Nov. 9, 1954 J. E. PETRI 2,693,765

FLUID PUMP AND METHOD OF MAKING THE SAME

Filed Sept. 22, 1951

2 Sheets-Sheet 1

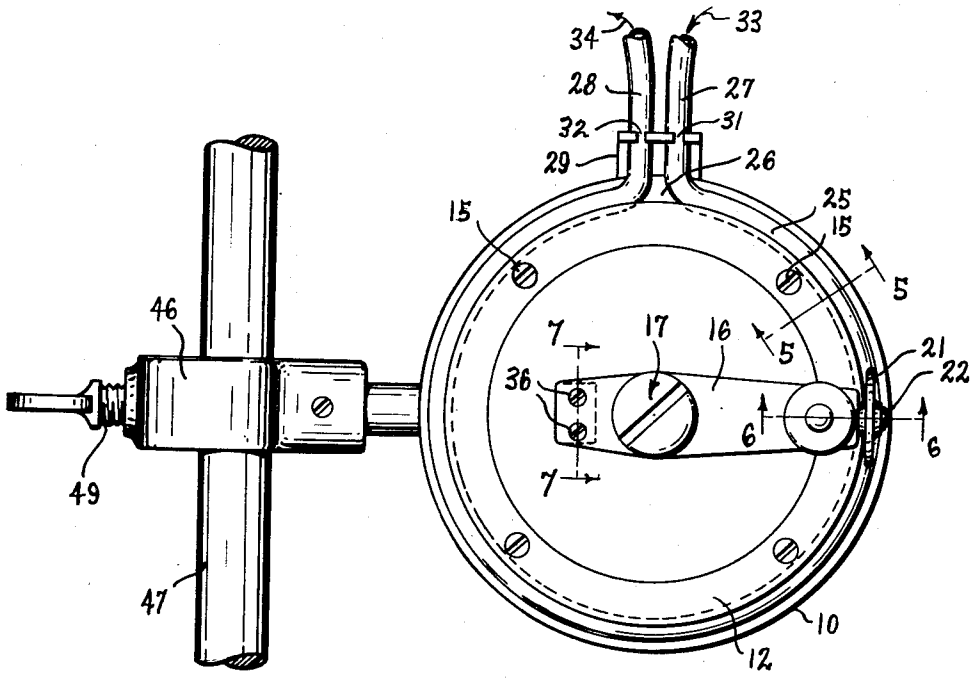

Fig. 1

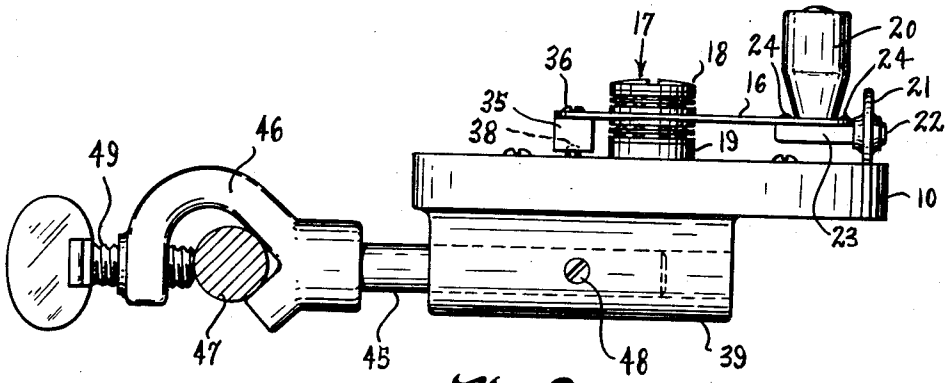

Fig. 2

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2 Sheets-Sheet 2

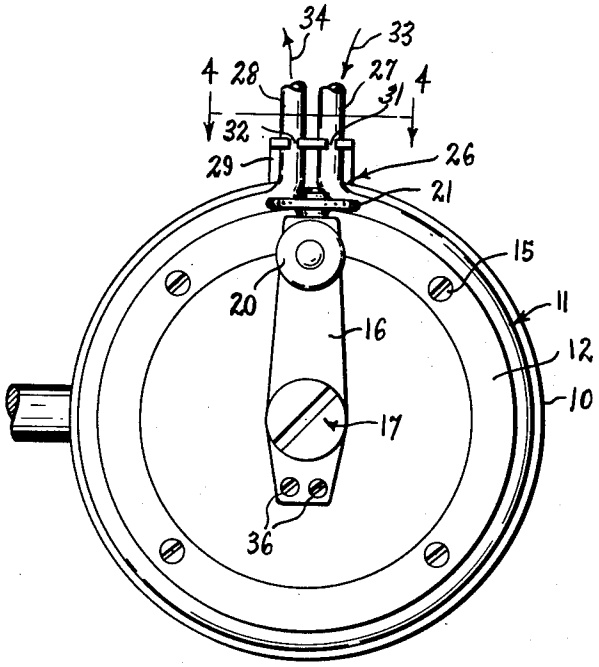

Fig. 3

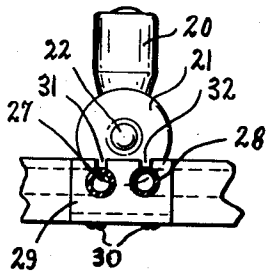

Fig. 4

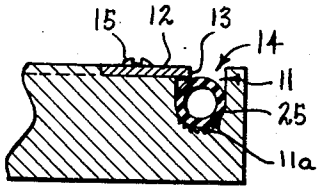

Fig. 5

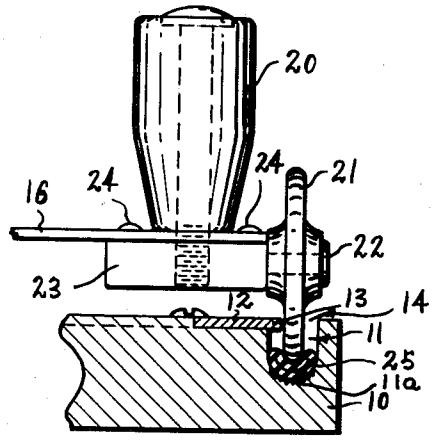

Fig. 6

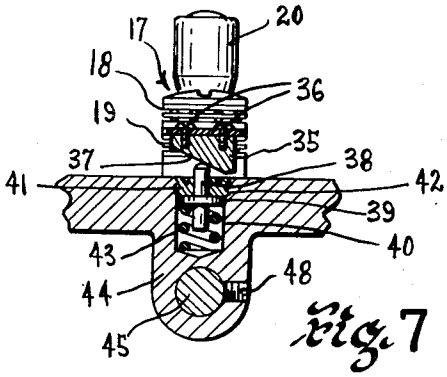

Fig. 7

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2,693,765

FLUID PUMP AND METHOD OF MAKING THE SAME

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Application September 22, 1951, Serial No. 247,830
7 Claims. (Cl. 103—149)

This invention relates to pumping apparatus and has particular reference to the provision of a novel and simple device which may be readily assembled with a continuous section of flexible tubing for pumping fluid through said tubing.

A principal object of the invention is to provide a simple and inexpensive pumping device which may be attached with ease to a continuous section of a flexible tube whereby said device, when operated, will function cooperatively with the tube in a positive and an exceptionally free operable manner for causing an enforced flow of a fluid through said tube while compensating for non-uniformity as to resiliency, wall thickness or other irregularities which might be present in the tube.

