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Kim et al.

[11] **3,788,318**

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[54] **EXPANDABLE CANNULAR, ESPECIALLY FOR MEDICAL PURPOSES**

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[52] **U.S. Cl.** **128/214.4,** 128/343, 128/348

[51] **Int. Cl.** **A61m 5/00**

[58] **Field of Search** ..... 128/347–351, 341, 128/343, 345, 214 R, 215, 214.4, 221, 3–9, 17, 18, 20, 242

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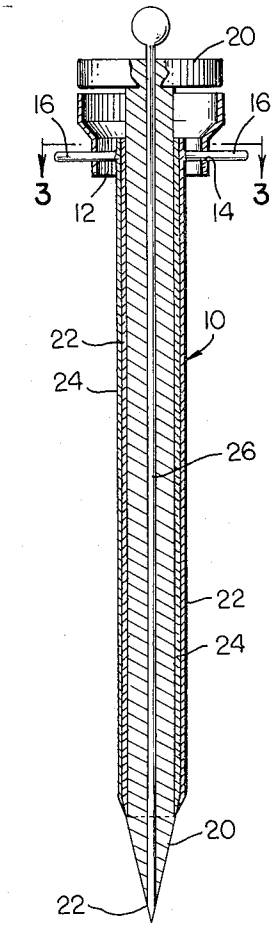
[57] **ABSTRACT**

An expandable tube, referred to herein as a cannula, is formed by arranging at least one sheet of thin flexible material to form a tube while providing teeth or the like on the interengaging surfaces to permit controlled expansion of the tube by adjusting the surfaces over one another.

