United States Patent

Santomieri

[15] **3,664,339**

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[54] DRIP CHAMBER AND METHOD

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[52] **U.S. Cl.** .....**128/214 C,** 137/399

[51] **Int. Cl.** **A61m 05/16**

[58] **Field of Search**.....137/399; 128/214, 214.2, 214 C; 210/92, 94, 136; 137/399

[56] **References Cited**

UNITED STATES PATENTS

3,035,575	5/1962	Broman	128/214
2,907,325	10/1959	Burke	128/214
2,168,270	8/1939	Paisley et al.	128/214
3,517,909	6/1970	Santomieri	251/342
2,989,052	6/1961	Broman	128/214
2,784,733	3/1957	Martinez	137/399

FOREIGN PATENTS OR APPLICATIONS

1,235,482	5/1960	France	128/214
1,118,247	3/1956	France	128/214

Primary Examiner—Dalton L. Truluck

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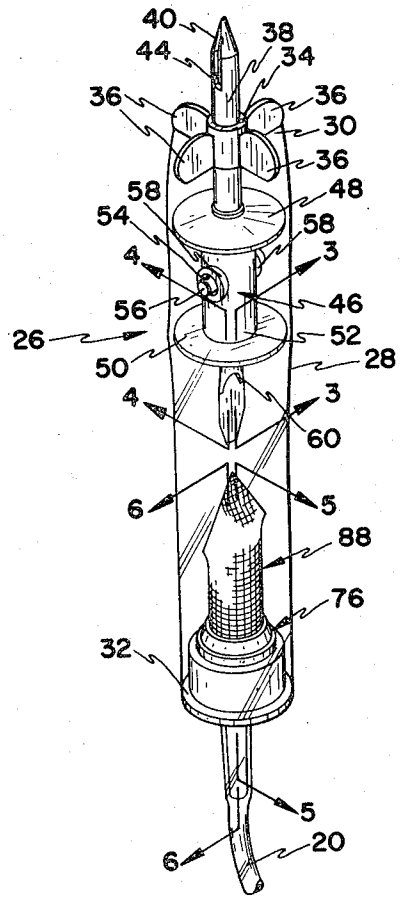
[57] **ABSTRACT**

A drip chamber having a flexibly resilient sleeve with memory and one-way inlet and outlet valves in each end of the sleeve, the valves respectively being in communication with a fluid source and an infusion tube. A control unit can be finger-actuated to determine a continuous drip at a constant rate from the inlet to the outlet valve. The method includes squeezing the sleeve to force fluid through the outlet valve into the infusion tube and thereafter allowing the sleeve to expand to draw fluid through the inlet tube into the sleeve.

