United States Patent [19]

Buselmeier

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[45] **July 30, 1974**

[54] **PROSTHETIC SHUNT**

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[52] **U.S. Cl.** ..... **128/214 R,** 128/348, 128/334 R

[51] **Int. Cl.** **A61m 05/00**

[58] **Field of Search** ..... 128/214 R, 214 B, 214.2, 128/334 R, 348, 350

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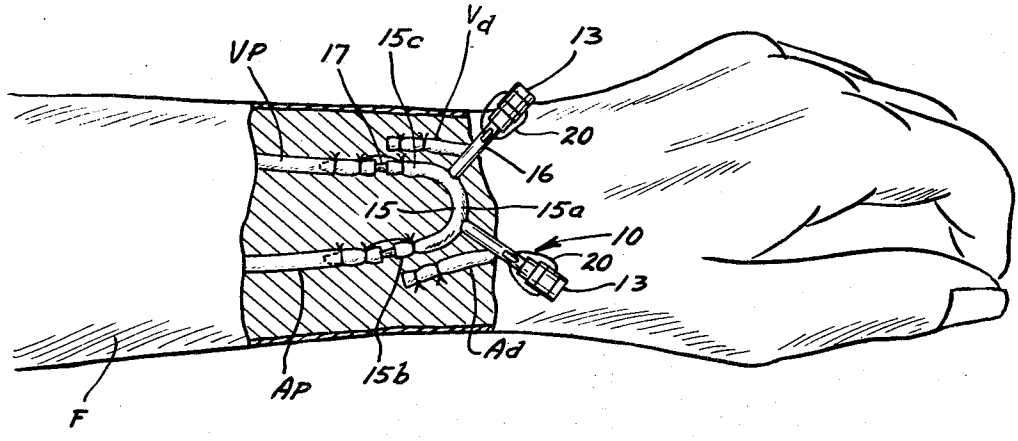
[57] **ABSTRACT**

A prosthetic device partially implantable in the human body for repeated intermittent access to the blood in the circulation system, the prosthetic device comprising a subcutaneous U-shaped shunt of preshaped Silastic, the ends of the U-shaped shunt having tubular tips or other means for connection with an artery and a vein to shunt blood from the artery to the vein; at least one access tube connected with the shunt between the ends thereof and in blood-flow communicating relation, at least the distal end of the access tube to be located at the exterior of the person's skin, and a removable plug entirely filling the full length of the access tube and being removable to obtain access to the blood in the shunt tube.