14 Claims, 10 Drawing Figures



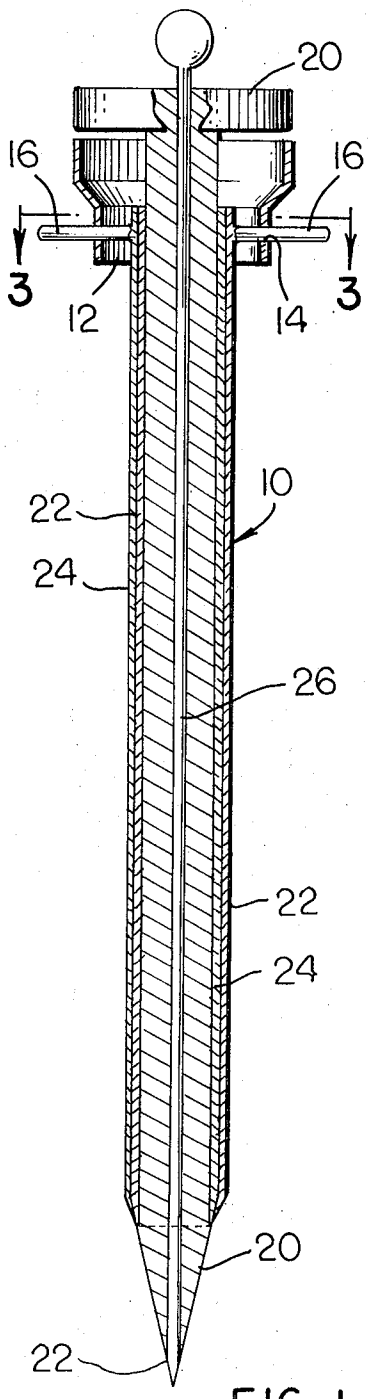


FIG. 1

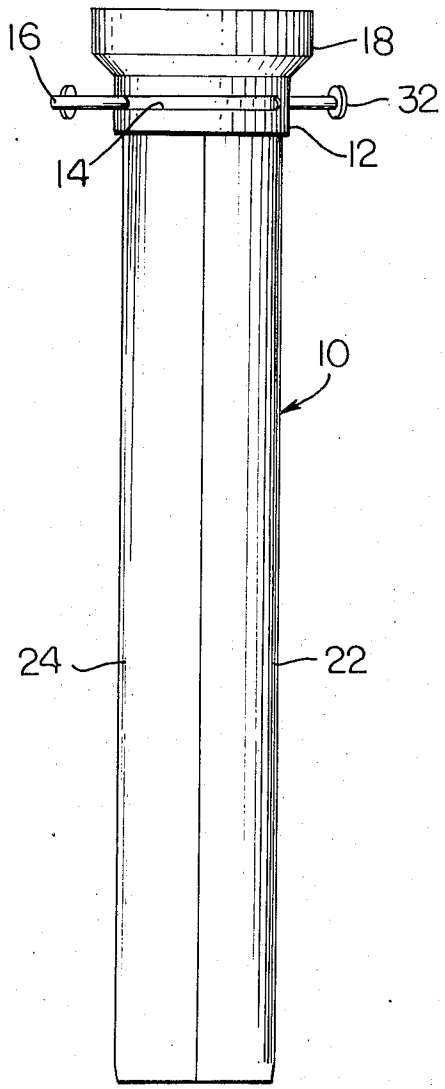


FIG. 2

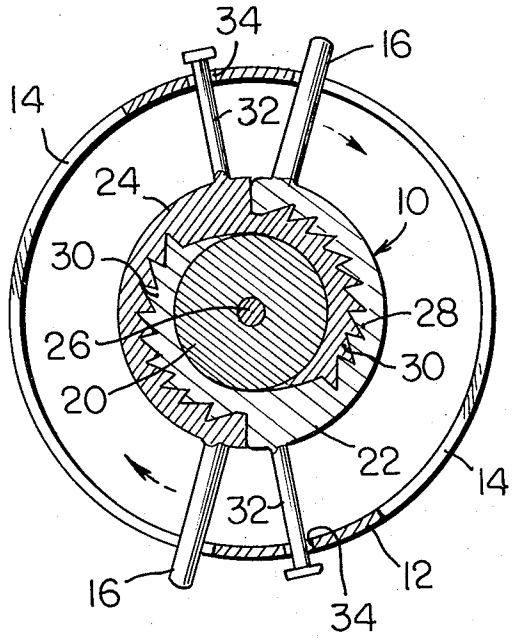


FIG. 3

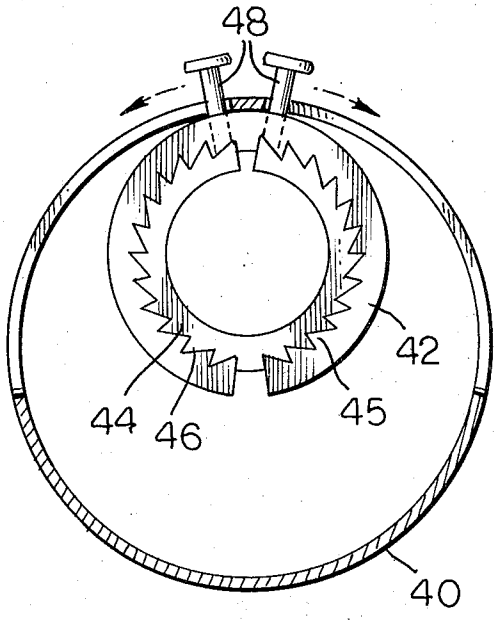


FIG. 4

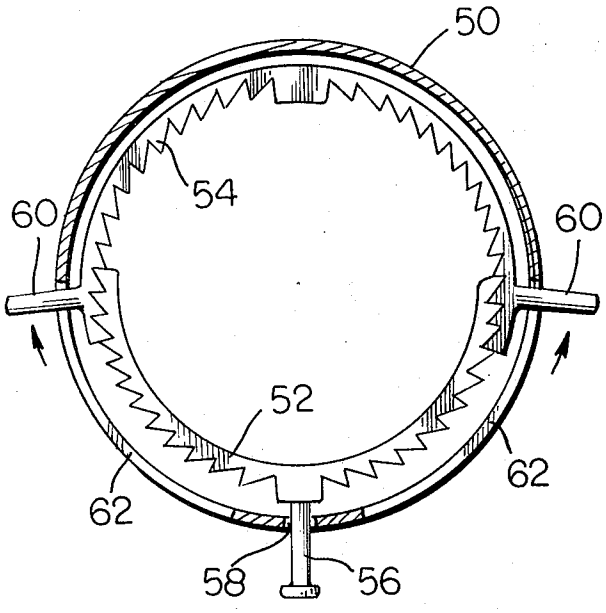


FIG. 5

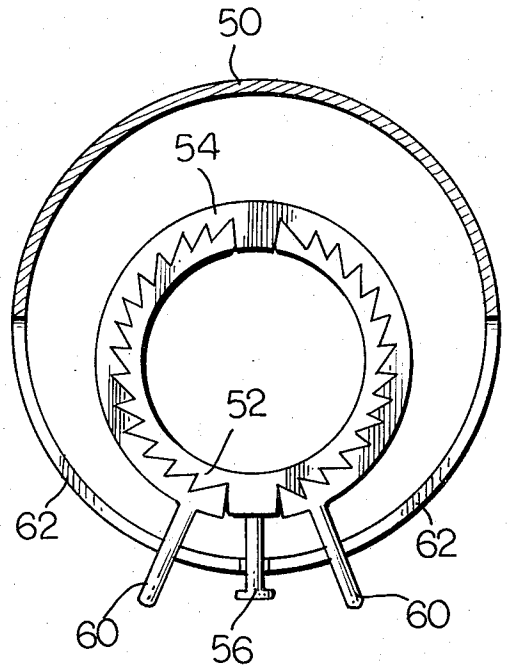


FIG. 6

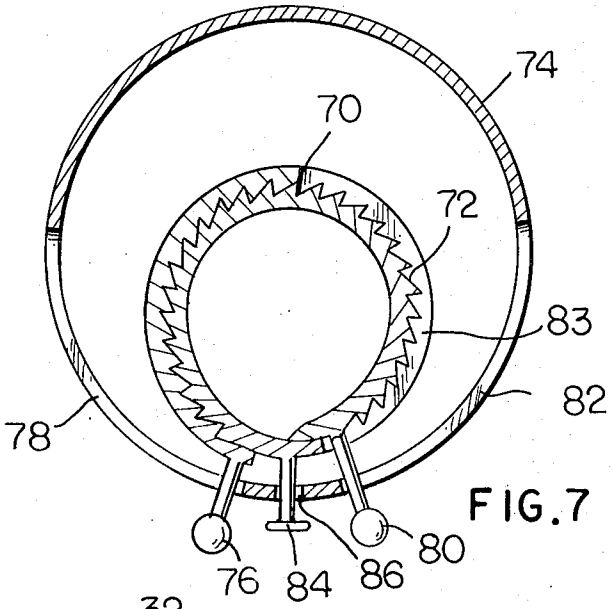


FIG. 7

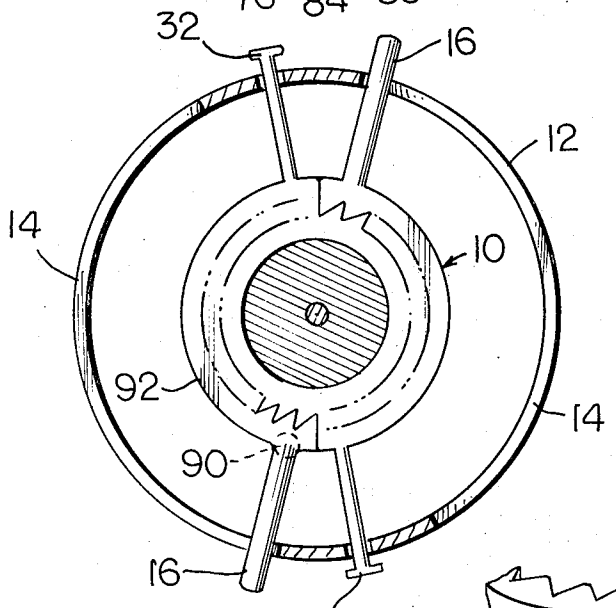


FIG. 9

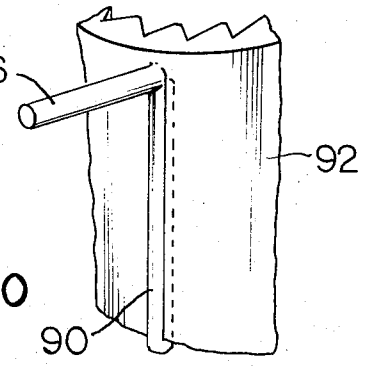


FIG. 10