Another object is to provide a device of the above character with a circular channel having a restricted mouth portion through which the flexible tube may be positioned and more positively held within said channel and having a rotatable disk member carried by a manually operable lever in such manner that the peripheral edge of the disk will extend through said restricted mouth portion into engagement with the tube to successively and progressively compress contiguous areas of the tube against the bottom surface of the channel to cause an enforced flow of a fluid through said tube when the lever is rotated and being so constructed as to permit adjustment of said disk, without disconnection of the device from the flexible tube, to a position which will permit gravital flow of the fluid through the tube.

A further object is to provide a device of the above character having means for controlling the direction of rotation of disk member and, therefore, the direction of pumping of the fluid through the tube.

Other objects and advantages of the invention will become apparent from the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a front elevational view of the device embodying the invention;

Fig. 2 is a side elevational view of said device;

Fig. 3 is a view generally similar to Fig. 1 illustrating the position of the disk member when it is desired to permit gravital flow of fluid through said device;

Fig. 4 is a fragmentary sectional view taken as on line 4—4 of Fig. 3 and looking in the direction indicated by the arrows;

Fig. 5 is an enlarged fragmentary sectional view taken as on line 5—5 of Fig. 1 and looking in the direction of the arrows;

Fig. 6 is an enlarged fragmentary sectional view taken as on line 6—6 of Fig. 1 and looking in the direction of the arrows; and

Fig. 7 is an enlarged fragmentary sectional view taken on line 7—7 of Fig. 1 and looking in the direction indicated by the arrows.

