United States Patent	12390587
Kind Code	B2
Date of Patent	August 19, 2025
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Circular roller clamp assembly

Abstract

A circular roller clamp assembly includes a semi-circular housing configured to receive a portion of an IV tube and a roller coupled to an arm, the roller configured to be movably received by a guide groove disposed in the semi-circular housing. The roller clamp assembly is configured to regulate a flow rate of fluid flowing through the IV tube based on engagement of the roller with the IV tube via circumferential movement of the roller along the guide groove. IV sets with circular roller clamp assemblies and methods of operating circular roller clamp assemblies are also provided.

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Appl. No.: **18/758350**

Filed: **June 28, 2024**

Prior Publication Data

Document Identifier	Publication Date
US 20240350726 A1	Oct. 24, 2024

Related U.S. Application Data

continuation parent-doc US 17969080 20221019 US 12053613 child-doc US 18758350
us-provisional-application US 63279959 20211116

Publication Classification

Int. Cl.: **A61M5/168** (20060101); **A61M39/28** (20060101); **F16L3/10** (20060101)

U.S. Cl.:

CPC **A61M5/16881** (20130101); **A61M5/16886** (20130101); **A61M39/28** (20130101); **F16L3/1041** (20130101); A61M2205/103 (20130101)

Field of Classification Search

CPC: A61M (5/16881); A61M (5/16886); A61M (39/28); A61M (2205/103); A61M (2205/10); A61M (2205/3334); A61M (2205/3561); A61M (2205/3576); A61M (2205/50); A61M (2205/8206); A61M (5/172); A61M (39/286); A61M (5/16813); A61M (5/16831); A61M (39/287); A61M (2205/3379); F16L (3/1041)

USPC: 248/74.1

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS (1) This application is a continuation of U.S. patent application Ser. No. 17/969,080, entitled “CIRCULAR ROLLER CLAMP

ASSEMBLY," filed on Oct. 19, 2022, which issued as U.S. Pat. No. 12,053,613 on Aug. 6, 2024, which claims the benefit of priority under 35 U.S.C. § 119 to U.S. Provisional Patent Application No. 63/279,959, entitled "CIRCULAR ROLLER CLAMP ASSEMBLY," filed on Nov. 16, 2021, the entirety of which is incorporated herein by reference.

TECHNICAL FIELD

(1) The present disclosure generally relates to a gravity intravenous (IV) set or infusion pump flow control device, and in particular a circular roller clamp assembly.

BACKGROUND

(2) Flow controllers in the form of roller clamps are used in the medical field for IV applications. Typical roller clamps control a flow rate through an IV tube by clamping the tube in between a roller wheel and a linear housing having a relatively short length. This approach, for one, provides a limited range of flow rate control because the roller wheel is essentially too sensitive in that a small movement of the roller wheel or dimension change causes a large change in flow rate of the fluid through the tube. Thus, the relatively course flow rate change provided by a typical roller clamp makes it difficult to provide precise flow control.

(3) Also, typical roller clamps have flow rate drifting issues based on slippage of the roller wheel, such as when fluid pressure in the tube causes the roller wheel to roll back from the adjusted position. Further, typical roller clamps are manual devices that require a user, such as a health care clinician, to adjust the roller clamp by hand. In addition, typical roller clamps are not reusable devices and are disposed of with the rest of the IV set when the IV set is thrown out.

(4) Thus, it is desirable to provide an automated roller wheel assembly that provides a large range of flow control resolution, allows for simple motor connections and eliminates or minimizes roller wheel slippage.

SUMMARY

(5) In one or more embodiments, a circular roller clamp assembly comprises: a semi-circular housing configured to receive a portion of an intravenous (IV) tube; and a roller coupled to an arm, the roller configured to be movably received by a guide groove disposed in the semi-circular housing, wherein the roller clamp assembly is configured to regulate a flow rate of fluid flowing through the IV tube based on engagement of the roller with the IV tube via circumferential movement of the roller along the guide groove.

(6) In one or more embodiments, an IV set comprises: an IV tube configured to be coupled to a fluid container; an infusion component coupled to the IV tube; and a roller clamp assembly coupled to the IV tube, the roller clamp assembly comprising: a semi-circular housing configured to receive the IV tube; and a roller configured to be movably received by a guide groove disposed in the semi-circular housing, wherein the roller clamp assembly is configured to regulate a flow rate of fluid flowing through the IV tube based on engagement of the roller with the IV tube via circumferential movement of the roller along the guide groove.

(7) In one or more embodiments, a method of operating a circular roller clamp assembly comprises: pulling a roller radially outward from a guide groove disposed in a perimeter surface of a semi-circular housing of the roller clamp assembly; placing an intravenous (IV) tube between roller and the guide groove; releasing the roller; contracting, by a biasing force, the roller radially inward towards the IV tube and the guide groove; pressing, by the roller, the IV tube against a varying sized tube channel disposed within the guide groove; moving the roller towards a smaller sized portion of the tube channel to increase impingement of the IV tube by the roller and decrease a rate of fluid flow through the IV tube; and moving the roller towards a larger sized portion of the tube channel to decrease impingement of the IV tube by the roller and increase the rate of fluid flow through the IV tube.