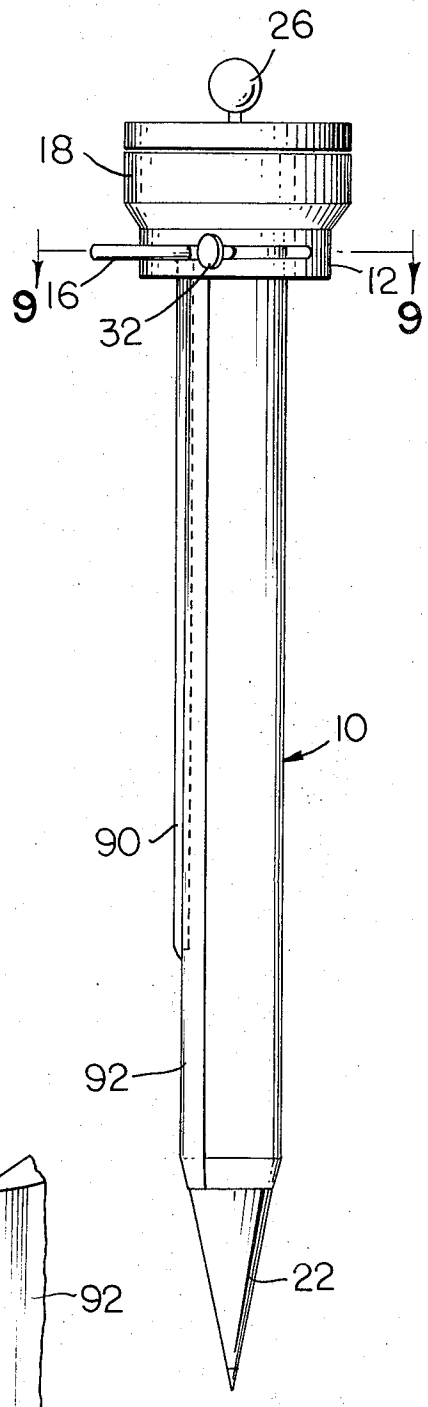


FIG. 8

EXPANDABLE CANNULAR, ESPECIALLY FOR MEDICAL PURPOSES

The present invention relates to an expandable tube, or cannula, especially for medical purposes.

Cannula are often used for medical purposes. A cannula may be defined as an elongated tube formed of plastic or metal large enough so that at least a small needle can be passed therethrough. A cannula is employed to provide access to a blood vessel or a body cavity to introduce fluid into the blood vessel or to withdraw fluid from a body cavity. In one case, a cannula is provided to give access to a vein with a tube being introduced into the vein through the cannula to remain therein during the supply of fluid to the vein.

In another case, such as Seldinger procedure, a cannula is introduced into a blood vessel and a wire is inserted through the cannula, whereupon the cannula is withdrawn and a larger cannula, or a catheter, is guided along the wire and introduced into the vessel.