Although the device embodying the present invention is designed for various different uses, its primary purpose is for use in hospitals, first-aid stations, and the like where enforced transfusions and infusions of blood are required. It has been a common practice in providing as enforced transfusion to employ one of three different methods as follows:

A. Cause the blood to flow through the tube by compressing the tube between the two fingers and sliding the fingers along the tube;

B. By using an apparatus embodying compressed oxygen for forcing the blood through the tube from a suitable container; and

C. By manual injection by means of a syringe.

All of the above methods have proven to be quite unsatisfactory and, in some instances, extremely dangerous.

The present invention relates particularly to overcoming the difficulties of the prior art methods by providing a device that may be used with a short length of rubber tubing incorporated in a standard transfusion set by simply threading a section of the tubing into the device and into cooperative relation with means which may be freely manipulated for forcing the blood through the tube at a controlled rate.

Among the several advantages of the present device is that it does not require the severing of the tube for assembly therewith and thereby overcomes any danger of dirt, dust, etc. gaining access to the interior of the tube and in no way effects the sterile condition which must be maintained during such transfusions.

Referring to the drawings wherein there is illustrated a preferred embodiment of the invention, the numeral **10** designates a housing having a circular channel **11** formed in a side surface thereof. The said housing **10**, adjacent the channel **11**, is recessed to receive an annular member **12** having its outer edge portion **13** overlying the channel to provide a restricted mouth portion **14**, see Figs. 5 and 6. The annular member **12** is secured to the housing **10** by screws or other suitable means **15**. A lever **16**, formed of resilient blade spring material, is pivotally connected at **17** concentrically with the channel **11** and is provided with suitable roller bearings **18** and **19** for ease of rotary movement thereof. The said lever is provided with a hand-grip member **20** by means of which it may be manually rotated. Adjacent the outer end of the lever **16**, there is supported a disk **21** mounted on a pivot **22** carried by a block **23**. The block **23** is connected with the lever **16** by rivets or other suitable connection means **24**. The disk **21** is provided with a convexly curved peripheral edge positioned to extend inwardly of the channel **11** through the mouth portion **14** and is adapted to engage and compress a tubular member **25** formed of resilient material such as rubber, synthetic rubber or the like located in said channel. The tube is adapted to be positioned internally of the channel **11** by forcing it inwardly through the restricted mouth portion **14** and is normally held therein by the lip **13**.

The outer side wall of the channel **11** is cut away, as illustrated at **26**, to permit the sections **27** and **28** of the tube **25** to be turned outwardly therethrough after the tube has been looped inwardly of the said channel **11**. The housing **10**, adjacent the cut away wall portion **26**, is provided with a bracket **29** secured thereto by screws or other suitable connecting means **30**. The bracket is provided with a pair of spaced openings having communicating slotted portions **31** and **32** for receiving the respective sections **27** and **28** and for aiding in retaining the portion of the tube positioned within the channel against creeping during the operation of the device. The spaced openings are of a diameter less than the diameter of the tubing and maintain a slight gripping action thereon during the use of the device. If the related dimensional characteristics of the channel and tubing are so controlled that the diameter of the tube is slightly greater than that of the width of the channel **11**, the inherent tendency for the tube to return to its initial set after stretching will cause said tube and inner wall of the channel to have frictional contact with each other. In most instances, this frictional contact will be sufficient to overcome any tendency of the disc **21** to cause the tube to creep when the device is operated. However, with a view to more positive assurance against such creeping, particularly in instances when the tube **25** might be slightly smaller in diameter than the inner dimension of the channel or slightly less than the optimum diameter of tubing which is normally used, the bottom surface of the channel **11** is provided with serrations **11***a* or radial grooves thereby forming an irregular surface having, in effect, a plurality of projections. By pressing the tubing against the serrations **11***a*, the friction created between the serrations and the tube will be substantially greater than the friction between the disk **21** and the tube thereby causing the tube to be retained in its original position at the point of compression.