(8) The foregoing and other features, aspects and advantages of the disclosed embodiments will become more apparent from the following detailed description and accompanying drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) The accompanying drawings, which are included to provide further understanding of the disclosure and are incorporated in and constitute a part of this specification, illustrate embodiments of the disclosure and together with the description serve to explain the principles of the disclosure.

(2) FIG. **1** depicts a perspective view of an example infusion set having a typical roller clamp.

(3) FIG. **2** depicts a cross-section side view of the roller clamp of FIG. **1**.

(4) FIG. **3** depicts a perspective view of an IV pole with a circular roller clamp assembly, according to aspects of the disclosure.

(5) FIG. **4** depicts a perspective view of the IV pole with a circular roller clamp assembly of FIG. **3**, according to aspects of the disclosure.

(6) FIG. **5** depicts a perspective view of the circular roller clamp assembly of FIG. **3**, according to aspects of the disclosure.

(7) FIG. **6** depicts a front view of the circular roller clamp assembly of FIG. **3**, according to aspects of the disclosure.

(8) FIG. **7** depicts a rear view of the circular roller clamp assembly of FIG. **3**, according to aspects of the disclosure.

(9) FIG. **8** depicts a cross-section perspective view of the circular roller clamp assembly of FIG. **3**, according to aspects of the disclosure.

(10) FIG. **9** depicts a cross-section perspective view of a motor arm of a circular roller clamp assembly, according to aspects of the disclosure.

(11) FIG. **10** illustrates a method of operating a circular roller clamp assembly, according to aspects of the disclosure.

DETAILED DESCRIPTION

(12) The detailed description set forth below describes various configurations of the subject technology and is not intended to represent the only configurations in which the subject technology may be practiced. The detailed description includes specific details for the purpose of providing a thorough understanding of the subject technology. Accordingly, dimensions are provided in regard to certain aspects as non-limiting examples. However, it will be apparent to those skilled in the art that the subject technology may be practiced without these specific details. In some instances, well-known structures and components are shown in block diagram form in order to avoid obscuring the concepts of the subject technology.

(13) It is to be understood that the present disclosure includes examples of the subject technology and does not limit the scope of the appended claims. Various aspects of the subject technology will now be disclosed according to particular but non-limiting examples. Various embodiments described in the present disclosure may be carried out in different ways and variations, and in accordance with a desired application or implementation.

(14) The present disclosure relates to a roller clamp and in particular to a roller clamp for use in gravity infusion. The roller clamp regulates the flow rate of a medical fluid (for example a solution of a drug to be administered to a patient, or blood) flowing through a tube. Typically, a standard infusion set is used to infuse the fluid. An example of a standard infusion set is shown in FIG. **1**.

(15) The infusion set includes a piercing spike **20** which may either be a sharp spike for piercing rubber stoppers or rounded and blunt for insertion into a bag. The spike contains one channel for fluid and optionally a second channel for venting. A vent **21** is usually present in the vicinity of the piercing spike to allow air to flow into the drop chamber **22**. The vent **21** may be provided with a