Due to the great many purposes to which a cannula can be put, a variety of sizes of cannula is provided so as to be able to meet each situation. The placing of cannula is often a difficult procedure requiring the cut down procedure and highly skilled personnel and many times resulting in great discomfort to the patient.

With the foregoing in mind, a primary objective of the present invention is the provision of a cannula which can be radially expanded from a small diameter size to a larger diameter size.

Another object of the invention is the provision of a cannula which can be radially expanded thereby permitting the formation of a relatively large access passage from a preliminary relatively small puncture or incision.

Another object of the present invention is the provision of a cannula which is expandable and which thereby eliminates the need for surgical procedure to search for a vein or artery of ample size to receive a large nonexpandable cannula.

Still another object of the present invention is the provision of an expansible cannula which is relatively easy to use thereby permitting an emergency situation to be met rapidly and efficiently.

A further object of this invention is to provide the larger cannula through which a large catheter, such as diagnostic angiographic catheter, cardiac catheterization catheter or an electrode of a temporary pace maker, can be introduced to desired level of blood vessel thereby eliminating the necessity of performing the Seldinger procedure.

BRIEF SUMMARY OF THE INVENTION

According to the present invention, either a single thin flexible sheet, or multiple sheets, are formed to define a tubular configuration about a predetermined axis with portions of the sheet, or sheets, in overlapping face to face engagement. The overlapped portions of the sheet, or sheets, are provided with interengaging teeth, somewhat like saw teeth, which permit expansion of the cannula by movement of the aforementioned overlapping portions in one direction relative to each other while preventing movement thereof in the opposite direction.

The cannula may be formed of sheet metal, such as stainless steel, or it may advantageously be formed of plastic material. One end of the cannula is adapted for introduction into the body and the other end is provided with a guide ring having a flange and with the guide ring cooperating with control elements for controlling the expansion of the cannula.

The cannula is tubular and open at both ends and is thereby adapted for receiving a piercing instrument for making a preliminary puncture in the body to receive the end of the cannula. The piercing instrument has an axial canal or bore for receiving a stylette which can be removed from the piercing instrument to indicate by blood flow that the piercing guide is in the proper location.

The foregoing objects as well as still other objects and advantages of the present invention will become more apparent upon reference to the following detailed specification taken in conjunction with the accompanying drawings in which:

FIG. 1 is a side elevational view of a cannula according to the present invention in minimum diameter position.

FIG. 2 is a view like FIG. 1 but shows the cannula in maximum expanded position.

FIG. 3 is a plan sectional view indicated by line III—III on FIG. 1 and showing details of construction of the cannula.

FIG. 4 is a view like FIG. 3 but shows a modification.

FIG. 5 is a view like FIG. 3 but shows a still further modification.

FIG. 6 is a view like FIG. 5 but shows the cannula in contracted position.

FIG. 7 is a view like FIG. 3 showing another modification.

FIG. 8 is a side view of a still further modification.

FIG. 9 is a section on line IX—IX of FIG. 8.

FIG. 10 is a fragmentary perspective view of a portion of FIG. 8.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings somewhat more in detail, the cannula shown in FIGS. 1 to 3 comprises an elongated tubular portion **10** open at both ends and having mounted on one end a guide ring **12** which is provided with slot means **14** through which extend one or more side bars, or finger piece means **16** which form the control means for controlling the expansion of the cannula.

Guide ring **12** is preferably provided with an upstanding flange **18.** The cannula, when in collapsed position as shown in FIG. **1,** is adapted for receiving a piercing instrument **20** introduced into the cannula from the guide ring end thereof and having a piercing point **22** projecting from the other end of the cannula.

When point **22** is introduced into the body, as for example, by piercing the skin and entering the vein or artery, the instrument will guide the tubular portion **10** of the cannula through the pierced aperture and into the artery or vein, whereupon the piercing instrument can be withdrawn and the cannula can then be expanded to the desired size.

