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(54) **PERISTALTIC COOLING PUMP SYSTEM**

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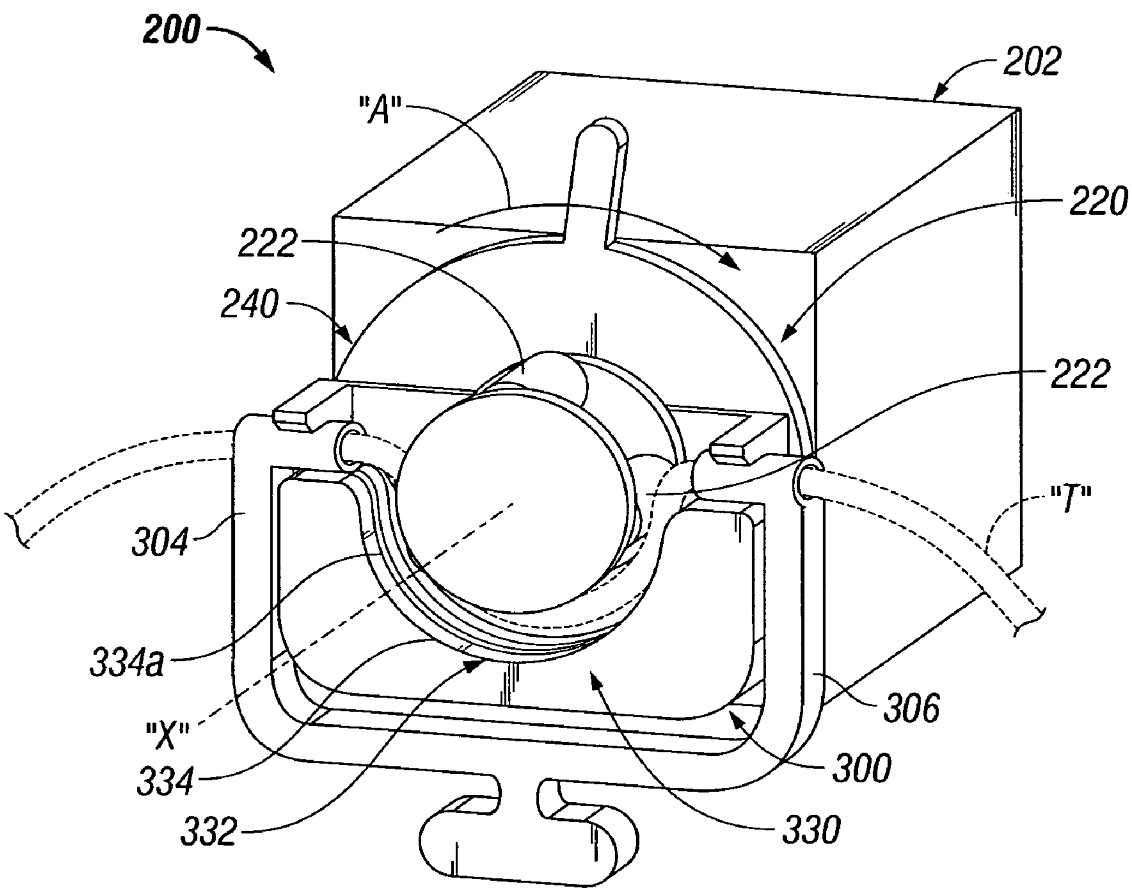
(57) **ABSTRACT**

A peristaltic cooling pump system is provided and includes an actuation housing rotatably supporting a rotor assembly. The rotor assembly includes a plurality of rollers each having an axis of rotation parallel to an axis of rotation of the rotor assembly. The peristaltic cooling pump system further includes a cartridge selectively operably connectable to the actuation housing. The cartridge is configured to operatively support a tube. The tube is made of a resilient and selectively compressible material. Accordingly, when the cartridge is connected to the actuation housing the tube is in operative association with at least one roller of the rotor assembly.



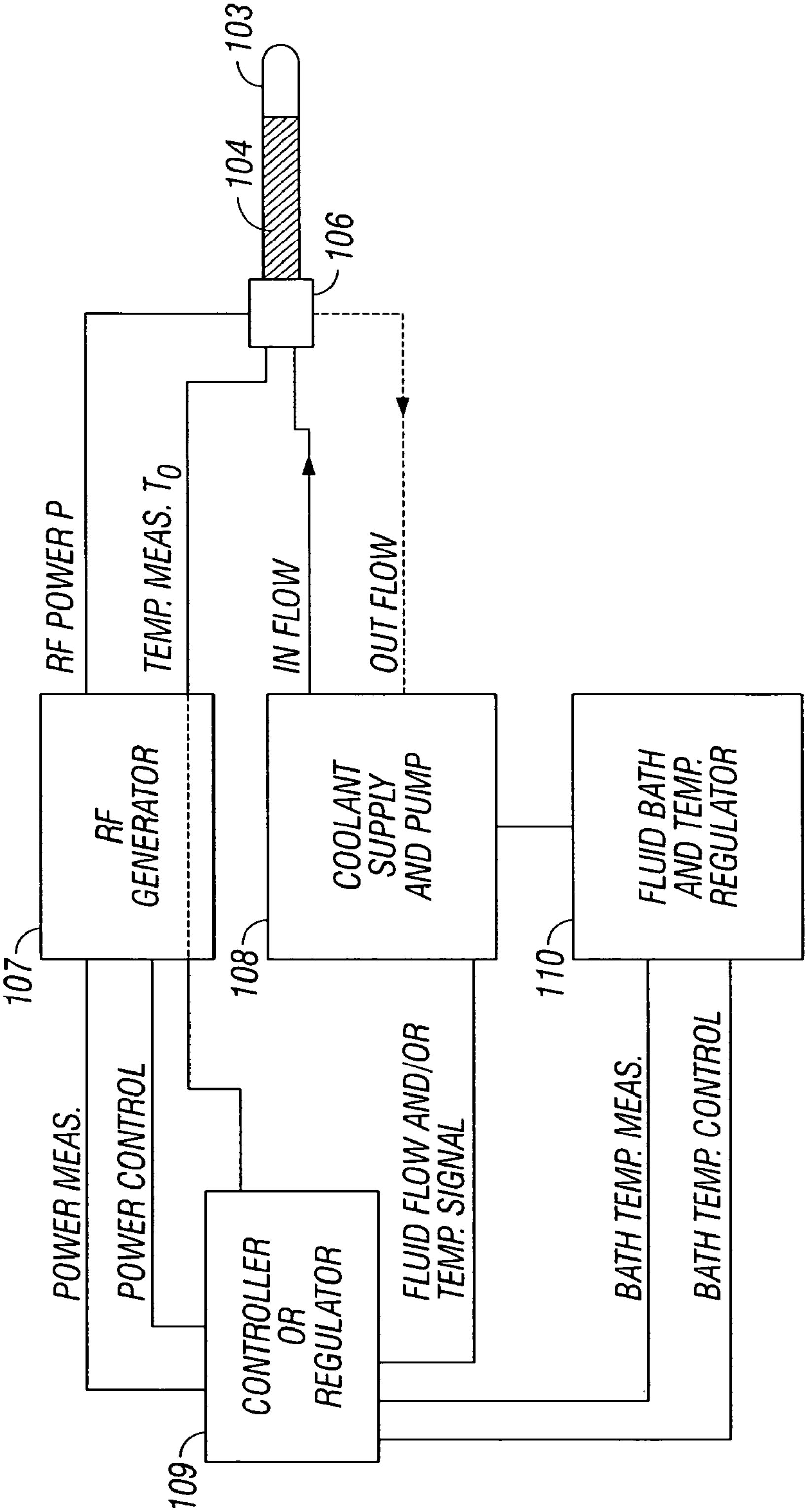


FIG. 1
(Prior Art)