13 Claims, 10 Drawing Figures



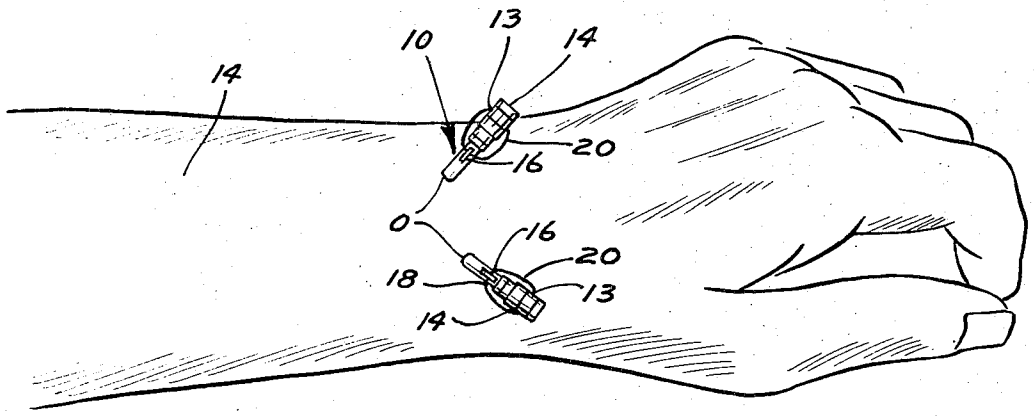


FIG. 1

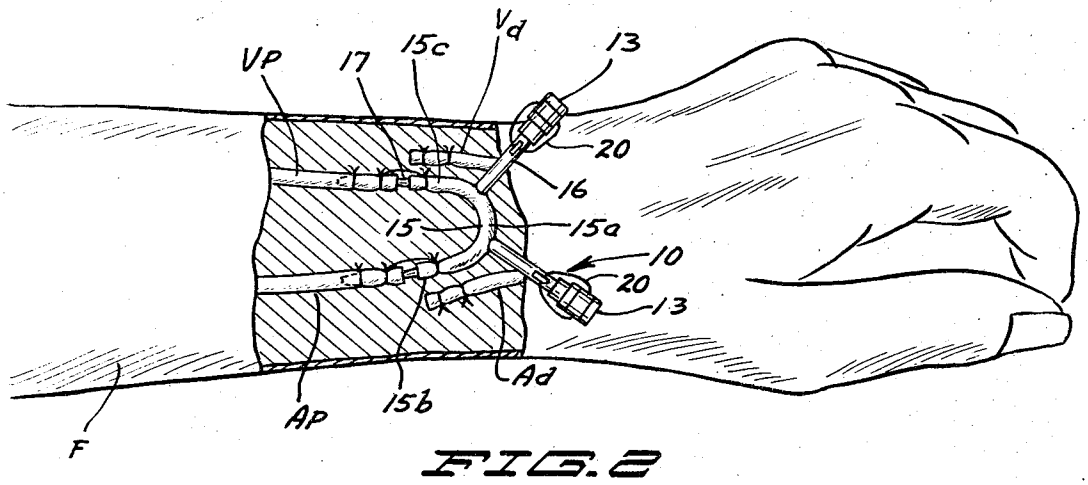


FIG. 2

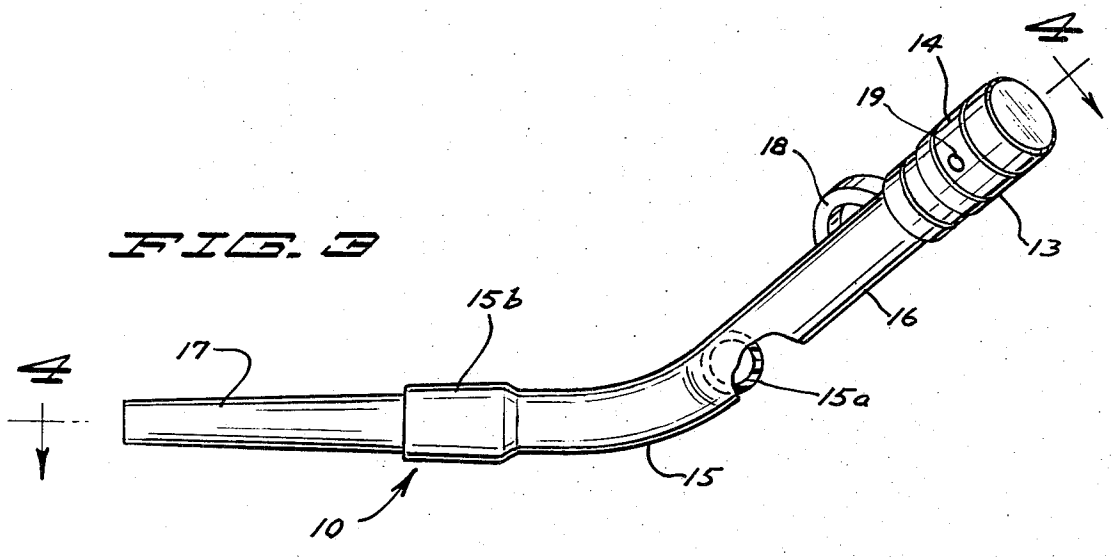


FIG. 3

FIG. 4

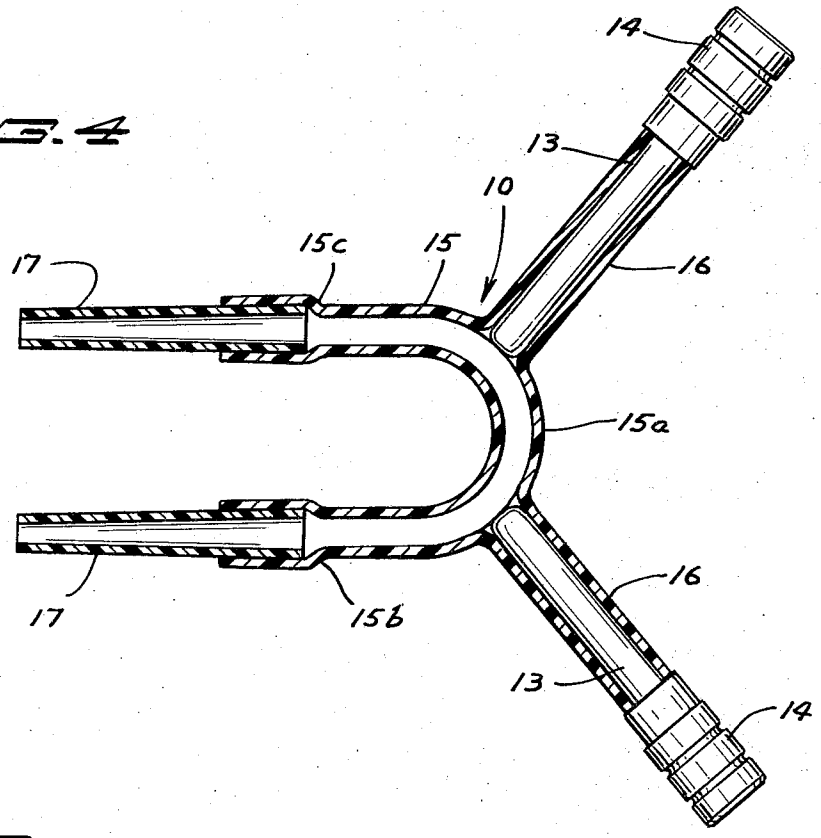
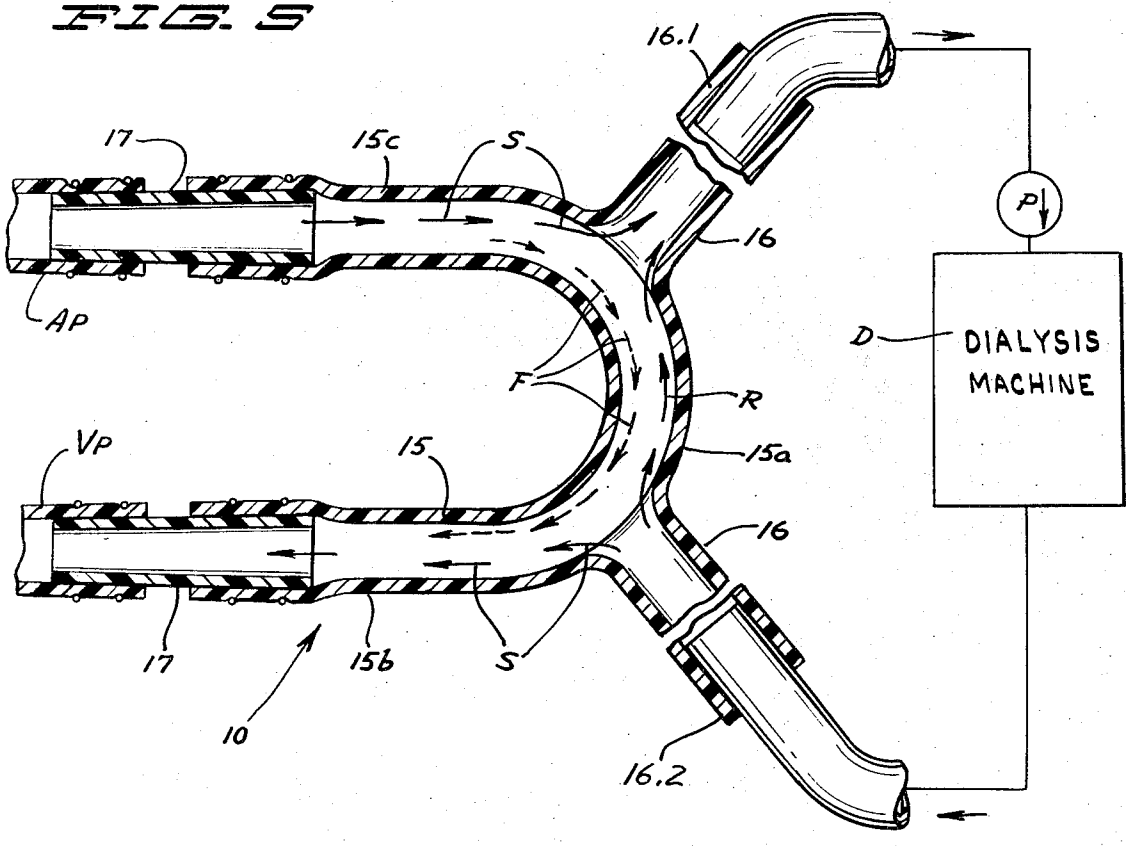