bacterial filter to prevent bacteria from entering the equipment.
(16) The drop chamber **22** has a drop generator **23** at the top of the drop chamber **22** that produces drops of a certain size. Drops from the drop generator **23** fall into the drop chamber **22** such that the drop chamber **22** is partially filled with liquid. This prevents air bubbles from entering the connector tube **24**, which would be harmful to a patient. A particle filter may be provided at the lower aperture of the drop chamber **22**.
(17) The connector tube **24** connects the drop chamber **22** with the patient. The connector tube **24** is usually around 150 cm long and can be manufactured from PVC. The tube **24** is shown shortened in FIG. **1** for clarity. The connector tube **24** typically has a continuous diameter throughout the length of the tube.
(18) At the end of the connector tube **24** is a Luer fitting **25** which is standardized for connection to all other pieces of apparatus having a standard Luer cone. The person skilled in the art will appreciate that the Luer fitting **25** can be fitted to a hypodermic needle (not shown) for infusing the medical fluid into the circulatory system of a patient (e.g., into a vein).
(19) Between the drop chamber **22** and the Luer fitting **25** and engaging with the connector tube **24**, is a roller clamp **26**. The present disclosure is concerned with an improved roller clamp assembly, but a typical roller clamp **26** as known in the art will now be described for background information.
(20) The roller clamp **26** illustrated in FIG. **2** has two opposing side walls **27** having a pair of guide grooves **30** that are aligned with each other and face each other. A flow-regulating roller **28** is provided having axially-projecting shafts **29** protruding from the centers of each side of the roller **28**. The roller **28** is shown in outline for clarity. The shafts **29** of the roller **28** are captured by and seated in the guide grooves **30** so that the roller **28** can move up and down the guide grooves **30** as indicated by the arrows in FIG. **2**.
(21) The entire roller clamp **26** has four walls (see FIG. **1**) in an open-ended boxlike construction and is dimensioned and configured to receive the connector tube **24**. In use, the tube **24** passes through the roller clamp **26**, between the two opposing side walls **27**, the roller **28** and a guide wall **31** that is opposed to the roller **28**.
(22) In the roller clamp **26**, the surface of the guide wall **31** converges along its length toward the position of the guide grooves **30** in the downward direction of the guide grooves **30** (e.g., in the direction of the arrows in FIG. **2**). This tends to urge the connector tube **24** within the roller clamp **26** toward the guide grooves **30** and thus toward roller **28**.
(23) Thus, rolling the roller **28** downwardly along the guide grooves **30** in the direction of the gradually closer guide wall **31** in the direction of the arrows causes the roller **28** to impinge against the connector tube **24**. As the roller **28** impinges on the tube **24**, the tube **24** becomes squeezed, as it is a flexible material such as PVC, and the lumen of the infusion tube **24** therefore becomes smaller. In this way, by narrowing of the lumen, the flow rate of liquid passing through the connector tube **24** can be regulated.
(24) Thus, the roller clamp **26** controls the flow rate through the infusion tube **24** by clamping the infusion tube **24** between the roller **28** and the guide wall **31**. As discussed above, this provides for a course flow rate change because a small movement of the roller **28** causes a large change in the flow rate of the fluid through the tube **24**. Also, the force of the fluid in the tube **24** exerts a biasing force against the roller **28**, which often leads to slippage of the roller **28** (e.g., the roller **28** rolls back) from the adjusted position. In addition, the roller clamp **26** requires manual adjustment and is not suitable for automated or processor controlled adjustment.
(25) With reference to FIGS. **3-9**, a circular roller clamp assembly **100** is shown mounted to an IV pole **190**. The circular roller clamp assembly **100** has a housing **110** having a semi-circular construction and is dimensioned and configured to receive tubing, such as connector tube **24** (see FIG. **4**). Two opposing side walls **112** define a guide groove **120** that receives a flow-regulating roller **130** that is disposed on an axially-projecting shaft **132** coupled to a motor arm **140** of a motor **150**. The shaft **132** is positioned outside outer peripheral walls **114** of the housing **110** so that the

roller **130** can move circumferentially along and within the guide groove **120**.

(26) Two inner peripheral walls **116** extend inward from the opposing side walls **112** and are disposed circumferentially within the guide groove **120**. For example, outer peripheral surfaces **118** of the inner peripheral walls **116** may form a base surface **122** (e.g., bottom surface) of the guide groove **120**. The inner peripheral walls **116** define a tube channel **160** having a varying width and/or depth along the circumferential path of the tube channel **160**. For example, a top end **162** of the tube channel **160** may have a narrow width W**1** and a bottom end **164** of the tube channel **160** may have a wide width W**2**. The inner peripheral walls **116** may be planar and angle inward from the base surface **122** until they intersect one another, thus causing the tube channel **160** to have a triangular shape (as shown in FIG. **6**). In aspects of the disclosure, the inner peripheral walls **116** may be curved (e.g., convex, concave) or any other suitable geometry. For example, the inner peripheral walls **116** may be concavely curved such that the tube channel **160** forms a U shape.

(27) The motor **150** may be provided as a central axis of the housing **110**. For example, as shown in FIG. **7**, the motor **150** may have a motor housing **151** disposed within a cavity **115** of the housing **110** and a cylindrical shaft **152** that is disposed within a central bore **111** of the housing **110** such that there is a peripheral gap **113** between the cylindrical shaft **152** and the central bore **111**. The peripheral gap **113** allows for unimpeded rotation of the cylindrical shaft **152** within the central bore **111**. Rotation of the cylindrical shaft **152** causes the motor arm **140** to rotate, which thus causes the shaft **132** and the roller **130** to move along the circumference of the housing **110**. A power interface **154** and a data interface **156** may be positioned on the motor **150** to receive power from a power source and to receive/send communications signals to and/or from processors and sensors. The power interface **154** and/or the data interface **156** may be wired or wireless. In aspects of the disclosure, the motor **150** may have its own power source (e.g., a battery) and/or a wireless communications interface.

(28) As shown in FIG. **9**, the motor arm **140** may include two arm sections **142**, **144** and a spring **146**, where a first spring end **145** is coupled to the first arm section **142** and a second spring end **147** is coupled to the second arm section **144**. The arm sections **142**, **144** may be slidably moveable relative to each other such that when the arm sections **142**, **144** are moved in directions away from each other, the spring **146** stretches. The stretched spring **146** provides a biasing force F**1** on the arm sections **142**, **144** to move the arm sections **142**, **144** back towards an engaged position.