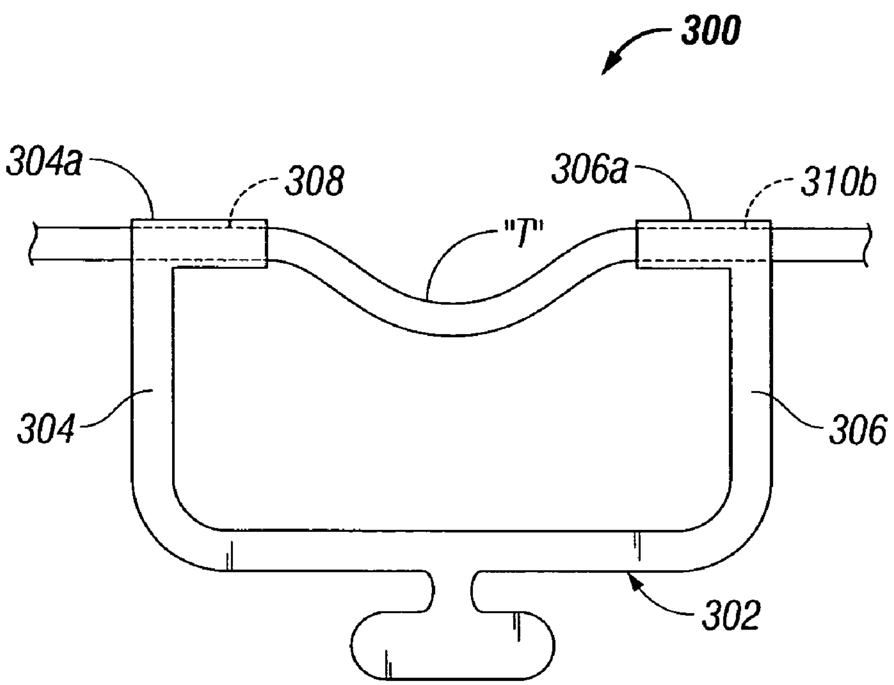

300
304a
308
306a
310b
"T"
304
306
302

FIG. 2

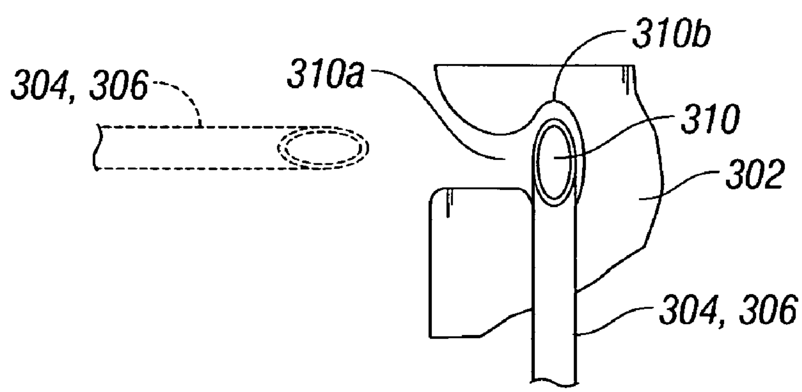

310b
310a
304, 306
310
302
304, 306

FIG. 3

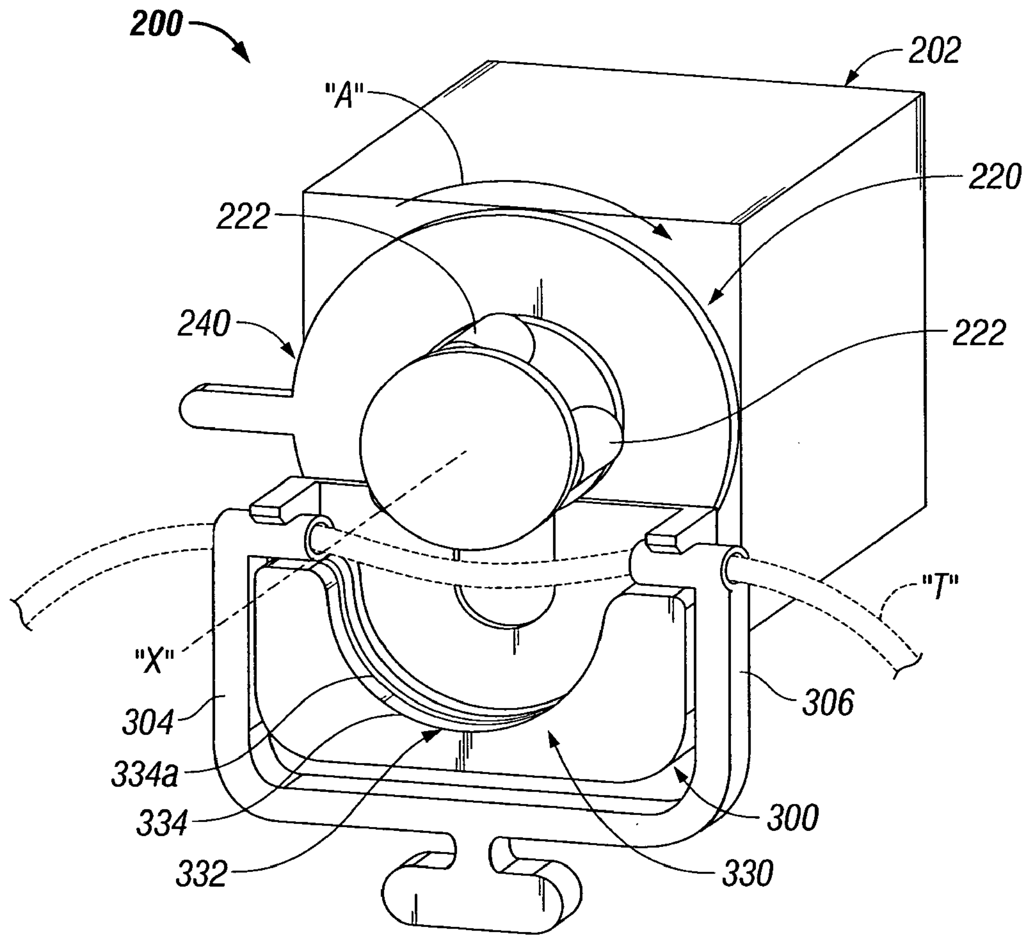