When the lever **16** is rotated in a clockwise direction about its pivot **17**, the disk **21** will compress the tube **25**, as illustrated best in Fig. 6, and will cause blood

or other fluid drawn from a source or origin to be drawn inwardly of the tube, as illustrated by the arrow **33**, and forced outwardly of the opposed end thereof, as illustrated by the arrow **34**. This is in response to the successive and progressive compression of contiguous areas of the tube by the disk **21** against the bottom of the channel **11**. Continuous rotary movement of the disk in a clockwise direction will, therefore, cause a continuous pumping action to take place and the speed of flow may be controlled by the speed of rotation of the lever **16**. Due to the fact that the lever **16** is made in the form of a resilient blade spring whereby the disk **21** will be resiliently urged in compressing relation with the tube **25**, any slight variations in the texture of the tube such as hard spots or dimensional changes will be readily compensated for by said resiliency and a smooth freely operable pumping action is obtained.

It is to be noted that when the disk **21** is located in a position, such as shown in Fig. 1, that the tube **25** will be compressed and will not permit a free flowing of blood or other liquid therethrough.

The diameter of the disk **21** and the distance between the sections **27** and **28** of the tube which extend outwardly of the cut away section **26** of the outer wall portion of the housing **10** are so controlled that when the disk **21** is located between said sections, as illustrated in Fig. 3, free gravital flow of the liquid through the tube **25** is permitted. This arrangement, therefore, permits instantaneous pumping, if desired, and also permits free gravital flow of a liquid through the tube without the necessity of detaching the device from the tube.

To insure against improper direction of flow during the pumping, the lever **16**, on the side thereof opposed to the hand-grip member **20**, extends outwardly of the pivot **17** and is provided with a block **35** which is secured thereto by screws or other suitable means **36**. The block **35**, as shown in Fig. 7, is provided with an angled undersurface **37** which is adapted to engage and compress a resiliently supported stop pin **38** to enable the lever **16** to be rotated in the proper pumping direction. This block **35**, however, when the lever **16** is rotated in the opposite direction, will engage and interlock with the stop pin and will prevent the lever from being rotated in said direction and thereby render the pump inoperative when said lever is moved in a direction opposite from that of the desired pumping direction.

The resiliently supported stop pin **38** has an enlarged flange **39** thereon which is mounted within a hollow bore **40** formed in the housing **10** and has its upper portion slidably mounted within an opening in a threaded nut-like member **41** which is threaded inwardly of a suitable threaded area **42** formed internally of the bore **40**. Surrounding the pin **38** beneath the flange **39** and internally of the bore **40** is a coil spring **43** which is adapted to constantly urge the pin **38** in a direction outwardly of the opening in the nut-like member **41**. The housing **10**, on the side thereof opposite the lever **16**, is provided with an integral boss **44** having a hollow bore adapted to receive the stem **45** of a clamp **46** by means of which the pump may be connected to a suitable supporting stand or other upright member **47**. The stem **45** is secured to the boss **44** by means of a suitable set screw or the like **48** and the clamp member **46** is provided with a wing screw **49** whereby the said clamp may be secured to the stand or upright **47** at any suitable height.

In operation, the device is coupled with the tube **25** by stretching a section of the tube and forcing it through the restricted mouth portion **14** inwardly of the channel **11**. This procedure is accomplished by first threading the section **27** of the tube inwardly of the opening in the bracket **29** through the slot **31** and thence drawing the tube through the cut away portion **26** of the side wall of the housing **10**. The tube is continuously stretched and forced inwardly of the channel until a continuous loop is formed throughout the channel and the opposed section of the tube **28** is drawn outwardly of the cut away area **26** and threaded inwardly of the opposite opening of the bracket through the slot **32**. The fact that the openings in the bracket which receive the two sections **27** and **28** are of a diameter slightly less than the diameter of the tubing, the inherent tendency of the material of the tube to return to its initial set after stretching will cause the respective portions of the bracket having the openings therein to have a gripping action with said respective sections.

It is particularly pointed out that while it has been described that the pumping results from the continuous and progressive compression of the tube in the direction of rotary movement of the disk **21**, the tube, immediately following the compressing must return to its initial set in order to create a sucking action whereby the fluid or blood will be drawn from the source of origin inwardly of the tube, as indicated by the arrow **33** and, simultaneous to this function, the progressive compressing of the tube will force the blood, previously drawn into the tube, outwardly of the opposed end thereof, as indicated by the arrow **34**. Therefore, the pumping action is definitely a cooperative function of the compressing action of the rotary disk **21** and the resiliency of the tube.