(29) In use, the motor arm **140** may be pulled in an outward direction away from the cylindrical shaft **152** so that the roller **130** is completely outside of the guide groove **120**. Tube **24** may then be fed into the guide groove **120** such that the tube **24** follows the cylindrical path of the guide groove **120** from the top end **162** of the tube channel **160** to the bottom end **164** of the tube channel **160**. The motor arm **140** may then be released so that the motor arm **140** contracts (e.g., arm sections **142**, **144** move closer towards each other due to biasing force F**1**) and the roller **130** engages the tube **24**. Thus, the tube **24** passes through the roller clamp assembly **100**, between the two opposing side walls **112**, the roller **130** and the tube channel **160** that is opposed to the roller **130**.

(30) Moving the roller **130** circumferentially along the guide groove **120** in the direction of the top end **162** of the tube channel **160** causes the roller **130** to impinge more forcefully against the tube **24** as less of the tube **24** fits within the narrower portion of the tube channel **160**. As the roller **130** impinges more forcefully on the tube **24**, the tube **24** is further squeezed, as it is a flexible material such as PVC, and the lumen (e.g., fluid flow path) of the infusion tube **24** therefore becomes smaller, thus reducing the fluid flow rate through the tube **24**.

(31) Similarly, moving the roller **130** circumferentially along the guide groove **120** in the direction of the bottom end **164** of the tube channel **160** causes the roller **130** to impinge less forcefully against the tube **24** as more of the tube **24** fits within the wider portion of the tube channel **160**. As the roller **130** impinges less forcefully on the tube **24**, the tube **24** is less squeezed and the lumen of the infusion tube **24** becomes larger, thus increasing the fluid flow rate through the tube **24**. In this way, by narrowing and expanding the lumen of the tube **24**, the flow rate of liquid passing through

the tube **24** can be regulated.

(32) As an example, as shown in FIG. **3**, the circular roller clamp assembly **100** may be mounted to IV pole **190** with the power interface **154** and data interface **156** connected to power wires and communications cables (not shown) disposed inside the IV pole **190**. A user (e.g., health care clinician) may pull the spring loaded motor arm **140** outward from the housing **110** and position IV tube **24** into the guide groove **120** along the tube channel **160**. The user may then release the motor arm **140** so that the biasing force F**1** of the spring **146** pulls the roller **130** inward against the IV tube **24**, pressing the IV tube **24** against the tube channel **160**. The motor **150** may communicate with an external flow sensor and rotate the motor arm **140** to position the roller **130** along the tube channel **160** to achieve the necessary compression of the IV tube **24** for the desired fluid flow rate through the IV tube **24**. In aspects of the disclosure, the motor **150** may be configured to be manually adjustable so that a user may manually select the position of the roller **130** for high resolution flow setpoint selection.

(33) The circular geometry of the circular roller clamp assembly **100** significantly increases the length of the flow control channel (e.g., semi-circular tube channel **160** versus the linear channel through roller clamp **26**), thus enabling a much larger flow control resolution. For example, the semi-circular tube channel **160** may have a 300% increase in length over the linear length of the roller clamp **26**. The circular geometry also allows for a simple motor **150** to be used to control the operation of the circular roller clamp assembly **100**.

(34) According to aspects of the disclosure, the circular roller clamp assembly **100** may be configured to hang on a bracket attached to the IV pole **190**. According to aspects of the disclosure, the circular roller clamp assembly **100** may be configured to hang directly on an IV line (e.g., tube **24**). According to aspects of the disclosure, the circular roller clamp assembly **100** may include a coupling mechanism on or adjacent a mounting surface **119** of the housing **110**. For example, the housing **110** may include one or more magnets within or on the mounting surface **119** or portions of the mounting surface **119** may be formed of a magnetic material, such that the circular roller clamp assembly **100** may be quickly and easily attached to any magnetic surface (e.g., metal pole, metal bed handrail, metal shelf). As another example, the coupling mechanism may be a clamping device configured to clamp to a desired surface (e.g., IV pole, bedrail, shelf, table).

(35) According to aspects of the disclosure, the circular roller clamp assembly **100** may be configured to integrate with a smart controller. For example, the circular roller clamp assembly **100** may be integrated into a controller housing, where the controller may receive input from one or more sensors (e.g., downstream flow rate sensor) and send control signals to the motor **150** based on the sensor input and/or programmed parameters (e.g., flow settings input by a user or another processor). As another example, the circular roller clamp assembly **100** may include its own smart controller that can directly receive sensor information, determine a position of the roller **130** that will achieve the desired flow rate and/or send control signals to the motor **150** to position the roller **130** in the determined position. According to aspects of the disclosure, the circular roller clamp assembly **100** may communicate with internal or external sensors/controllers/processors via wired and/or wireless communications.