FIG. 4

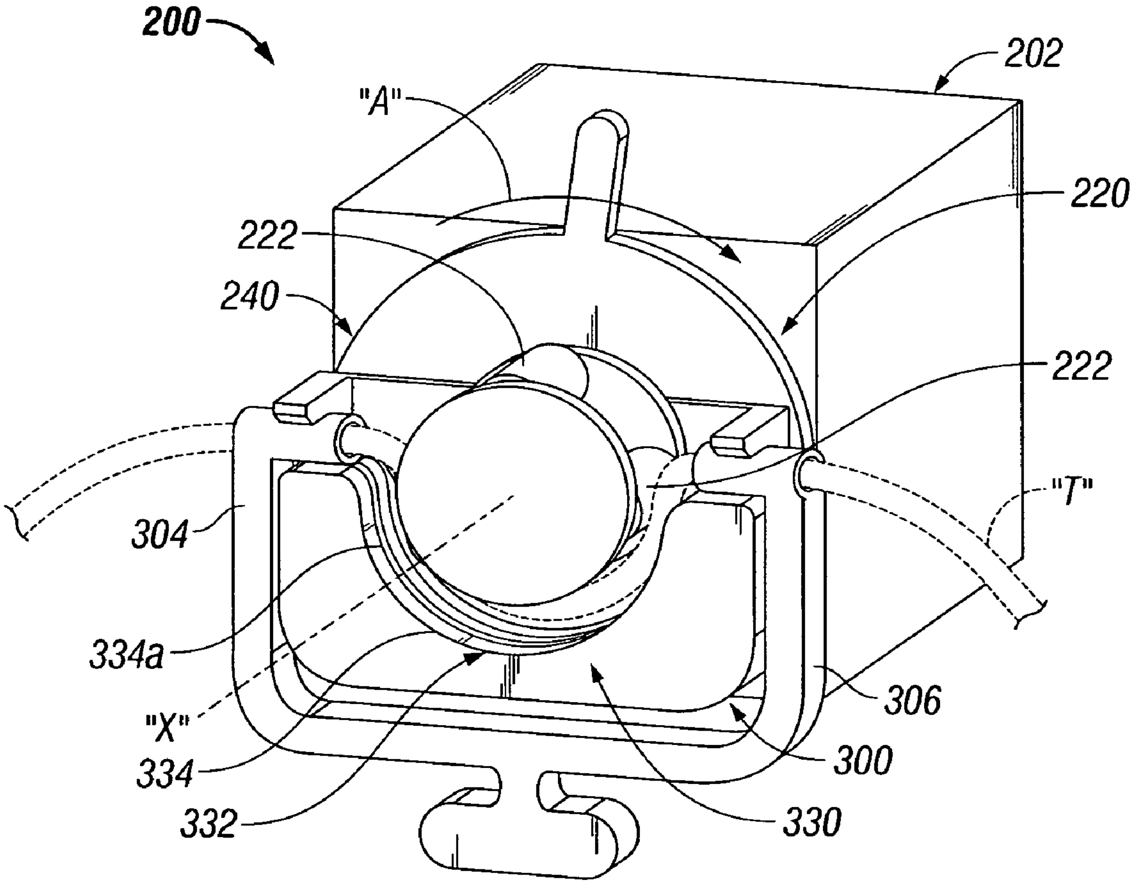


FIG. 5

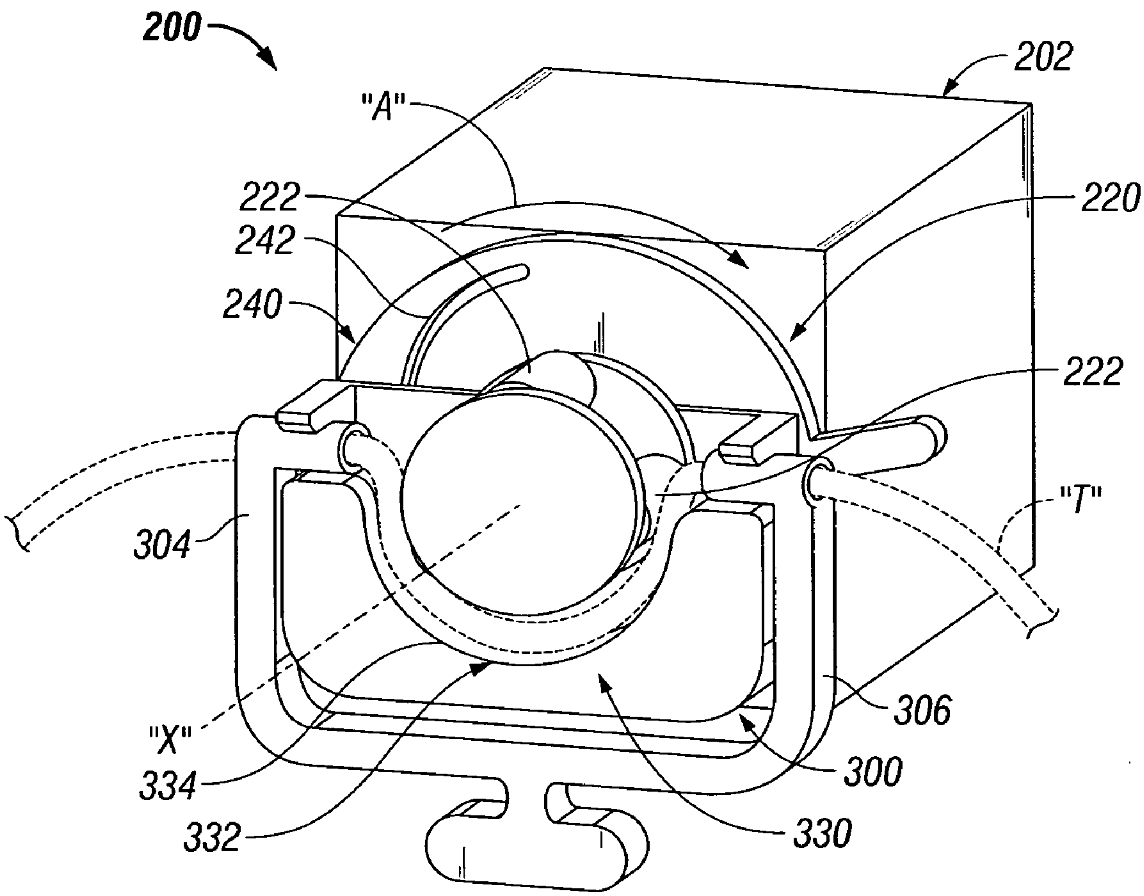


FIG. 6

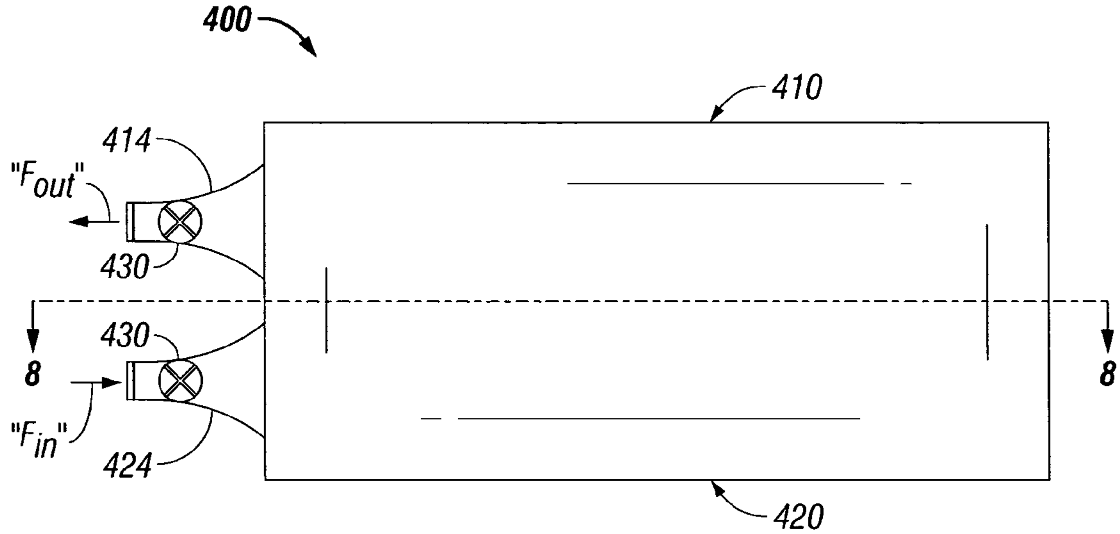

400
410
414
"Fout"
430
430
8
8
"Fin"
424
420

FIG. 7