14
13
10
15c
15
17
16
15a
16
17
15b
13
14

FIG. 5


16.1
17
15c
S
16
AP
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F
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15a
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16.2

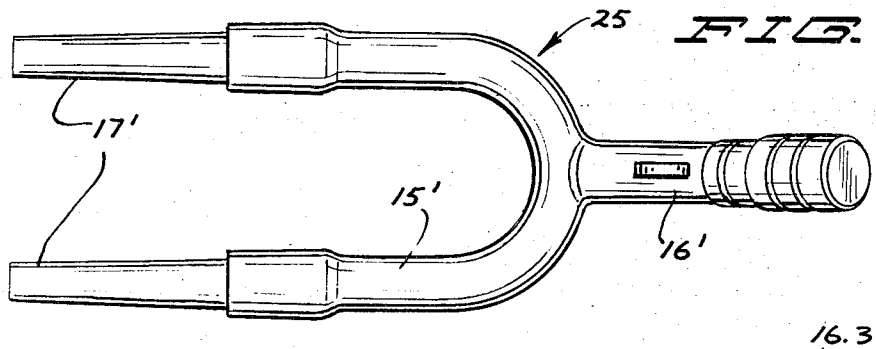


FIG. 6

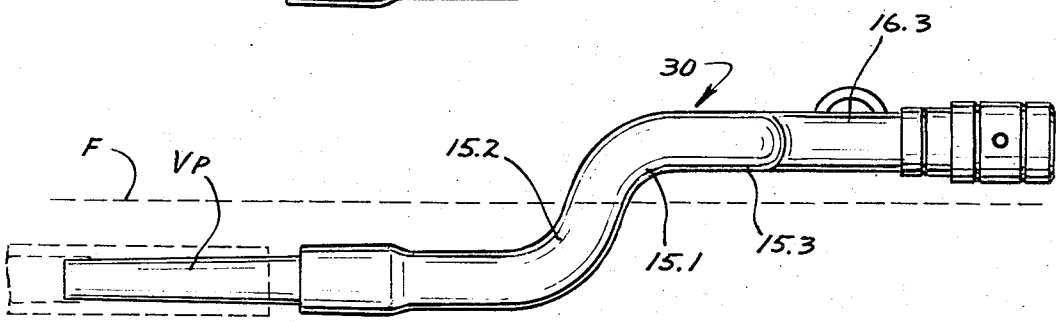


FIG. 7

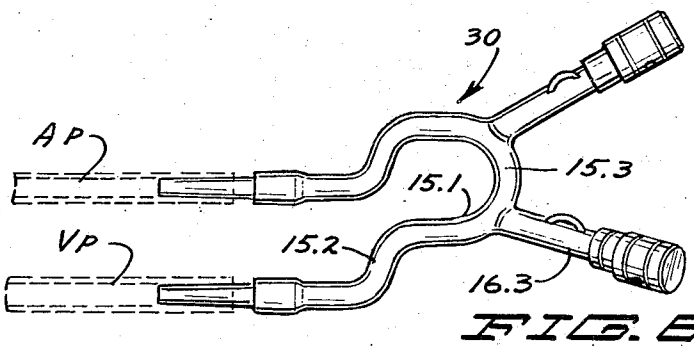
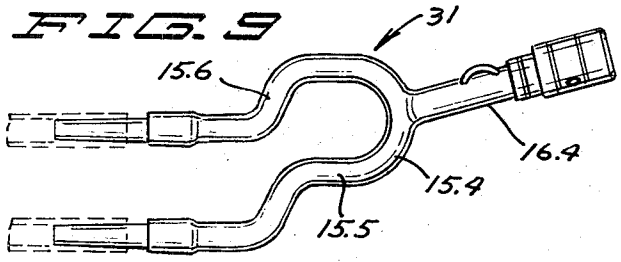