(36) With reference to FIG. **10**, a method **200** of operating a circular roller clamp assembly (e.g., circular roller clamp assembly **100**) is provided. In step **210**, the roller (e.g., roller **130**) is pulled away from the housing (e.g., housing **110**). For example, a motor arm (e.g., motor arm **140**) may be expandable via spring loaded slidable portions (e.g., arm sections **142**, **144** and spring **146**), thus allowing the roller coupled to the motor arm to be pulled with a force that exceeds the biasing force (e.g., biasing force F**1**) of the spring. Tubing (e.g., IV tube **24**) is placed or inserted into the housing such that the tubing is disposed within a housing channel (e.g., tube channel **160** within guide groove **120**), in step **220**.

(37) In step **230**, the roller is released to pull back and engage the tubing. For example, the release of the roller allows the biasing force of the spring to contract the motor arm, thus pulling the roller

into the housing channel so that the roller engages and compresses the tubing into the housing channel. Control signals may be provided to the motor (e.g., motor **150**) to direct the motor to move the roller to a specific position on the housing, in step **240**. For example, the motor may monitor sensor signals and adjust the roller position in order to change the fluid flow rate to a desired flow rate. Here, positioning the roller near a first end of the channel housing (e.g., top end **162** of the tube channel **160**) may cause the roller to impinge the tubing to a great degree (e.g., zero or minimal fluid flow), while positioning the roller near a second end of the channel housing (e.g., bottom end **164** of the tube channel **160**) may cause the roller to impinge the tubing to a very low degree (e.g., full or maximum fluid flow).

(38) In step **250**, the roller may be moved along the housing channel by the motor to impinge the tubing at the desired level. For example, the roller may be moved from the second end of the channel housing to the first end of the channel housing so that a narrowing between the housing channel and the roller causes the roller to compress or squeeze the contacted portion of the tubing, thus causing the fluid flow rate in the tubing to change to a lower or blocked flow rate (e.g., from 250 ml/hr to 0 ml/hr). Similarly, moving the roller along the housing channel in the opposing direction will cause the fluid flow rate to change to a higher or open flow rate (e.g., from 0 ml/hr to 250 ml/hr). Thus, positioning the roller in various positions between the first and second ends of the channel housing will vary the fluid flow rate accordingly (e.g., 50 ml/hr, 100 ml/hr, 150 ml/hr, 200 ml/hr).

(39) In one or more embodiments, a circular roller clamp assembly comprises: a semi-circular housing configured to receive a portion of an IV tube; a motor; a motor arm coupled to the motor; and a roller coupled to the roller arm, the roller configured to be movably received by a guide groove disposed in the semi-circular housing, wherein the circular roller clamp assembly is configured to regulate a flow rate of fluid flowing through the IV tube based on engagement of the roller with the IV tube via circumferential movement of the roller along the guide groove.

(40) In aspects of the disclosure, the guide groove comprises two opposing side walls extending radially inward from a perimeter surface of the semi-circular housing and a base surface disposed at an inward end of the side walls. In aspects of the disclosure, the semi-circular housing comprises two inner peripheral walls extending radially inward from the base surface of the guide groove and defining a tube channel configured to receive a portion of the IV tube. In aspects of the disclosure, the tube channel comprises a varying width from a first width at a first end to a second width at a second end, the second width being wider than the first width. In aspects of the disclosure, the tube channel comprises a varying depth from a first depth at a first end to a second depth at a second end, the second depth being deeper than the first depth. In aspects of the disclosure, the inner peripheral walls extend radially inward from the base surface of the guide groove at an acute angle and intersect with one another to define the tube channel as a triangular shape.

(41) In aspects of the disclosure, a cylindrical shaft of the motor is disposed within a central bore of the semi-circular housing and a peripheral gap is disposed between the cylindrical shaft and the central bore, wherein the motor arm is coupled to an end of the cylindrical shaft, and wherein the cylindrical shaft is configured to rotate unimpeded within the central bore. In aspects of the disclosure, a power interface is disposed on the motor, the power interface configured to receive power from a power source. In aspects of the disclosure, a communications interface is disposed on the motor, the communications interface configured to one of send communications signals to one of a processor and a sensor and receive communications signals from one of a processor and a sensor.

(42) In aspects of the disclosure, the motor arm comprises: a first arm section; a second arm section movably coupled to the first arm section; and a spring having a first spring end coupled to the first arm section and a second spring end coupled to the second arm section, wherein the spring is configured to stretch to provide for opposing movement of the first arm section relative to the second arm section and to provide a biasing contracting force to pull the first arm section and the

second arm section towards one another towards a base position. In aspects of the disclosure, the motor arm is configured to extend so that the roller is positioned outside of the guide groove for insertion of the IV tube into the guide groove, and wherein the motor arm is configured to contract due to the biasing force of the spring to pull the roller against the IV tube. In aspects of the disclosure, the semi-circular housing is configured to be mounted on an IV pole. In aspects of the disclosure, the circular roller clamp assembly comprises a magnetic coupler configured to mount to a magnetic surface. In aspects of the disclosure, the circular roller clamp assembly is configured to hang from the IV tube.