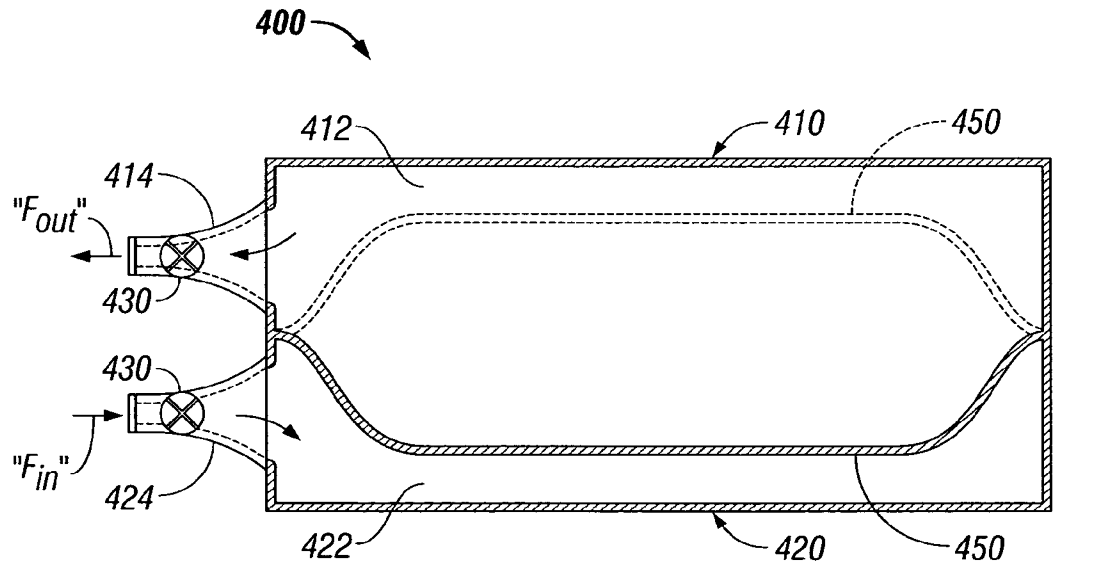

400
412
410
450
414
"Fout"
430
430
"Fin"
424
422
420
450

FIG. 8

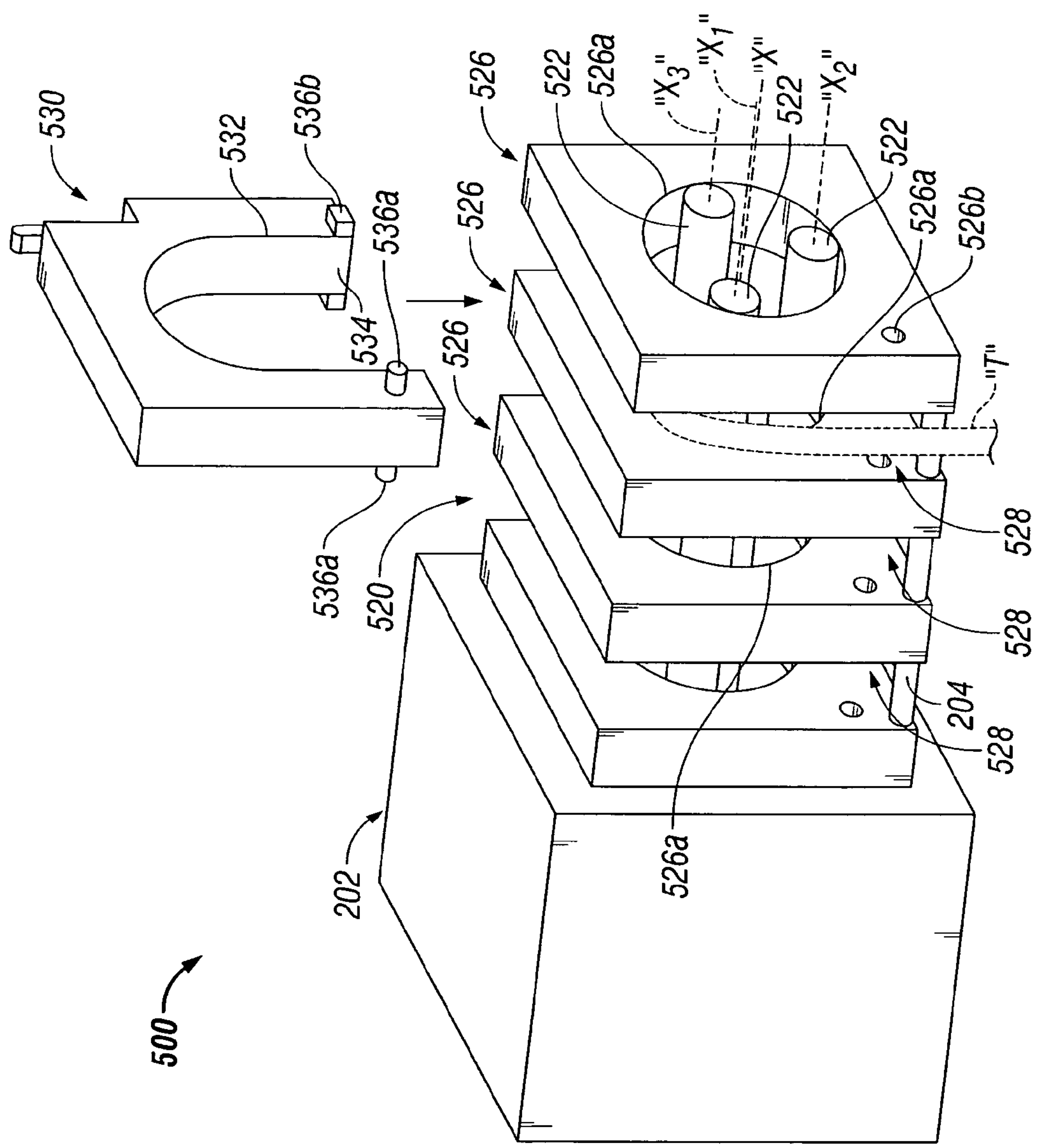

500
202
520
526
526a
522
"X3"
"X1"
"X"
"X2"
530
532
536b
536a
534
526b
"T"
528
204