FIG. 8

FIG. 9



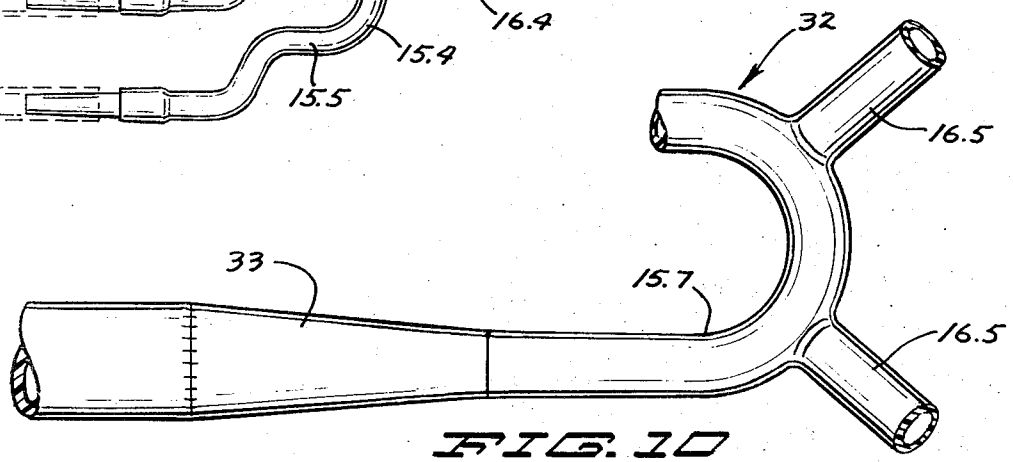


FIG. 10

PROSTHETIC SHUNT

BACKGROUND OF THE INVENTION AND PRIOR ART

Men have felt the need to obtain access to the circulatory system since the very earliest times when bloodletting was popular. Subsequently, access has become more important for the repeated administration of medicines and other fluids; and more recently, since the early 1940's, access has been important for the process of hemodialysis.

Hemodialysis is a process whereby blood is removed from an individual, passed through an artificial kidney machine, sometimes referred to as a dialyzer, and then subsequently returned to the body so that the continuous and consecutive passage as well as purification of segments of the blood through a cleaning machine is allowed over a 6 to 8 hour period. Although the first artificial kidney machine was only used on animals and was subsequently discarded, in 1941 Culf designed an artificial kidney to be used in humans. The principal limitation at that time was the inability to repeatedly gain access to the blood of the circulatory system over a long period of time. Until 1961, the techniques used provided only a very short term access, measured in hours or days, to the blood in the human circulatory system.

In 1961, the Quinton-Scribner prosthesis was developed and subsequently modified to obtain a rather long term access to the blood in the circulatory system. The Quinton-Scribner shunt utilized a pair of small and relatively stiff tubes or vessel tips respectively inserted into an artery and a nearby vein. These tips are attached to larger lengths of Silastic tubing which are brought out through the skin, and are then connected together by a connector so that these Silastic tubes can be separated from each other and respectively connected to the supply and return ducts of the dialysis machine. Ordinarily, these Silastic tubes which are brought out through the person's skin have an overall length of approximately 35 to 40 cm, and an internal diameter of approximately 0.104 inches. At the time of dialysis, the two Silastic tubes are separated and one of the tubes is connected to the dialysis machine so that blood could flow from the tube connected to an artery, through the machine and be constantly returned through the tube connected to the vein; and no alternative circulatory pathway is provided while the two tubes are separated and attached to the machine. When the dialysis is completed or terminated, the two Silastic tubes are clamped to terminate flow, disconnected from the machine, and then interconnected to one another so that when the clamps are released, blood may begin to flow through the length of tubing from the artery to the vein.

This Quinton-Scribner prosthesis is prone to many problems, mainly because of thrombosis and infection. The thrombosis resulted from the relatively long tubing which provided a good deal of resistance to flow of blood, and thrombosis often necessitated the removal and replacement of the Quinton-Scribner prosthesis to a totally different location or in a more proximal location in the same limb. Infection resulted around the materials which protruded from the skin, and even around the materials which were inserted in the blood vessel. Unexpected trauma of voluntary disconnection of the

long and cumbersome lengths of tubing, also provided for exsanguination in some cases. It has been postulated that the infection and indeed also the thrombosis may have been contributed to a large extent by the movement of this cumbersome external loop which could not be very easily totally immobilized between dialysis treatments.

Of course, cosmetics was also a problem with the Quinton-Scribner prosthesis. However, regardless of problems encountered, the prosthesis was practical and was able to be used over relatively long periods of time for repeated intermittent dialysis treatments.