(43) In one or more embodiments, an IV set comprises: an IV tube configured to be coupled to a fluid container; an infusion component coupled to the IV tube; and a circular roller clamp assembly coupled to the IV tube, the circular roller clamp assembly comprising: a semi-circular housing configured to receive the IV tube; a motor; a motor arm coupled to the motor; and a roller coupled to the roller arm, the roller configured to be movably received by a guide groove disposed in the semi-circular housing, wherein the circular roller clamp assembly is configured to regulate a flow rate of fluid flowing through the IV tube based on engagement of the roller with the IV tube via circumferential movement of the roller along the guide groove.

(44) In aspects of the disclosure, the guide groove comprises two opposing side walls extending radially inward from a perimeter surface of the semi-circular housing and a base surface disposed at an inward end of the side walls, the semi-circular housing comprises two inner peripheral walls extending radially inward from the base surface of the guide groove and defining a tube channel configured to receive a portion of the IV tube, and the tube channel comprises one of: a varying width from a first width at a first end to a second width at a second end, the second width being wider than the first width; and a varying depth from a first depth at the first end to a second depth at the second end, the second depth being deeper than the first depth.

(45) In aspects of the disclosure, the motor arm comprises: a first arm section; a second arm section movably coupled to the first arm section; and a spring coupled to the first arm section and to the second arm section, the spring configured to stretch to provide for opposing movement of the first arm section relative to the second arm section and to provide a biasing contracting force to pull the first arm section and the second arm section towards one another, wherein the motor arm is configured to extend so that the roller is positioned outside of the guide groove for insertion of the IV tube into the guide groove, and wherein the motor arm is configured to contract due to the biasing force of the spring to pull the roller against the IV tube.

(46) In one or more embodiments, a method of operating a circular roller clamp assembly comprises: pulling a roller coupled to an extendable motor arm radially outward from a guide groove disposed in a perimeter surface of a semi-circular housing of the circular roller clamp assembly; placing an intravenous (IV) tube between roller and the guide groove; releasing the roller wherein a biasing force of a spring of the motor arm contracts the motor arm radially inward towards the IV tube and the guide groove; pressing, by the roller, the IV tube against a varying sized tube channel disposed within the guide groove; rotating, by a motor, the motor arm in a first direction to move the roller towards a smaller sized portion of the tube channel to increase impingement of the IV tube by the roller and decrease a rate of fluid flow through the IV tube; and rotating, by the motor, the motor arm in a second direction to move the roller towards a larger sized portion of the tube channel to decrease impingement of the IV tube by the roller and increase the rate of fluid flow through the IV tube.

(47) In aspects of the disclosure, the method comprises monitoring, by a sensor, the rate of fluid flow through the IV tube; and providing control signals from a processor to the motor to rotate the motor arm to adjust a position of the roller to change the rate of fluid flow to a determined rate. In aspects of the disclosure, the method comprises wherein positioning the roller at a smallest sized portion of the tube channel causes the roller to occlude the IV tube and prevent any fluid flow through the IV tube downstream of the occlusion; and wherein positioning the roller at a largest