FIG. 9

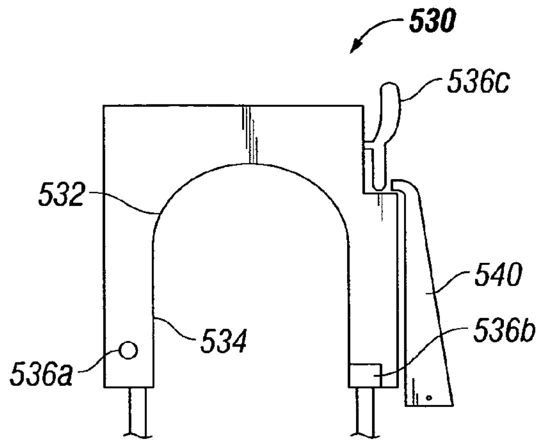

530
536c
532
540
534
536b
536a

FIG. 10

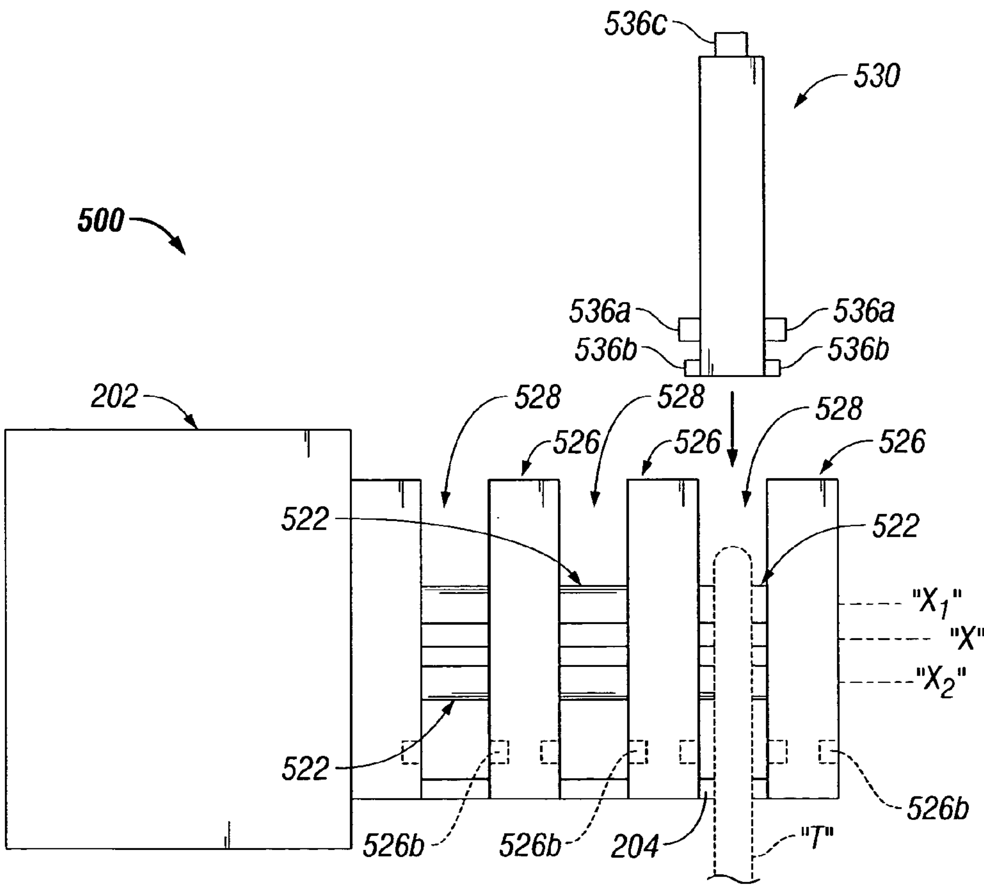

536c
530
500
536a
536a
536b
536b
202
528
528
528
526
526
526
522
522
"X1"
"X"
"X2"
522
526b
526b
526b
204
"T"

FIG. 11

PERISTALTIC COOLING PUMP SYSTEM

BACKGROUND

[0001] 1. Technical Field

[0002] The present disclosure relates to cooling pumps and systems and, more particularly, to peristaltic cooling pumps and/or systems typically used to circulate sterile fluids and the like to a target surgical site and/or through a surgical instrument for cooling and the like.

[0003] 2. Background of Related Art

[0004] A wide variety of pump types have been used in the past for pumping any number of a variety of different liquids for any of a number of different functions and applications. Typically, a peristaltic-type pump is used in connection with many medical applications and is applied externally of the fluid delivery tube. Thus, the peristaltic pump does not interfere with the sterile state which must be maintained for the infusion fluid within the fluid delivery tube.

[0005] Many peristaltic pumps are typically used in medical, biomedical and laboratory applications, including and not limited to, irrigation devices and/or systems, suction devices and/or systems, circulation devices and/or systems, and the like. One example of a peristaltic pump is shown schematically in FIG. **1** and is described in commonly assigned U.S. Pat. No. 6,575,969, the entire contents of which are incorporated herein by reference. This so-called "cool-tip" radiofrequency thermosurgery electrode system includes an example of a pump for circulating cooling fluid.

[0006] More particularly and as seen in FIG. **1**, an insulated electrode shaft **104** with exposed tip **103** is provided for insertion into a patient's body so that tip **103** achieves a target volume to be ablated. A high frequency generator such as a radiofrequency generator **107** is provided for supplying RF power to electrode shaft **104**, as shown by the RF power P line. At the same time, electrode shaft **104**, is provided with a temperature sensor, provides feed back to the RF generator or controller circuit **109** relating to a temperature reading To or multiple temperature readings of a similar nature of the tissue coolant fluid or tip arrangement. Depending upon the temperature reading, the RF output power P may be modified by controller **109** by modulating the RF voltage, current, and/or power level, accordingly, to stabilize the ablation volume or process. If temperature rises to boiling, as indicated by temperature measurement To, the power could be either shut off or severely cut back by generator **107** or controller **109**. Thus a feedback loop between power and temperature (or any other set of parameters associated with the lesion process) can be implemented to make the process safer or to simply monitor the process as a whole.

[0007] As further seen in FIG. **1**, element **108** represents the coolant fluid supply and pump system which can be configured to measure pressure and/or flow. Input flow from element **108** to electrode shaft **104** and output flow are indicated by the arrows to and from the electrode shaft **104** and element **108**, respectively. Accordingly, the controller **109** monitors the procedure and regulates the fluid flow of the coolant between controller **109** and element **108** which, in turn, prevents the electrode from over heating. In conjugation, the combined mediation of flow, power, temperature, or other lesioning parameters could be integrated in controller **109**, and the entire system of generator **107**, element **108**, and controller **109** can be one large feedback control network and system. Fluid bath **110** may also be included with the system as a reservoir of coolant fluid which may also be regulated by controller **109**.

[0008] Typically, element **108**, including the pump, is an integral part of control system **100**. Accordingly, should the pump fail, break down, become contaminated or the like, the entire control system **100** needs to be replaced or extensive work performed on control system **100** in order to replace, remove, sterilize, dispose and/or otherwise treat the pump of element **108**.

SUMMARY

[0009] Accordingly, a need exists for improved pumps and/or systems for use with sterile fluids which overcome at least some of the deficiencies and/or drawbacks of existing pumps and/or systems. A need thus exists for improved pumps and/or pump systems that can be or are sterilized and that are used in connection with the transmission of sterile fluids.

[0010] A further need also exists for improved pumps and/or pump systems that can be selectively coupled and un-coupled to and from an ablation generator as needed and/or desired. Yet another need exists for improved pumps and/or pump systems having interchangeable components, which components may be each individually sterilizable, replaceable and/or disposable. A still further need exists for improved pumps and/or pump systems for use with cool-tip radiofrequency thermosurgery electrode system and improved pumps and/or pump systems having improved fluid management characteristics.

[0011] According to an aspect of the present disclosure, a peristaltic cooling pump system is provided and includes an actuation housing rotatably supporting a rotor assembly. The rotor assembly includes a plurality of rollers each having an axis of rotation parallel to an axis of rotation of the rotor assembly. The peristaltic cooling pump system further includes a cartridge selectively operably connectable to the actuation housing. The cartridge is configured to operatively support a tube. The tube is made of a resilient and selectively compressible material. Accordingly, when the cartridge is connected to the actuation housing the tube is in operative association with at least one roller of the rotor assembly.

[0012] The cartridge may include a supporting body having a pair of spaced apart arms, wherein a first arm defines a lumen formed near a free end thereof and a second arm defines a passage formed near a free end thereof, wherein the tube is extendable across the pair of arms when the tube is operatively associated with the cartridge.

[0013] The lumen formed near the free end of the first arm may be configured and dimensioned to slidably engage the tube when the tube is positioned therein. The passage formed near the free end of the second arm may be configured and dimensioned to fixedly engage the tube when the tube is positioned therein.

[0014] The peristaltic cooling pump system may further include a plurality of dividing walls spaced along a length of the rollers. The dividing walls define pumping regions therebetween. A plurality of cartridges may be provided for operative engagement, one each, into a respective pumping region. Each pumping region may be sized to accommodate a different sized tube. Accordingly, each cartridge may have an occlusion surface having a different diameter.

[0015] The actuation housing may be configured to support a plurality of cartridges thereon. Each cartridge may accommodate a tube having a different cross-sectional dimension.