Realizing the drawbacks of the Quinton-Scribner prosthesis, Brescia and Cimino developed a new technique in 1966 for repeated intermittent access to the circulation. They attached an artery (high pressure system) to a vein (low pressure system) through a 5 to 10 millimeter anastomosis (connecting window), thereby producing an arteriovenous fistula. After a 2 to 3 week maturation period in which the venous walls dilated and thickened, it is possible to do needle cannulation (insertion of a needle in the vessel) in the vein close to the anastomosis for supply to an artificial kidney machine, and also do needle cannulation at a portion more proximal to the heart for return of the blood to the body from the kidney machine. As a result of this subcutaneous connection without any synthetic prosthesis, enough vein dilation occurred so that the needles could be inserted for flow to and from the machine.

However, there were certain drawbacks in this Brescia-Cimino technique. Firstly, the arteriovenous fistula required approximately 3 weeks to a month to develop. Secondly, the fistula required that the patient have the placement of two large needles each time dialysis was required. Thirdly, the veins were occasionally damaged by the needle sticks, and clots were encountered. Fourthly, infection is said to have developed and been promoted by the shunt from the artery to the vein. Fifthly, there has been a question of the contribution of the fistula to cariac failure when the shunts were too large. Furthermore, the creation of the arteriovenous fistula is a somewhat difficult operation which required a highly skilled surgeon. This Brescia-Cimino technique was a giant stride over the Quinton-Scribner prosthesis and allowed hemodialysis to proceed through many, many consecutive treatments without anywhere near as numerous complications of thrombosis or infection as had been encountered previously. However, the medical centers which deal with acute patients who need dialysis immediately and such centers which deal with home dialysis and its training, often have difficulty with patients and their families who do not wish to place needles in the vein for dialysis. Further, the acute patients require immediate dialysis and cannot be allowed the time necessary for the proper development of the arteriovenous fistula.

SUMMARY OF THE INVENTION

This prosthetic shunt has been devised to eliminate most of the disadvantages of the prior devices and techniques. The present invention includes a preformed U-shaped shunt tube of a relatively soft and resiliently yieldable material which is self-supporting and resiliently resistive to collapse, and a suitable material used in the shunt tube is a material known by its name as Silastic. The opposite ends of the shunt tube which extend in the same direction, have relatively stiff, but re-

siliently yieldable connector tubes or vessel tips telescopically received therein to be respectively cannulated into an artery of a person's limb, specifically his forearm, and into an adjacent vein. It is expected that, in most instances, the entire U-shaped shunt tube will be subcutaneously implanted upon cannulation into the proximal vein and artery, while the distal portion of the same vein and artery are tied off.

The present invention has at least one and in many cases two separate access tubes connected to the shunt tube between the ends thereof and extending transversely therefrom so that the distal ends of the outlet tubes may project outwardly of the surface of the skin of the forearm. These outlet tubes have flow communication with the lumen of the U-shaped shunt tube, and normally the access tubes carry a closure plug having an intralumenal portion extending the full length of the access tube, but without infringement into the lumen of the shunt tube. The extralumenal portion of the plug forms a gripping cap facilitating removal of the plug and also incorporating an eyelet by which a safety wire retains the plug in the access tube, the wire being also attached to a loop or eyelet formed integrally of the access tube. Alternately, the ends of the shunt tube may be skirted with the flexible film or fabric material such as a Dacron type skirt which allows anastomosis to the vessels.

It will be appreciated that the end portions of U-shaped shunt tube are parallel to lie in a plane and oblique to the bight portion of the shunt tube which may overlie one of the bones in the forearm. The access tube or tubes lie in the plane of the bight portion of the shunt tube so that the access tubes may normally protrude through and outwardly of the skin of the limb. Alternatively, the U-shaped shunt tube may have an offset between the end portions and the bight so that only the portions of the shunt adjacent to the vessels are subcutaneously implanted while the intermediate portion and the entire access port or ports are superficially positioned.

The access ports may be used singly or simultaneously, depending upon the purpose being accomplished and the type of equipment being used with the present invention. A single access tube may be utilized with one type of dialysis machine blood supply system which requires only one access location, alternately drawing blood from and returning blood to the shunt tube through the single access tube. Additionally, the forms of shunt with one or two access tubes may be used in non-uremic patients requiring leukapheresis, the infusion of caustic substances such as sclerosing high calorie solutions (hyperalimentation) or irritating antibiotics, etc. Furthermore, either type of shunt, with a single access tube or double access tubes may be utilized for arterial blood sampling without the need for arterial puncture.

In the case of the prosthetic device using two access tubes, one of these tubes will be positioned closer to the artery and the other tube will be closer to the cannulated vein, the former access tube acting as the blood outlet for supplying blood to the artificial kidney machine, and the other access tube serving to simultaneously return the blood to the shunt and the circulatory system. Of utmost advantage is the fact that, unlike the situation in the Quinton-Scribner prosthesis, the flow through the shunt is maintained at all times, while the outlets are plugged, while connecting or disconnecting the shunt to the machine, and even while supplying and returning blood to and from the machine. A portion of the blood which returns from the dialysis machine into the shunt may recirculate through the shunt and back out for recirculation again through the dialysis machine. This feature is particularly valuable in preventing spasms in the supplying vessel, and also allows the re-exposure of the segments of the blood to the outside influence, as of the dialysis machine. It is particularly significant that this recirculation flow pattern produces a greater large particle (in the range of 300 to 2,000 molecular weight commonly referred to as "middle molecule") removal as compared to the removal of smaller particles (in the range of 0 to 300 molecular weight), the larger particles being mainly membrane dependent and the smaller particles being mainly flow dependent for their major removal rate limiting factors.