Due to the fact that as the disk **21** is rotated it tends to continually force the tube **25** in a direction inwardly of the channel **11**, there is little, if any, danger of the tube being displaced from the channel during the use of the device. The fact that the tube compressing force on the disk is parallel and offset with respect to the axis of rotation of the lever **16** also greatly obviates mechanical friction on the pivot and results in a free and smooth functioning device. This is due also to the fact that suitable ball bearings are provided for permitting free pivotal movement of the lever **16** and that the spring lever **16** will automatically compensate for variations of thickness and other irregularities in the resilient tube. The tension of the blade spring lever **16** is such that it will completely compress the tube **25** as the disk **21** is rotated thereby assuring a positive pumping action. To insure that only a compressing action takes place as the disk is rotated the base of the channel **11** is curved substantially to the same cross-sectional shape as the tube.

The lip **13** forming the restricted mouth of the channel also aids in retaining the looped portion of the tube internally of said channel.

By varying the speed of rotation of the disk, the amount of blood delivered to the patient and the pressure thereof during said delivery may be controlled.

Although the pump has been particularly described as being adaptable to transfusions or infusions, it is quite apparent that it might be put to several other uses where a fluid pump is required and also where sterile conditions must be maintained.

From the foregoing description, it will be seen that simple, efficient and economical means have been provided for accomplishing all the objects and advantages of the invention. It will be apparent, however, that many changes may be made in the details of construction and arrangement of parts shown and described without departing from the spirit of the invention as expressed in the accompanying claims. Therefore, it is to be understood that all matter set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

Having described my invention I claim:

1. A pumping apparatus for use with flexible tubing to move fluid therethrough by successively and progressively compressing said tubing in a direction longitudinally of a section thereof comprising a base having a circular channel in a side surface thereof provided with an open mouth facing in a direction paralleling the axis about which the channel is defined and having a passageway extending through the wall of the channel and communicating with said channel whereby a looped section of said tubing may be positioned in said channel with the ends of the looped section extending outwardly of the passageway, said base having a lever rotatably connected thereto in concentric relation with the axis about which said circular channel is defined, and a disk rotatably connected with the lever, its axis of rotation being substantially perpendicular to the axis of rotation for the lever, and said disk being spaced from the axis of rotation of the lever whereby the peripheral edge of the disk will extend within the channel and will engage the tubing of resilient material when in position in said channel, the peripheral edge of said disk being convexly curved and having a thickness less than that of the width of the channel whereby the tubing will be successively and progressively compressed with a minimum amount of creep as the lever is rotated and a smooth freely operating pumping action may be obtained.

2. A pumping apparatus for use with flexible tubing to move fluid therethrough by successively and progressively compressing said tubing in a direction longitu-

dinally of a section thereof comprising a base having a tubing receiving circular channel formed in a side surface thereof, said channel having a semi-circular bottom and an overlying lip portion forming a restricted mouth portion to the channel that is substantially narrower than the diameter of the tubing with which the apparatus is intended to be used, said restricted mouth portion of the channel facing in a direction paralleling the axis about which the circular channel is defined, said base having a passageway in the outer edge wall thereof communicating with the channel, said channel being adapted to receive a looped section of said flexible tubing with the opposed ends of said looped section extending outwardly of the passageway, a lever rotatably connected with the base in concentric relation with said axis about which the channel is defined, and a disk rotatably connected with said lever with its longitudinal axis of rotation being substantially perpendicular with respect to the longitudinal axis of rotation for the lever, said disk being so supported on the lever from the axis about which the lever rotates as to have its peripheral edge extend through the restricted mouth portion into the channel whereby the said disk will engage the looped section of the resilient tubing when positioned in said channel and will cause successive and progressive portions of said tubing to be compressed as the lever is rotated.

3. A pumping apparatus for use with flexible tubing to move fluid therethrough by successively and progressively compressing said tubing in a direction longitudinally of a section thereof comprising a base having a circular channel formed in a side surface thereof to receive a looped section of said tubing, the bottom surface of said channel being curved substantially to the curvature of the contour of said tubing when positioned internally of said channel and the mouth of said channel facing in a direction paralleling the axis about which the circular channel is defined, an annular member secured to the base with its outer edge portion overlying said mouth of the channel so as to form a restricted mouth portion communicating with said channel, said channel being of a width less than the cross-sectional dimension of the section of said resilient tubing to be positioned therein, a lever rotatably connected with the base in concentric relation with said axis about which the channel is defined, and a disk rotatably connected with the lever with its axis in normal relation with the axis of rotation for the lever whereby the peripheral edge of said disk will extend through said restricted mouth portion internally of the channel and, when the lever is rotated, it will engage and successively and progressively compress the section of resilient tubing in said channel.

