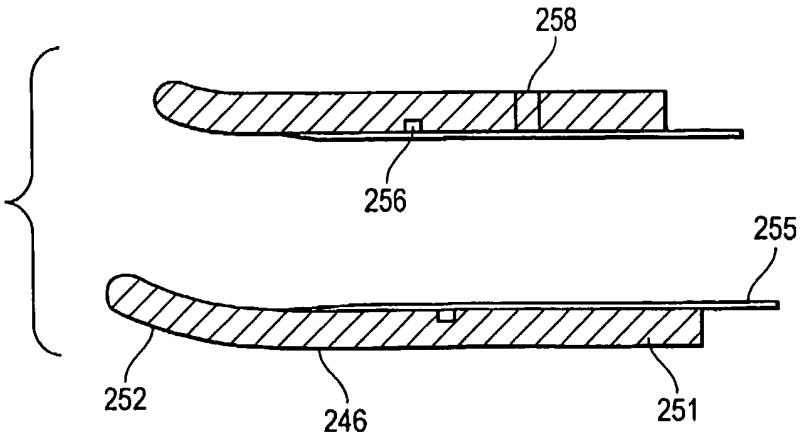


FIG. 7



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US03/18111

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : A 61 N 1/362
US CL : 600/16

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)
U.S. : 600/16, 17; 623/3.1, 3.26, 3.3

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 5,810,708 A (Woodard et al) 22 September 1998 (22.09.1998) Figs. 1 and 3	1, 2, 14, 15 --- 3, 16
Y	US, 6,001,056 A (Jassawalla et al) 14 December 1999 (14.12.1999) column 6, lines 45-46	3, 16
X --- Y	US 5,613,935 A (Jarvik et al) 25 March 1997 (25.03.1997) colum 7, lines 27-41 and Figs. 1-10	30-32, 36, 37 --- 33-35, 38-42

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 July 2003 (30.07.2003)	02 OCT 2003
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (703)305-3230	Authorized officer Angela Sykes Telephone No. (703) 308-0858

Form PCT/ISA/210 (second sheet) (July 1998)