FIG. **3** will show that tubular portion **10** is formed of two sheet elements **22** and **24** with each less than completely circular and which are coaxial with the axis **26** of tubular portion **10.** Each of the elements **22** and **24** is provided on the inside near one end with teeth **28** and on the outside near the other end with teeth **30.** The teeth **28** of each of the elements **22** and **24** cooperate with the teeth **30** on the other thereof to permit expanding of the cannula while preventing collapsing

thereof so that in the event the cannula is subjected to external pressure when in use, it will not collapse.

It will be seen that the elements **22** and **24** are advantageously formed with a somewhat resilient plastic material and could also comprise a metal, such as stainless steel, if so desired.

Each of the elements **22** and **24** is provided with a control post **32** extending radially therefrom and through a corresponding aperture **34** in guide ring **12.** Further near the free outer end of each of the elements **22** and **24,** there is provided the aforementioned side bar, or finger piece, **16** slidable in the respective slot **14** in guide ring **12.**

It will be evident that the finger pieces **16** can be moved along the respective slots **14** provided therefor and thereby effect expansion of the cannula radially and that the cannula will remain in any adjusted position thereof, even though subjected to considerable external pressure.

In the arrangement of FIG. **4,** disposed inside a guide ring **40** is an outer element **42** forming less than a complete circle and therein is an inner element **44** also forming somewhat less than a complete circle with the axial regions of separation of the ends of the elements diametrically opposite each other. Inner element **44** has external teeth **46** thereon and outer element **42** has internal teeth **44** thereon cooperating in the same manner as teeth **28** and **30** pertaining to the first described modification.

The free ends of the inner member are provided with respective finger pieces **48** which extend through circumferential slot means formed in the outer elements **42** and in guide ring **40** so that movement of finger pieces **48** away from each other will effect expansion of the cannula radially.

FIG. **5** shows a modification similar to that of FIG. **4** and wherein there is disposed within guide ring **50** an inner toothed element **52** and an outer toothed element **54** with the elements cooperating in the same manner as described in connection with FIG. **4.** However, in FIG. **5,** inner element **52** has a control post **56** thereon extending through an aperture **58** in guide ring **50** while the free ends of outer element **54** are provided with the finger pieces **60** moveable along slots **62** in guide ring **50** for expanding the cannula.

FIG. **6** shows the FIG. **5** modification in contracted position.

FIG. **7** shows a modification in which a single sheet-like flexible element **70** is wound up in the form of a spiral with the interengaging faces of the spiral having teeth **72** somewhat like saw teeth and so inclined as to permit the interengaged surfaces of the wound up sheet to move over each other in the expanding direction of the cannula while preventing movement in the opposite direction. In the modification of FIG. **7** the outer end of the cannula is surrounded by a guide ring **74** and the free outer end of element **70** is provided with a finger piece **76** extending radially through guide ring **74** and moveable circumferentially thereof along slot **78.**

Similarly, the inner end of the wound up sheet is provided with a finger piece **80** extending radially through the guide ring and circumferentially adjustable thereof along slot **82.** Finger piece **80** also projects through a circumferential slot in the convolution of element **70** immediately radially outwardly therefrom to permit adjusting movements of finger piece **80.**

At some intermediate point along the wound up element **72** there is provided a control post **84** fixed to the element and extending radially therefrom through an aperture **86** provided in guide ring **74.**

In each of the modifications illustrated and described, the cannula is adapted to expand from an initial starting diameter, which can be made quite small and is locked in each position of radial expansion.

The cannula is provided, at the end opposite the end which is introduced into the body, with a guide ring having elements thereon and flanged for manipulation of the cannula and flanged for receiving a connecting portion such as connector to I.V. tubing or connector to syringe and to guide a piercing instrument or the like therein.