[0016] The peristaltic cooling pump system may further include a fluid reservoir management system containing a quantity of fluid therein. The fluid reservoir management system is fluidly connected to an inlet and an outlet of the tube. The fluid reservoir management system may include a first reservoir fluidly connectable to an inlet of the tube; a second reservoir fluidly connectable to an outlet of the tube; and a diaphragm separating the first and second reservoirs. In use, prior to the operation of the peristaltic cooling pump system the first reservoir may contain all of the fluid and the second reservoir contains no fluid. Further, during operation of the peristaltic cooling pump system the fluid may travel from the first reservoir, through the tube, to the second reservoir. The diaphragm may be configured to move to contract the first reservoir and expand the second reservoir as fluid is flowing therebetween.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIG. **1** is a schematic diagram of a prior art cool-tip control system for RF heating ablation showing an RF generator, coolant system, fluid bath source and control system that monitors and regulates critical parameters relating to temperature, power and fluid flow;

[0018] FIG. **2** is a schematic plan view of a cartridge according to an embodiment of the present disclosure;

[0019] FIG. **3** is a partially broken away side elevational view illustrating an installation of the cartridge of FIG. **2** into an actuation housing according to an embodiment of the present disclosure;

[0020] FIGS. **4-6** are perspective schematic views of a peristaltic cooling pump system according to an embodiment of the present disclosure, shown at various stages of loading and operation;

[0021] FIG. **7** is a schematic plan view of a fluid reservoir management system for use with the peristaltic pump system of FIGS. **4-6**;

[0022] FIG. **8** is a cross-sectional view of the fluid reservoir management system of FIG. **7**, as taken through line **8-8** of FIG. **7**;

[0023] FIG. **9** is a schematic perspective view of a peristaltic pump system according to an alternate embodiment of the present disclosure;

[0024] FIG. **10** is an elevational view of a cartridge for use with the peristaltic pump system of FIG. **9**; and

[0025] FIG. **11** is side, elevational view of the peristaltic pump system of FIG. **9** illustrating the operative engagement of the cartridge of FIGS. **9** and **10** thereto.

DETAILED DESCRIPTION

[0026] The presently disclosed sterilizable pumps and systems, together with attendant advantages, are best understood by reference to the following detailed description in conjunction with the figures.

[0027] Referring again to FIG. **1**, a prior art control system for RF heating ablation is shown generally as **100**. Control system **100** includes an insulated electrode shaft **104** having an exposed tip **103** for insertion into a patient's body such that exposed tip **103** can achieve a target volume to be ablated. Electrode shaft **104** extends from a hub **106** and includes at least one mechanical interface (not shown) for connecting electrode shaft **104** to RF generator **107** and coolant supply and pump **108**.

[0028] RF generator **107** supplies RF power to electrode shaft **104**, as shown by the RF power connection "P". At the same time, electrode shaft **104** which includes a temperature sensor (not shown), feeds temperature information back to RF generator **107** and/or a controller circuit **109** relating to a temperature reading To or multiple temperature readings of the tissue coolant fluid or tip arrangement. According to the temperature reading, any modulation of the RF output power "P" is accorded by controller **109**. More particularly, controller **109** modulates the RF voltage, current, and/or power level to stabilize the ablation volume or process. If temperature reading To rises to a boiling point, the power is either shut off or severely cut back to generator **107** by controller **109**. Thus a feedback loop between power and temperature (or any other set of parameters associated with the lesion process) can be implemented to monitor the overall process.

[0029] In addition, as seen in FIG. **1**, control system **100** further includes power measurement connections from RF generator **107** to controller **109** and a feedback power control signal from controller **109** to RF generator **107**. The entire heating process may be preconfigured by the operator before the procedure based on the imaging and preplanned calculations of ablation volume verses the tip geometry and other ablation parameters. Thus, controller **109** is capable of regulating the entire heating process by controlling the RF power "P" from generator **107**.

[0030] With continued reference to FIG. **1**, control system **100** further includes a coolant fluid supply and pump system **108** with potential thermo-monitoring, pressure monitoring, flow monitoring, etc. Input flow from coolant fluid supply and pump system **108** to electrode shaft **104** and output flow from the electrode shaft are indicated by the arrows which connect hub **106** and the coolant fluid supply and pump system **108**. Such input and output flow can be monitored by appropriate pressure or flow monitoring elements or detection devices (not shown). These are well known in the fluid control industry. Accordingly, the fluid flow and the temperature of the coolant can be fed back between controller **109** and coolant supply **108** so the controller **109** can regulate the input and output flow. Combined regulation mediation of flow, power, temperature, and/or other lesioning parameters may also be integrated in controller **109**, the generator **107**, and the coolant supply **108**. The controller **109** may also be configured as one large feedback control network and system.

[0031] Control system **100** may also include a reservoir of coolant fluid **110** which may have possible interior temperature regulation within the fluid bath. Bath temperatures and control signals are fed back and forth to controller system **109**. These parameters also could be integrated in the overall control of the ablation process. Indwelling controllers, electronics, microprocessors, or software may be included to govern the entire process or allow preplanned parameters to be configured by the operator based on the selection of a tip geometry and overall ablation volume which are typically selected according to a tumor or pathological volume to be destroyed. Many variants or interconnections of the block diagram shown in FIG. **1** or additions of the diagram could be devised by those skilled in the art of fluid control power and regulation systems.

[**0032**] Turning now to FIGS. **2** and **3**, a cartridge **300**, according to an embodiment of the present disclosure, is shown and described. Cartridge **300** is configured and adapted for use with a peristaltic pump system **200**, as will be described in greater detail below. Cartridge **300** includes a clevis-like supporting body **302** having a pair of upstanding spaced apart arms **304**, **306**. First arm **304** includes a lumen **308** formed in a free end **304***a* thereof. Lumen **308** is configured and dimensioned to permit tube "T" to slide therewithin. Second arm **306** includes a passage **310** formed in a free end **306***a* thereof. Passage **310** is configured and dimensioned to engage tube "T" when tube "T" is properly positioned therewithin such that tube "T" is fixed in position. Tube "T" may be fixed within passage **310** in any suitable manner, such as with a suitable adhesive.

[**0033**] As seen in FIG. **3**, in one embodiment, arms **304**, **306** have an ovular cross-sectional profile. As such, arms **304**, **306** are inserted into an opening **310***a* of an actuation housing **202**. Once a particular arm is inserted into passage **310***a*, the cartridge **300** is rotated approximately 90° such that the long axis of the arm cross-sectional profile is substantially aligned with a longitudinal axis of a pouch **310***b*. In so doing, an arm is thus substantially fixed in position within pouch **310***b*.

[**0034**] Cartridge **300** functions to hold tube "T" in position during connection with the remainder of peristaltic pump system **200**, such that a user does not have to hold tube "T".

[**0035**] Turning now to FIGS. **4-6**, a peristaltic pump system **200** is shown, in accordance with an embodiment of the present disclosure, for use in control system **100** and with coolant supply **108**. Pump system **200** includes a rotor assembly **220** rotatably supported on an actuation housing **202**. Actuation housing **202** may include a drive mechanism (e.g., a drive motor or the like) which is adapted for delivering either forward or reverse rotation to rotor assembly **220**. As will be described in greater detail below, rotor assembly **220** functions to repetitively compress tube "T" in order to squeeze fluid contained within tube "T" therefrom and to create or produce a volumetric pumping effect through tube "T".

[**0036**] As seen in FIGS. **4-6**, rotor assembly **220** includes a plurality of rollers **222** rotatably supported at the free ends of a frame (not shown). The axis of rotation of each roller **222** is parallel to an axis of rotation "X" of rotor assembly **220**. For example, each roller **222** may be supported near a free end of a spoke, which spoke is secured or otherwise operatively connected to a rotational drive shaft of the drive mechanism (not shown). Accordingly, in use, as the shaft of the drive mechanism is rotated, the rollers **222** rotate in a planetary orbit around rotational axis "X" of rotor assembly **220**.

[**0037**] While only two rollers **222** are shown in FIGS. **4-6**, three, evenly spaced apart rollers may be provided. Rotor assembly **220** may be provided with any number of rollers **222** or may be provided with any other appropriate structure for accomplishing the volumetric pumping effect desired.