sized portion of the tube channel causes the roller to not impinge the IV tube and provide full fluid flow through the IV tube downstream of the roller.
(48) It is understood that any specific order or hierarchy of blocks in the methods of processes disclosed is an illustration of example approaches. Based upon design or implementation preferences, it is understood that the specific order or hierarchy of blocks in the processes may be rearranged, or that all illustrated blocks be performed. In some implementations, any of the blocks may be performed simultaneously.
(49) The present disclosure is provided to enable any person skilled in the art to practice the various aspects described herein. The disclosure provides various examples of the subject technology, and the subject technology is not limited to these examples. Various modifications to these aspects will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other aspects.
(50) A reference to an element in the singular is not intended to mean "one and only one" unless specifically so stated, but rather "one or more." Unless specifically stated otherwise, the term "some" refers to one or more. Pronouns in the masculine (e.g., his) include the feminine and neuter gender (e.g., her and its) and vice versa. Headings and subheadings, if any, are used for convenience only and do not limit the invention.
(51) The word "exemplary" is used herein to mean "serving as an example or illustration." Any aspect or design described herein as "exemplary" is not necessarily to be construed as preferred or advantageous over other aspects or designs. In one aspect, various alternative configurations and operations described herein may be considered to be at least equivalent.
(52) As used herein, the phrase "at least one of" preceding a series of items, with the term "or" to separate any of the items, modifies the list as a whole, rather than each item of the list. The phrase "at least one of" does not require selection of at least one item; rather, the phrase allows a meaning that includes at least one of any one of the items, and/or at least one of any combination of the items, and/or at least one of each of the items. By way of example, the phrase "at least one of A, B, or C" may refer to: only A, only B, or only C; or any combination of A, B, and C.
(53) A phrase such as an "aspect" does not imply that such aspect is essential to the subject technology or that such aspect applies to all configurations of the subject technology. A disclosure relating to an aspect may apply to all configurations, or one or more configurations. An aspect may provide one or more examples. A phrase such as an aspect may refer to one or more aspects and vice versa. A phrase such as an "embodiment" does not imply that such embodiment is essential to the subject technology or that such embodiment applies to all configurations of the subject technology. A disclosure relating to an embodiment may apply to all embodiments, or one or more embodiments. An embodiment may provide one or more examples. A phrase such an embodiment may refer to one or more embodiments and vice versa. A phrase such as a "configuration" does not imply that such configuration is essential to the subject technology or that such configuration applies to all configurations of the subject technology. A disclosure relating to a configuration may apply to all configurations, or one or more configurations. A configuration may provide one or more examples. A phrase such a configuration may refer to one or more configurations and vice versa.
(54) In one aspect, unless otherwise stated, all measurements, values, ratings, positions, magnitudes, sizes, and other specifications that are set forth in this specification, including in the claims that follow, are approximate, not exact. In one aspect, they are intended to have a reasonable range that is consistent with the functions to which they relate and with what is customary in the art to which they pertain.
(55) It is understood that the specific order or hierarchy of steps, operations or processes disclosed is an illustration of exemplary approaches. Based upon design preferences, it is understood that the specific order or hierarchy of steps, operations or processes may be rearranged. Some of the steps, operations or processes may be performed simultaneously. Some or all of the steps, operations, or

processes may be performed automatically, without the intervention of a user. The accompanying method claims, if any, present elements of the various steps, operations or processes in a sample order, and are not meant to be limited to the specific order or hierarchy presented.
(56) All structural and functional equivalents to the elements of the various aspects described throughout this disclosure that are known or later come to be known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the claims. Moreover, nothing disclosed herein is intended to be dedicated to the public regardless of whether such disclosure is explicitly recited in the claims. No claim element is to be construed under the provisions of 35 U.S.C. § 112 (f) unless the element is expressly recited using the phrase “means for” or, in the case of a method claim, the element is recited using the phrase “step for.” Furthermore, to the extent that the term “include,” “have,” or the like is used, such term is intended to be inclusive in a manner similar to the term “comprise” as “comprise” is interpreted when employed as a transitional word in a claim.
(57) The Title, Background, Summary, Brief Description of the Drawings and Abstract of the disclosure are hereby incorporated into the disclosure and are provided as illustrative examples of the disclosure, not as restrictive descriptions. It is submitted with the understanding that they will not be used to limit the scope or meaning of the claims. In addition, in the Detailed Description, it can be seen that the description provides illustrative examples and the various features are grouped together in various embodiments for the purpose of streamlining the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the claimed subject matter requires more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive subject matter lies in less than all features of a single disclosed configuration or operation. The following claims are hereby incorporated into the Detailed Description, with each claim standing on its own as a separately claimed subject matter.
(58) The claims are not intended to be limited to the aspects described herein, but are to be accorded the full scope consistent with the language claims and to encompass all legal equivalents. Notwithstanding, none of the claims are intended to embrace subject matter that fails to satisfy the requirement of 35 U.S.C. § 101, 102, or 103, nor should they be interpreted in such a way.

Claims

1. A roller clamp assembly comprising: a semi-circular housing configured to receive a portion of an intravenous (IV) tube; an arm disposed externally to the semi-circular housing; and a roller coupled to the arm, the roller configured to be movably received by a guide groove disposed in the semi-circular housing, wherein the roller clamp assembly is configured to regulate a flow rate of fluid flowing through the IV tube based on engagement of the roller with the IV tube via circumferential movement of the roller along the guide groove.
2. The roller clamp assembly of claim 1, wherein the guide groove comprises: two opposing side walls extending radially inward from a perimeter surface of the semi-circular housing; and a base surface disposed at an inward end of the side walls.
3. The roller clamp assembly of claim 2, wherein the semi-circular housing comprises: two inner peripheral walls extending radially inward from the base surface of the guide groove and defining a tube channel configured to receive a portion of the IV tube.
4. The roller clamp assembly of claim 3, wherein the tube channel comprises a varying width from a first width at a first end to a second width at a second end, the second width being wider than the first width.
5. The roller clamp assembly of claim 3, wherein the tube channel comprises a varying depth from a first depth at a first end to a second depth at a second end, the second depth being deeper than the first depth.
6. The roller clamp assembly of claim 3, wherein the inner peripheral walls extend radially inward

from the base surface of the guide groove at an acute angle and intersect with one another to define the tube channel as a triangular shape.