It will be recognized that a significant advantage of the present invention is the relative ease of surgical insertion into the patient's limb. A large percent of the small prosthetic device is subcutaneously implanted. As a result, there is considerably less exposure to outside influences tending to move the tubes and a greatly improved cosmetic effect. Because the shunt tube is quite short and has a smoothly curved U-shape, the tube has considerably less resistance and greater intrinsic flow of blood therethrough, tending to minimize any sludging or clotting. This, of course, results in improved longevity as a result of there being less chance of clotting and infection. There is immediate access to the circulation without need for needle cannulation or maturation development. This prosthetic device is adaptable to either a single port or double port blood pump supply system.

It is particularly significant that the present invention functions satisfactorily even in non-uremic patients who do not have the anticoagulant toxins that uremic patients possess. In such non-uremic patients, there is a tendency for more clotting, but the present invention functions quite satisfactorily even with these non-uremic patients, an advantage which has not been generally observed with placement of prosthetic devices in non-uremic patients.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a perspective view of a person's forearm with the prosthetic device implanted.

FIG. **2** is a view similar to FIG. **1**, but with portions of the forearm cut away in order to illustrate the present invention and its intended use.

FIG. **3** is a side elevation view, partly broken away for clarity of detail, of the present invention.

FIG. **4** is a longitudinal section view of the present invention, taken on a section line as indicated at **4—4** of FIG. **3**.

FIG. **5** is an enlarged section view of the invention similar to FIG. **4**, but showing the expected circulation in the shunt.

FIG. **6** is a top plan view of a modified form of the invention.

FIG. **7** is a side elevation view of a second modification of the present invention.

FIG. **8** is a top plan view of the form of the invention illustrated in FIG. **7**.

FIG. **9** is a top plan view of another modified form of the invention.

FIG. 10 is a plan view of still another modification of the invention.

DETAILED DESCRIPTION OF THE INVENTION

Although the prosthetic device incorporating the present invention is illustrated in the drawings as implanted in the forearm, it will be understood that this device may be implanted in any of the limbs of the person, and may also be implanted in other appropriate parts of a person's body, such as in his leg or neck.

In FIG. 1, a person's forearm is illustrated with the prosthetic device, indicated in general by numeral 10, implanted. Only a small portion of the device 10 will normally be in a superficial position. Only the access tubes 16 protrude through surgically formed openings 0 in the forearm F. The access tubes 16 may be used singly or together in order to obtain the desired access to the circulation. Normally the access tubes are closed by plugs 13. Only the head or extralumenal protrusion 14 of the plugs is normally visible on the access tubes 16. These plugs 13 will be removed, as necessary, in order to connect the access tubes to a dialysis machine or other equipment to be used.

As illustrated in FIGS. 2, 3 and 4, the prosthetic device 10 comprises a shunt tube 15 constructed of relatively soft, resiliently yieldable and self-supporting material resistant to collapse. Certain plastic materials which are molded have this desired characteristic and a specific example is a product known as Silastic. The shunt tube 15 has a smoothly curved U-shape wherein the bight 15*a* of the tube lies in a plane which is obliquely oriented with respect to the parallel ends 15*b* and 15*c*. When implanted, the curved or bight portion 15*a* of shunt 15 will usually overlie a bone in the forearm and the preformed configuration of the shunt will be substantially maintained with small variations, according to the characteristics of the particular forearm or body in which the device 10 is being implanted.

The prosthetic device 10 also includes one or more access tubes 16, two of which are illustrated in FIGS. 1 – 5. The access tubes 16 are formed of the same relatively soft, resiliently yieldable and self-supporting material resistant to collapse of which the shunt tube 15 is constructed, and the tubes 16 may be molded integrally of the shunt tube 15 and in one piece therewith. The tubes 16 are in free flow communication with the interior of the shunt tube 15 so that there can be substantial flow of blood between the shunt tube 15 and the access tubes 16 without any material resistance.

The ends 15*c* and 15*b* of the shunt tube are provided with means for subcutaneous and free flow connection with the proximal portion of an artery A_p and the proximal portion of a vein V_p, and such means as illustrated in FIGS. 1 – 5 comprise relatively stiff, resiliently flexible tubular tips 17 constructed of any suitable material such as a plastic known as Teflon. The tips 17 will provide flow communication between the shunt 15 and the artery A_p and vein V_p, and the tips 17 are confined within the ends 15*b* and 15*c*, and the tips 17 are confined within the ends 15*c* and 15*b* of the shunt 15. The resilient Silastic of the shunt 15 grips and retains the tips 17 in place. When the implant is actually made in a person's forearm as illustrated in FIG. 2, tips 17 of a suitable size so as to match the sizes of the lumen of the artery and vein are selected, and, after being inserted, the ends of the artery A_p and vein V_p are tied onto the tips 17 and the tie is also used to tie the Silastic shunt 15 onto the tips 17 so as to assure that the proper assembly will be continuously maintained.

It should be parenthetically noted that, although the distal artery A_d is severed from the proximal artery A_p, and similarly the distal vein V_d is severed from the proximal vein V_p, this will not result in any shortage of blood-carrying capacity to the hand because of the existence of other generally parallel arteries and veins to provide adequate circulation. The distal vein V_d and the distal artery A_d which have been severed are simply tied off and allowed to be non-functional.

As best illustrated in FIG. 3, it is preferable that the access tubes 16 extend obliquely of the plane in which the ends 15*b*, 15*c* of the U-shaped shunt tube 15 lies. Only the distal end of the access tube will protrude through the skin of the forearm as illustrated in FIG. 1.