4. A pumping apparatus for use with flexible tubing to move fluids therethrough by successively and progressively compressing said tubing in a direction longitudinally of a section thereof comprising a base having a circular channel formed in a side surface thereof to receive a section of said tubing, the bottom surface of said channel being curved substantially to the contour of said section of tubing when positioned internally of said channel and its mouth facing in a direction paralleling the axis about which the channel is defined, an annular member secured to the base with its outer edge portion overlying the said mouth of the channel so as to form a restricted mouth portion communicating with said channel, said channel being of a width less than the cross-sectional dimension of the section of resilient tubing to be positioned therein, a lever rotatably connected with the base in concentric relation with said axis about which the channel is defined and a disk rotatably connected with the lever with its axis in normal relation with the axis of rotation of the lever whereby the peripheral edge of said disk will extend internally of the channel and, when the lever is rotated, it will engage and successively and progressively compress the section of resilient tubing in said channel, said lever being formed of resilient blade spring material to hold the disk under resilient tension during the rotation thereof.

5. A pumping apparatus for use with flexible tubing to move fluid therethrough by successively and progressively compressing said tubing in a direction longitudinally of a section thereof comprising a base having a circular channel in a side surface thereof and having a passageway extending through the wall of the channel and communicating with said channel whereby a looped section of said tubing may be positioned in said channel with its ends extending outwardly of the passageway, said channel having its mouth facing in a direction paralleling the axis about which the channel is defined, and a lever rotatably connected to said base in concentric relation with said axis about which the circular channel is defined, and a disk rotatably connected with the lever with its axis being substantially perpendicular to the axis of rotation of the lever whereby the peripheral edge of the disk will extend within the channel and will engage and successively and progressively compress the tubing when the lever is rotated, said lever being formed of resilient blade spring material to hold the disk under resilient tension during the rotation thereof whereby slight variations in the texture of the tubing such as hard spots and dimensional changes will be readily compensated for and a smooth freely operable pumping action may be obtained.

6. A pumping apparatus for use with flexible tubing to move fluids therethrough by successively and progressively compressing said tubing in a direction longitudinally of a section thereof comprising a base having a circumferential groove therein and a passageway communicating with said groove whereby a looped section of said tubing may be positioned internally of the groove with the opposed ends thereof extending outwardly of the passageway, the mouth of said groove facing in a direction paralleling the axis about which the groove is defined, a resilient lever rotatably connected with the base in concentric relation with said axis about which the groove is defined, a disk connected with said lever for rotation about an axis disposed normal to said axis of rotation of the lever and having its edge extending within the groove to engage the looped section of resilient tubing when positioned therein and to successively and progressively compress said looped section when the lever is rotated, and a handle on said lever adjacent the connection of the disk therewith, the compressing force of the disk on the tubing being substantially parallel and offset with respect to the axis about which the lever is rotated whereby a smooth freely pumping action may be had.

7. A pumping apparatus for use with flexible tubing to move fluids therethrough by successively and progressively compressing said tubing in a direction longitudinally of a section thereof comprising a base having a circumferential groove therein with its mouth facing in a direction paralleling the axis about which the groove is defined and a passageway communicating with said groove through which a looped section of said flexible tubing may be positioned internally of the groove and with the opposed ends of said looped section extending through said passageway, a lever rotatably connected with the base in concentric relation with the groove, a disk rotatably connected with said lever for movement in a circumferential path about an axis disposed approximately normal to said axis about which the groove is defined and having its edge extending within the groove to engage the looped section of the tubing when positioned therein so as to successively and progressively compress said looped section when the lever is rotated, the tubing being retained against substantial creeping in said groove during said successive and progressive compressing thereof, and means for so supporting said opposed ends of the looped section of the tubing as to provide a space along the path of the disk in the groove where substantially no compressing action will be imparted to said tubing by said disk and so permit uninterrupted flow of fluid through the tubing when the disk is located in said space.

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