7. The roller clamp assembly of claim 1, further comprising a motor coupled to the arm, wherein a cylindrical shaft of the motor is disposed within a central bore of the semi-circular housing, wherein a peripheral gap is disposed between the cylindrical shaft and the central bore, wherein the arm is coupled to an end of the cylindrical shaft, and wherein the cylindrical shaft is configured to rotate unimpeded within the central bore.

8. The roller clamp assembly of claim 7, further comprising: a power interface disposed on the motor, the power interface configured to receive power from a power source.

9. The roller clamp assembly of claim 7, further comprising: a communications interface disposed on the motor, the communications interface configured to one of: send communications signals to one of a processor and a sensor; and receive communications signals from one of the processor and the sensor.

10. The roller clamp assembly of claim 1, wherein the arm comprises: a first arm section; a second arm section movably coupled to the first arm section; and a spring having a first spring end coupled to the first arm section and a second spring end coupled to the second arm section, wherein the spring is configured to stretch to provide for opposing movement of the first arm section relative to the second arm section and to provide a biasing contracting force to pull the first arm section and the second arm section towards one another towards a base position.

11. The roller clamp assembly of claim 10, wherein the arm is configured to extend so that the roller is positioned outside of the guide groove for insertion of the IV tube into the guide groove, and wherein the arm is configured to contract due to the biasing force of the spring to pull the roller against the IV tube.

12. The roller clamp assembly of claim 1, wherein the semi-circular housing is configured to be mounted on an IV pole.

13. The roller clamp assembly of claim 1, further comprising a magnetic coupler configured to mount to a magnetic surface.

14. The roller clamp assembly of claim 1, wherein the roller clamp assembly is configured to hang from the IV tube.

15. An intravenous (IV) set comprising: an IV tube configured to be coupled to a fluid container; an infusion component coupled to the IV tube; and a roller clamp assembly coupled to the IV tube, the roller clamp assembly comprising: a semi-circular housing configured to receive the IV tube; an arm disposed externally to the semi-circular housing; and a roller coupled to the arm and configured to be movably received by a guide groove disposed in the semi-circular housing, wherein the roller clamp assembly is configured to regulate a flow rate of fluid flowing through the IV tube based on engagement of the roller with the IV tube via circumferential movement of the roller along the guide groove.

16. The IV set of claim 15, wherein the guide groove comprises two opposing side walls extending radially inward from a perimeter surface of the semi-circular housing and a base surface disposed at an inward end of the side walls, wherein the semi-circular housing comprises two inner peripheral walls extending radially inward from the base surface of the guide groove and defining a tube channel configured to receive a portion of the IV tube, and wherein the tube channel comprises one of: a varying width from a first width at a first end to a second width at a second end, the second width being wider than the first width; and a varying depth from a first depth at the first end to a second depth at the second end, the second depth being deeper than the first depth.

17. The IV set of claim 15, further comprising: a motor; and an arm coupled to the motor and to the roller, wherein the arm comprises: a first arm section; a second arm section movably coupled to the first arm section; and a spring coupled to the first arm section and to the second arm section, the spring configured to stretch to provide for opposing movement of the first arm section relative to the second arm section and to provide a biasing contracting force to pull the first arm section and

the second arm section towards one another, wherein the arm is configured to extend so that the roller is positioned outside of the guide groove for insertion of the IV tube into the guide groove, and wherein the arm is configured to contract due to the biasing force of the spring to pull the roller against the IV tube.

18. A method of operating a roller clamp assembly, the method comprising: pulling a roller radially outward from a guide groove disposed in a perimeter surface of a semi-circular housing of the roller clamp assembly; placing an intravenous (IV) tube between roller and the guide groove; releasing the roller; contracting, by a biasing force, the roller radially inward towards the IV tube and the guide groove; pressing, by the roller, the IV tube against a varying sized tube channel disposed within the guide groove; moving the roller towards a smaller sized portion of the tube channel to increase impingement of the IV tube by the roller and decrease a rate of fluid flow through the IV tube; and moving the roller towards a larger sized portion of the tube channel to decrease impingement of the IV tube by the roller and increase the rate of fluid flow through the IV tube.

19. The method of claim 18, further comprising: monitoring, by a sensor, the rate of fluid flow through the IV tube; and providing control signals from a processor to adjust a position of the roller to change the rate of fluid flow to a determined rate.

20. The method of claim 18, further comprising: wherein positioning the roller at a smallest sized portion of the tube channel causes the roller to occlude the IV tube and prevent any fluid flow through the IV tube downstream of the occlusion; and wherein positioning the roller at a largest sized portion of the tube channel causes the roller to not impinge the IV tube and provide full fluid flow through the IV tube downstream of the roller.