In order to accommodate the difference in the size of the lumen of shunt tube 15 as compared to the lumen size in the artery or vein to which the tube 15 is connected, the tips 17 are simply tapered convergently toward the connection with the vein or artery because, ordinarily, the size of the vein or artery is somewhat less than the size of the shunt tube 15.

The access tubes are provided with exterior eyelets or loops 18 integral with the tubes; and the heads 14 of plugs 13 have transverse holes 14*a* therethrough. A safety line or wire 16*b* may be threaded through hole 14*a* and the adjacent eyelet 16*a* and tied to securely anchor the plug 13 in tube 16.

After the prosthetic device has been implanted, and the two access tubes 16 have been connected to the dialysis machine which is shown diagrammatically in FIG. 5 and indicated in general by letter D, the access tube 16.1 serves as the outlet from shunt tube 15 for supplying blood to the dialysis machine D, and the access tube 16.2 serves the function of returning the blood to the shunt 15 from the dialysis machine. It will be understood that the dialysis machine incorporates a suction pump to actually draw blood from the access tube 16.1 and from the adjacent shunt tube 15 and artery A_p as indicated by the arrows S. In addition, a portion of the blood continues to flow from the artery A_p through the shunt 15 and directly into the vein V_p as indicated by the arrows F. The same blood pumped or drawn into the dialysis machine D is returned into the circulation through access tube 16.2 as indicated by the letter S. A portion of the blood which is returned to the shunt 15 through access port 16.2 may be recirculated and actually flow from the access tube 16.2 to the access tube 16.1, counter to the direction of flow F and in the direction of arrows R as illustrated in FIG. 5. This function of recirculating the blood back into the dialysis machine as indicated by the blood flow arrows R provides substantial advantages in connection with this prosthetic device 10. Firstly, the adaptability for recirculation prevents spasm in the supplying vessel or artery A_p. Secondly, the recirculation would also allow for re-exposure of segments of the blood to the dialysis machine or other outside influence for treatment being carried on.

It may be desirable, in many instances, to utilize only one of the access tubes 16. Certain blood treating machines require only a single access port through which blood is drawn into the machine and intermittently returned to the circulation. A single access tube may be utilized while the other tube 16 remains closed, as for

non-uremic patients requiring hyperalimentation, and antibiosis. Access through the ports also facilitates leukapheresis. A single access tube may be used for simply sampling the arterial blood supply.

It will be noted that the access tubes **16** are provided with external eyelets **18**, and the plug heads **14** are also provided with holes **19** so that a safety line or wire **20** may be used to tie the plug in the respective access tube when the access tubes are not actively being used to obtain access to the circulation. It will be understood that the safety wire may be simply clipped when the plug is to be removed and then subsequently replaced.

A modified form of the prosthetic device is illustrated in FIG. **6** and is indicated in general by numeral **25**. This device is very similar to that illustrated in FIGS. **1 – 5** and is constructed of identical material. The prosthetic device **25** has a shunt **15'**, connecting tubes or tips **17'**, but the prosthetic device **25** only has a single access tube **16'**. Of course, the access tube is provided with a removable closure or plug **13'** substantially identical to that previously described. Of course, the decision to implant a prosthetic device with one access tube or two access tubes will be made according to the type of equipment that is expected to be used.

Another modified form of the prosthetic device is illustrated in FIGS. **7** and **8** and is indicated in general by numeral **30**. This form of device has a shunt tube **15.1** which is similar to the shunt tube **15** of FIGS. **1 – 5**, but has an offset **15.2** in each of the end portions so that the bight **15.3** of the tube may be superficially located while the ends of the shunt are subcutaneously attached to the blood vessels. The bight **15.3** and the access tubes **16.3** will be superficially located. The shunt tube **15.1** protrudes through the skin of the person's forearm approximately at the offset portion **15.2**.

The form of the device **30** illustrated in FIGS. **7** and **8** will have certain advantages such as ease of installation, particularly in limbs of persons who are minimally developed.

The form of the prosthetic device **31** illustrated in FIG. **9** is substantially identical to that illustrated in FIGS. **7** and **8** except that only a single access tube **16.4** is connected to the bight **15.4** of the shunt tube **15.5**. In this form the end portions also have offsets **15.6** so that only the ends of the shunt will be implanted and subcutaneously attached to the blood vessels.

In the form of the invention illustrated in FIG. **10**, the prosthetic device **32** is substantially identical to that illustrated in FIGS. **1 – 5** and has the shunt tube **15.7** and one or more access tubes **16.5** connected to the shunt tube. In this form, a flexible Dacron fabric skirt **33** is attached securely, as by welding, to each end of the shunt tube. This skirt will flare divergently from the end tube **15.7** to enlarged sizes at the distal end of the skirt. The skirt will be cut off according to the size of the vessel to which it will be attached and then is attached by stitching to the vessel. Of course, this form of connection between the shunt tube and the vessels allows more flexibility in relation to the size of vessels with which the shunt may be utilized.

It will be seen that I have provided a new and improved prosthetic device for repeated intermittent blood access, principally including a shunt tube for connection between an artery and an adjacent vein, offering minimal resistance to flow of blood and therefore a minimal likelihood of thrombosis. It is intended that, in some instances, the entire U-shaped shunt tube will be implanted, while in other instances only the portion adjacent to the vessel is subcutaneous in location. Access tubes are connected to the shunt tube and protrude transversely therefrom so that the distal ends of the shunt tubes will be located at the exterior of the skin, providing ready and easy access to the circulation in the shunt tube. Suitable openable closures are provided for the access tubes and, in the form illustrated, plugs are used throughout the whole length of the access tubes without infringing into the lumen of the shunt tube, thereby minimizing any likelihood of thrombosis at this location. The prosthetic device may be permanently implanted and used repeatedly to obtain blood access without requiring any further cannulating of the veins or arteries.