[**0038**] As seen in FIGS. **4-6**, pump system **200** further includes cartridge **300**, as described above, operatively supported by actuation housing **202** and operatively engagable with rollers **222** of rotor assembly **220**. Actuation housing **202** includes a frame **330** that defines an annular recess **332** defining an occlusion surface **334** formed in a surface thereof. Occlusion surface **334** of frame **330** is configured and dimensioned for operative association with rollers **222** of rotor assembly **220** and with a section of tube "T" (i.e., the section of tube "T" disposed between arms **304**, **306** of cartridge **300**). Occlusion surface **334** of frame **330** may include a groove **334***a* extending along the length thereof which is configured and dimensioned to at least partially receive the portion of tube "T" therein. Occlusion surface **334** may extend for approximated **1800**.

[**0039**] As seen in FIGS. **4-6** and described above in FIG. **3**, cartridge **300** is mounted to actuation housing **202** such that tube "T" is placed into operative engagement between rollers **222** of rotor assembly **220** and occlusion surface **334** of frame **330**. Tube "T" may be fabricated from an elastomeric material that allows for tube "T" to be compressed between rollers **222** and occlusion surface **332** and that returns to its un-compressed condition when not between rollers **222** and occlusion surface **332**.

[**0040**] With continued reference to FIGS. **4-6**, pump system **200** is further provided with an engaging mechanism **240** configured and adapted to move actuation housing **202** toward and away from rotor assembly **220** to thereby secure tube "T" therebetween and to vary the flow rate of fluid through tube "T". As seen through FIGS. **4-6**, rotation of engaging mechanism **240**, in the direction of arrow "A" about the rotational axis "X", results in the movement of actuation housing **202** toward rotor assembly **220**. Likewise, rotation of engaging mechanism **240**, in the direction opposite to arrow "A" about the rotational axis "X", results in the movement of actuation housing **202** away from rotor assembly **220**.

[**0041**] As seen in FIG. **4**, with tube "T" operatively supported in cartridge **300**, cartridge **300** is mounted to actuation housing **202** such that cartridge **300** is spaced a distance away from rotor assembly **220**. With cartridge **300** mounted to actuation housing **202** and tube "T" positioned between frame **330** and rotor assembly **220**, engaging mechanism **240** is rotated, in the direction of arrow "A", to approximate actuation housing **202** toward rotor assembly **220**. Engaging mechanism **240** is rotated an amount sufficient to securely clamp tube "T" between frame **330** and rotor assembly **220**, as seen in FIG. **5**.

[**0042**] With reference now to FIGS. **5** and **6**, the use of engaging mechanism **240** to control of the rate of fluid flow through tube "T" is shown. Engaging mechanism **240** includes an indicator **242** which illustrates the degree of the rate of fluid flow through tube "T". In use, the greater the amount of indicator **242** that is visible the greater the rate of fluid flow through tube "T". Accordingly, as seen in FIG. **5**, a relatively small amount of indicator **242** is visible and thus a relatively small rate of fluid will flow through tube "T". As seen in FIG. **6**, a relatively larger amount of indicator **242** is visible and thus a relatively greater rate of fluid will flow through tube "T".

[0043] Adjustment of the rate of fluid flow through tube "T" is accomplished by further rotation of engagement mechanism **240** about the rotational axis "X", in the direction of arrow "A". The greater the degree of rotation of engagement mechanism **240** about the rotational axis "X", the more actuation housing **202** is approximated toward rollers **222** of rotor assembly **220** and the greater the degree of compression of tube "T" by rollers **222** of rotor assembly **220** against occlusion surface **334** of frame **330**. In operation, the greater the degree of compression of tube "T" between rollers **222** of rotor assembly **220** against occlusion surface **334** of frame **330** the greater the rate of fluid flow through tube "T".

[0044] In operation, when fluid "F" is pumped through tube "T", fluid "F" is pumped to the operative site (i.e., to electrode shaft **104**) to thereby maintain the operative site at a substantially constant temperature during the surgical procedure. Engagement mechanism **240** may be provided with tactile feedback structure (not shown), which provides the user with sensory feedback during the rotation of engagement mechanism **240** about the rotational "X" axis.

[0045] Turning now to FIGS. **7** and **8**, a fluid reservoir management system for use with the peristaltic pump system of FIGS. **2-6** (or any of the pump systems disclosed herein), is shown and is generally designated as **400**. Fluid management reservoir **400** includes a pair of bladders **410** and **420** each defining a chamber or reservoir **412** and **422**, respectively. A respective nozzle **414**, **424** is operatively connected to each bladder **410**, **420** for providing access to each chamber or reservoir **412**, **422**. Valves **430***a*, **430***b* are fluidly connected to each nozzle **414**, **424**, respectively, and provide selective opening and closing of bladders **410**, **420**.

[0046] Chambers or reservoirs **412**, **422** are fluidly separated from one another. Bladders **410**, **420** may be fabricated from any material known by one having skill in the art, including and not limited to pliable, flexible and/or elastomeric materials; rigid, non-flexible materials or any combinations thereof.

[0047] A first end of tube "T" is connectable to nozzle **414** of first reservoir **412**, through valve **430***a*, while a second end of tube "T is connectable to second reservoir **422**, through valve **430***b*. Prior to operation or use of fluid reservoir management system **200** first reservoir **412** of first bladder **410** is filled with a fluid, such as distilled or sterile water, while second reservoir **422** of second bladder **420** is empty. In use, as pump system **200** is in operation, fluid "F_{out}" is drawn out of first reservoir **412** and communicated through tube "T" passing through pump system **200**, and fluid "F_{in}" is deposited into second reservoir **422**. Pump system **200** also delivers fluid to the target surgical site before returning the fluid to the second reservoir **422**.

[0048] Effectively, fluid management reservoir **400** is a single use-type reservoir. Once the initial fluid contained within first reservoir **412** is completely used and deposited within second reservoir **422**, fluid management reservoir **400** is replaced with a new fluid management reservoir.

[0049] Fluid management reservoir **400** includes a diaphragm **450** separating first reservoir **410** from second reservoir **420**. In operation, as fluid flows from first reservoir **412** to second reservoir **422**, thereby emptying first reservoir **412** and filling second reservoir **422**, diaphragm **450** moves from second reservoir **422** toward first reservoir **412** thereby constricting first reservoir **412** and expanding second reservoir **422**.

[0050] Turning now to FIGS. **9-11**, a peristaltic pump system in accordance with another embodiment of the present disclosure, for use in control system **100** and with coolant supply **108**, is shown generally as **500**. Pump system **500** includes a rotor assembly **520** rotatably supported on an actuation housing **202**. Actuation housing **202** may include a drive mechanism (e.g., a drive motor or the like) which is adapted for delivering either forward or reverse rotation to rotor assembly **220**. As will be described in greater detail below, rotor assembly **220** functions to repetitively compress at least one tube "T" in order to squeeze fluid contained within the tube(s) "T" therefrom and create or produce a volumetric pumping effect through tube(s) "T".

[0051] As seen in FIGS. **9** and **11**, rotor assembly **520** includes a plurality of rollers **522** extending from actuation housing **202**. Rollers **522** are rotatably connected to actuation housing **202** in such a manner so as to rotate about a central axis of rotation "X" for rotor assembly **520**. Each roller **522** may define an axis "X_n" of rotation which is parallel to axis of rotation "X" of rotor assembly **520**. For example, each roller **522** may be operatively supported in actuation housing **202** in such a manner that rollers **522** are rotatable about the central rotational "X" axis, and each roller **522** is rotatable about their respective longitudinal axes "X_n".

[0052] While only three rollers **522** are shown in FIG. **9**, rotor assembly **520** may include any suitable number of rollers **522** or may include any other appropriate structure.

[0053] As seen in FIGS. **9** and **11**, pump system **500** includes a plurality of dividing walls **526** disposed along the length of rollers **522**. Each dividing wall **526** is provided with an aperture **526***a* through which rollers **522** extend. In this manner, a plurality of pumping regions **528** are defined between dividing walls **526**. Dividing walls **526** are supported on actuation housing **202** by a beam, arm or the like **204** extending from actuation housing **202**.