FIGS. **8, 9** and **10** show a modification adaptable to any of the foregoing modifications illustrated. In FIG. **8,** the tubular portion **10** of the cannula, which may be made up of one or more sheets of flexible material, has thereon, at at least the outermost edge of the sheet means, a stiffening rod **90** extending axially along the edge of the sheet means and advantageously connected at its upper end to the finger piece or side bar pertaining to the respective sheet means.

More than one of the side rods **90** could be employed wherever stiffening of the tubular portion of the cannula was desired and wherever it was desired to effect fine control over the adjustment of the cannula over the entire length thereof.

Side rod **90** can be of any cross sectional configuration and may be round as shown in FIG. **10** and is adapted for being imbedded in the respective sheet means **92** to which it pertains so that no forwardly facing edge is formed by the end of the side rod. The side rod could, of course, be ribbon-like and it would be stiff in the circumferential direction of the cannula while remaining flexible in the lateral direction thereof.

Modifications may be made within the purview of the appended claims.

What is claimed is:

1. A cannula for insertion into the body vascular system comprising an elongated tubular portion open at both ends having slidably received therein a removable piercing instrument having a body piercing point protruding from one end of said elongated tubular portion, said tubular portion comprising at least two sheet elements concave toward the axis of said tubular portion, said sheet elements having circumferential portions thereof in overlapping face to face engagement along substantially the entire longitudinal length of said tubular portion, and interengaging teeth formed on the opposed faces of said circumferential portions of said sheet elements and also extending along at least a portion of the longitudinal length of said tubular portion; said teeth being circumferentially inclined to permit relative radial movement of said circumferential portions of said sheet elements in a direction to expand said tubular portion while preventing relative movement of said circumferential portions in the opposite direction, and adjustable means including means connected to said sheet elements and operable to adjust said overlapping regions relatively in at least the direction to increase the diameter of the tubular portion.

2. A cannula according to claim **1** in which each sheet element has teeth formed on the inside at a first circumferential portion at one end and on the outside at a second circumferential portion at the other end,

said elements being disposed with the said one end of each element overlapping the outside of the said other end of the other element.

3. A cannula according to claim **1** in which one said element is provided with teeth on the radially outer side and the other said element is provided with teeth on the radially inner side and the elements are disposed in concentric engagement with said one element inside said other element.

4. A cannula according to claim **1** in which said tubular portion comprises a single sheet element wound into a spiral form about the axis of said tubular portion and having the inside of the outer end and the outside of the inner end provided with interengaging teeth, said teeth being inclined to permit relative movement of said ends in a direction to expand said cannula while preventing relative movement thereof in the opposite direction.

5. A cannula according to claim **1** which includes a guide ring on said cannula at one end and said adjusting means comprises finger piece means connected to said tubular portion and adjustable circumferentially of said ring.

6. A cannula according to claim **1** which includes a guide ring at one end of said cannula surrounding said tubular portion, said adjusting means including finger piece means connected to said sheet means and projecting radially therefrom outwardly beyond said guide ring and adjustable circumferentially of said guide ring.

7. A cannula according to claim **6** which includes means anchoring at least one point along the circumference of said sheet means to said guide ring.

8. A cannula according to claim **6** which includes flange means at the guide ring end of said cannula.

9. A cannula according to claim **8** in which said flange means is attached to said guide ring.

10. A cannula according to claim **6** in which said guide ring is circumferentially slotted for receiving said finger piece means.

11. A cannula according to claim **6** which includes rod means extending axially along said sheet means in a region thereof circumferentially near said finger piece means.

12. A cannula according to claim **11** in which said rod means is connected to said finger piece means whereby the control action afforded by said finger piece means is effective over the entire axial length of said sheet means.

13. A cannula according to claim **12** in which said sheet means is a resilient plastic material and said rod means is imbedded therein.

14. A cannula according to claim **1** in which a circumferential portion of each said element is disposed inside the circumferential portion of the other said element, and means connected to at least the outer side edges of said sheet elements for adjusting said sheet elements relative to each other to vary the diameter of said tubular portion.

* * * * *