What is claimed is:

1. A prosthetic device for human implantation, comprising:

a U-shaped arterio-venous shunt tube of resiliently yieldable material and having juxtaposed ends extending in similar directions for subcutaneous flow connection to an artery and to a vein and said shunt tube also having an intermediate portion in unbroken and continuous flow connection with such juxtaposed ends to constantly circulate blood between such ends; and

an access tube having a proximal end interlumenally and fixedly connected in continuous free flow communication to said shunt tube and a distal end through which access to the blood may be obtained, and a closure for the access tube situated thereon.

2. The prosthetic device according to claim **1** and said ends having means including stiff tubular tips on the ends of the shunt tube, the distal ends of said tips being convergently tapered toward the ends thereof to fit within the lumens of the artery and vein.

3. The prosthetic device according to claim **1** and wherein said ends have means including a skirt of flexible material attached to the ends of the shunt tube and adapted for direct connection to the walls of the vein and artery.

4. The prosthetic device according to claim **1** and including a second such access tube adjacent said first mentioned access tube and also having a proximal end interlumenally and fixedly connected in continuous free flow communication to said shunt tube and a distal end through which access to the blood may be obtained, and a second closure for the second access tube situated thereon.

5. A prosthetic device for human implantation, comprising:

a preshaped arterio-venous shunt tube having juxtaposed ends extending in generally similar directions with means for subcutaneous flow connection to an artery and to a vein and having an intermediate portion in unbroken and continuous flow connection with such ends to constantly circulate blood between such ends; and

an access tube having a proximal end interlumenally and fixedly connected in continuous free flow communication to said shunt tube and a distal end through which access to the blood may be obtained, and

operable closure means for said access tube located thereon and effective at the interlumenal connec-

tion between the access tube and the shunt tube to alternately exclude blood from and allow flow of blood through the proximal end of the access tube while permitting continuous circulation of blood through said intermediate portion of the shunt tube and between the ends thereof.

6. A prosthetic device for human implantation, comprising:

a U-shaped arterio-venous shunt tube with juxtaposed ends extending in similar directions for subcutaneous flow connection to an artery and to a vein, and the U-shaped shunt tube having a bight intermediate the juxtaposed ends and also having an offset between the bight and the ends to permit superficial positioning of the bight; and

an access tube having a proximal end interlumenally and fixedly connected in continuous free flow communication to the bight of the shunt tube and a distal end through which access may be obtained, and a closure for the access tube situated thereon.

7. A prosthetic device for human implantation, comprising:

an implantable U-shaped arterio-venous shunt tube of resiliently yieldable material with juxtaposed ends for subcutaneous flow connection to an artery and to a vein, the U-shaped shunt tube having a bight intermediate said juxtaposed ends and the bight of the shunt tube lying substantially in a plane oblique to the juxtaposed ends;

an access tube having a subcutaneous proximal end connected in free flow communication to the shunt tube and to extend through the skin to the open distal end through which access to the circulation may be obtained, the access tube extending substantially in said plane to permit superficial positioning of the distal end of the access tube; and

a closure for the access tube situated thereon.

8. The prosthetic device according to claim **7** and including a second access tube lying substantially in said plane in spaced relation with said first mentioned access tube and also connected in free flow communication to the shunt tube.

9. A prosthetic device for human implantation, comprising:

an implantable U-shaped arteriovenous shunt tube of resiliently yieldable material having juxtaposed ends for subcutaneous flow connection to an artery and to a vein and having a bight intermediate said ends, each of the ends and the bight of the shunt tube carrying continuous blood flow; and

an access tube connected in free flow communication to the shunt tube adjacent the bight and having a distal end offset with respect to the juxtaposed ends of the shunt tube to remain superficially of the person and provide access to the blood continuously flowing in the shunt tube.

10. The prosthetic device according to claim **9** and the distal end of the access tube being disposed at an oblique angle with respect to the juxtaposed ends of the shunt tube.

11. The prosthetic device according to claim **9** and the distal end of the access tube being oriented generally parallel to the juxtaposed ends of the shunt tube and being spaced to one side of said juxtaposed ends to remain superficially of the person.

12. The prosthetic device according to claim **9** and including a second access tube also connected in free flow communication to the shunt tube and adjacent the bight thereof and also spaced from said first mentioned access tube, the distal end of the second access tube also being offset with respect to the juxtaposed ends of the shunt tube.

13. In the art of obtaining access to the blood in a human body, the method steps consisting of subcutaneously implanting a U-shaped arterio-venous shunt tube of resiliently yieldable material having juxtaposed ends extending in similar directions and an intermediate portion in unbroken and continuous flow connection with such juxtaposed ends and also having an access tube with a proximal end interlumenally and fixedly connected in continuous free flow communication to said shunt tube and a distal end through which access into the shunt tube may be obtained and a closure for the access tube and situated thereon, entirely in the body and anastomosing the juxtaposed ends of the shunt tube to an artery and to an adjacent vein respectively while allowing the distal end of the access tube and at least a portion of the closure therefor to remain superficially of the body for connection to external blood-receiving or supply means.

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