[0054] As seen in FIGS. **9-11**, pump system **500** further includes at least one cartridge **530** which is selectively, and operatively positionable in pumping regions **528**. Cartridge **530**, when positioned in pumping region **528** resides in operative engagement with rollers **522** of rotor assembly **520**. Cartridge **530** includes an annular recess **532** which defines an occlusion surface **534** formed in a surface thereof. Occlusion surface **534** of cartridge **530** is configured and dimensioned for operative association with rollers **522** of rotor assembly **520** and with a section of tube "T". Occlusion surface **534** may extend for approximated 180°.

[0055] Each cartridge **530** is configured and adapted for engagement in any of pumping regions **528**. In particular, each cartridge **530** includes a locking element **536***b* (see FIGS. **10** and **11**) that is configured and adapted for selective snap-fit engagement in a complementary locking feature **526***b* (see FIG. **11**) provided in dividing walls **526**. Cartridge **530** may be pivotally connected to dividing walls **526** by way of a pivot pin **536***a* (see FIG. **10**) or the like. Cartridge **530** may also be provided with a finger tab **536***c* for facilitating movement of cartridge **530** between a position in which occlusion surface **534** is in close cooperative arrangement with rollers **522** and a second position in which occlusion surface **534** is in spaced non-cooperative arrangement with rollers **522**.

[**0056**] In operation, when tube "T" is positioned in a pumping region **528** and a respective cartridge **530** is moved to a close cooperative arrangement with rollers **522**, fluid may be pumped through tube "T" and to the operative site (i.e., to electrode shaft **104**) to thereby maintain the operative site at a substantially constant temperature during the surgical procedure.

[**0057**] In accordance with the present embodiment, a plurality of tubes "T" may be placed in respective pumping regions **528** and respective cartridges **530** may be used to operatively engage tubes "T" and create a pumping action through the tubes "T" as the rotor assembly **520** is rotated. In this manner, a plurality of different cooling paths or circuits are defined, more particularly, a plurality of discrete fluid paths are defined. In other words, the fluid from one cooling path does not mix with the fluid from another fluid path.

[**0058**] Tubes "T" of varying diameters may be placed into various pumping regions **528** in order to pump varying volumes of fluid at varying rates. Dividing walls **526** may be spaced by varying amounts in order to define pumping region **528** of varying sizes which in turn can accommodate tubes "T" of various sizes. Accordingly, it is envisioned that cartridges **530** must be provided in varying sizes to cooperate and complement the sizes of the pumping regions **528**.

[**0059**] Additionally, occlusion surface **534** of cartridge **530** may have a relatively larger or smaller diameter depending on the size of tube "T" which is being used. For example, if a relatively larger diameter tube "T" is being used, a cartridge **530** having an occlusion surface **534** with a relatively larger diameter will be used. Likewise, if a relatively smaller diameter tube "T" is being used, a cartridge **530** having an occlusion surface **534** with a relatively smaller diameter will be used.

[**0060**] Cartridges **530** may be provided with tactile feedback structure (not shown) which provides the user with sensory feedback during the connection and/or placement of cartridges **530** into pumping regions **528**.

[**0061**] As seen in FIG. **10**, pump system **500** may include a latch structure **540** or the like for locking and maintaining cartridge **530** into position between walls **526** and against tube "T".

[**0062**] Although illustrative embodiments of the present disclosure are described herein, the disclosure is not limited to those embodiments, and various other changes and modifications may be affected therein by one skilled in the art without departing from the scope or spirit of the disclosure. All such changes and modifications are intended to be included within the scope of the present disclosure.

What is claimed is:

1. A peristaltic cooling pump system, comprising:

an actuation housing rotatably supporting a rotor assembly, the rotor assembly including a plurality of rollers each having an axis of rotation parallel to an axis of rotation of the rotor assembly; and

a cartridge selectively operably connectable to the actuation housing, the cartridge being configured to operatively support a tube, wherein the tube is resilient and selectively compressible, wherein when the cartridge is connected to the actuation housing the tube is in operative association with at least one roller of the rotor assembly.

2. The peristaltic cooling pump system according to claim 1, wherein the cartridge includes:

a supporting body having a pair of spaced apart arms, wherein a first arm defines a lumen formed near a free end thereof and a second arm defines a passage formed near a free end thereof, wherein the tube is extendable across the pair of arms when the tube is operatively associated with the cartridge; and

the actuation housing having a frame, the frame defining an occlusion surface having a substantially arcuate profile, wherein the tube is operatively engagable with the occlusion surface when the cartridge is in operative engagement with the actuation housing.

3. The peristaltic cooling pump system according to claim 2, wherein the lumen formed near the free end of the first arm is configured and dimensioned to slidably engage the tube when the tube is positioned therein.

4. The peristaltic cooling pump system according to claim 2, wherein the passage formed near the free end of the second arm is configured and dimensioned to fixedly engage the tube when the tube is positioned therein.

5. The peristaltic cooling pump system according to claim 4, wherein the actuation housing is configured to snap-fit engage the cartridge therein.

6. The peristaltic cooling pump system according to claim 2, further comprising an engaging mechanism for approximating the actuation housing toward the rotor assembly.

7. The peristaltic cooling pump system according to claim 6, wherein approximation of the actuation housing towards the rotor assembly compresses the tube between at least one roller and the frame.

8. The peristaltic cooling pump system according to claim 2, further comprising a plurality of dividing walls spaced along a length of the rollers, wherein the dividing walls define pumping regions therebetween.

9. The peristaltic cooling pump system according to claim 8, wherein a plurality of cartridges are provided for operative engagement, one each, into a respective pumping region.

10. The peristaltic cooling pump system according to claim 9, wherein each pumping region is sized to accommodate a different sized tube.

11. The peristaltic cooling pump system according to claim 10, wherein each cartridge has an occlusion surface having a different diameter.

12. The peristaltic cooling pump system according to claim 2, wherein the actuation housing is configured to support a plurality of cartridges thereon.

13. The peristaltic cooling pump system according to claim 12, wherein each cartridge accommodates a tube having a different cross-sectional dimension.

14. A peristaltic cooling pump system, comprising:

an actuation housing rotatably supporting a rotor assembly, the rotor assembly including a plurality of rollers each having an axis of rotation parallel to an axis of rotation of the rotor assembly;

a cartridge selectively connectable to the actuation housing and being configured to support a tube, wherein the tube is resilient and selectively compressible, wherein when the cartridge is connected to the actuation housing the tube is in operative association with at least one roller of the rotor assembly;

the cartridge including a supporting body having a pair of spaced apart arms, wherein a first arm defines a lumen formed near a free end thereof and a second arm defines a passage formed near a free end thereof, wherein the tube is extendable across the pair of arms when the tube is operatively associated with the cartridge;

the actuation housing having a frame, the frame defining an occlusion surface having a substantially arcuate profile, wherein the tube is operatively engagable with the occlusion surface when the cartridge is in operative engagement with the actuation housing; and

a fluid reservoir management system containing a quantity of fluid therein, wherein the fluid reservoir management system is fluidly connected to an inlet and an outlet of the tube.

15. The peristaltic cooling pump system according to claim 14, wherein the fluid reservoir management system includes:

a first reservoir fluidly connectable to an inlet of the tube;

a second reservoir fluidly connectable to an outlet of the tube; and

a diaphragm separating the first and second reservoirs.

16. The peristaltic cooling pump system according to claim 15, wherein, prior to operation of the peristaltic cooling pump system, the first reservoir contains all of the fluid and the second reservoir contains no fluid.

17. The peristaltic cooling pump system according to claim 15, wherein, during operation of the peristaltic cooling pump system, the fluid travels from the first reservoir, through the tube, to the second reservoir.

18. The peristaltic cooling pump system according to claim 17, wherein the diaphragm is configured to move to contract the first reservoir and expand the second reservoir as fluid is flowing therebetween.

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