5 Claims, 9 Drawing Figures



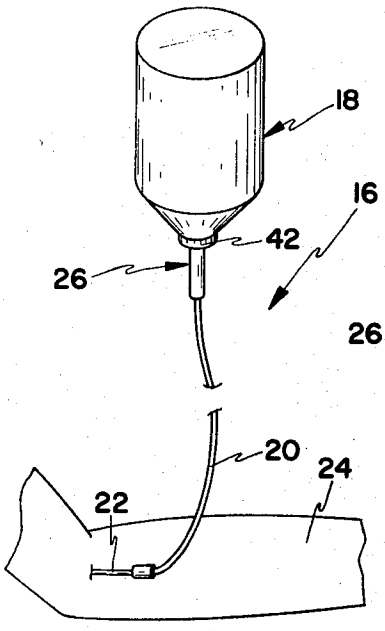


FIG. 1

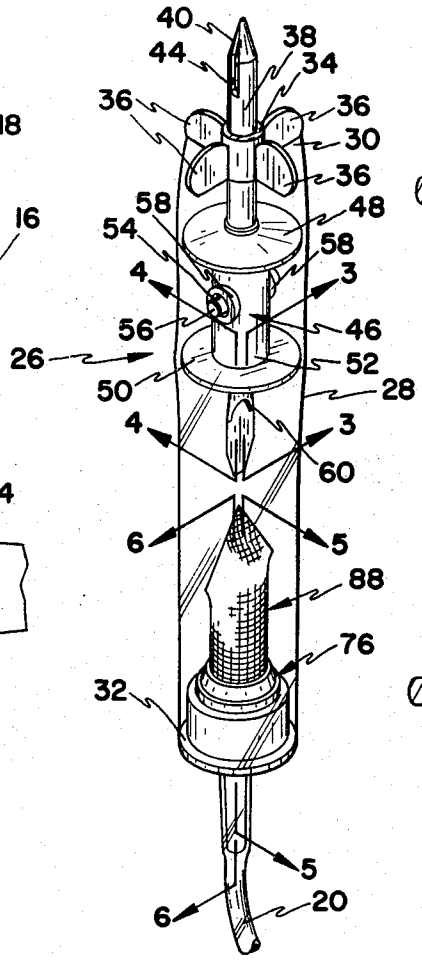


FIG. 2

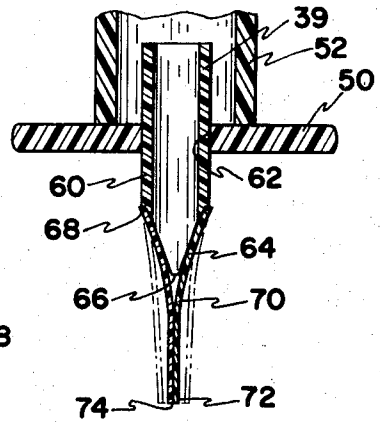


FIG. 3

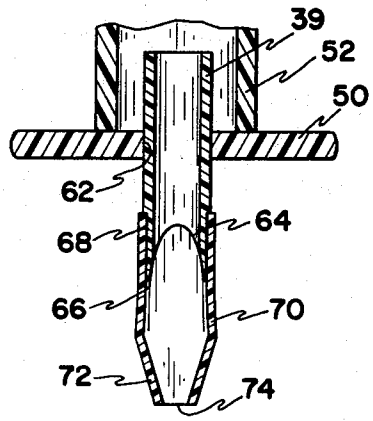


FIG. 4

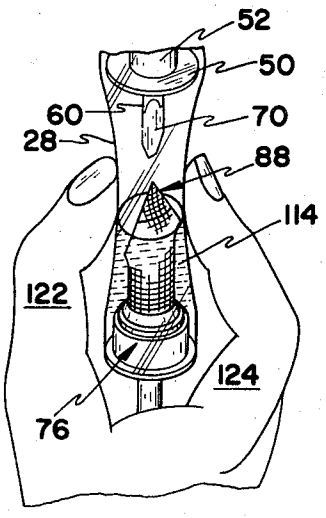


FIG. 8

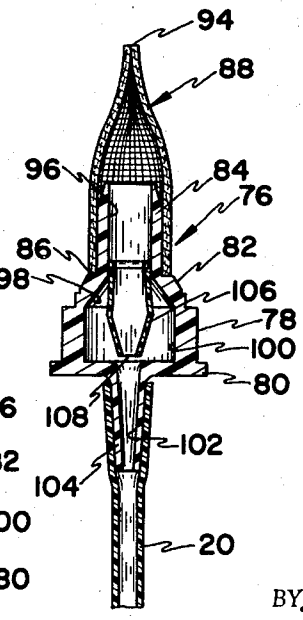


FIG. 6

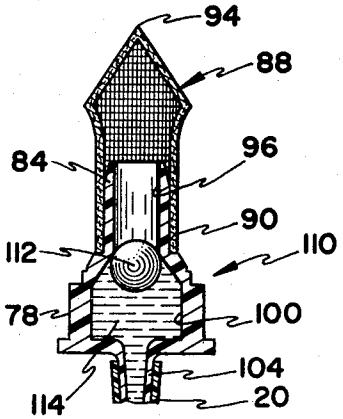


FIG. 7

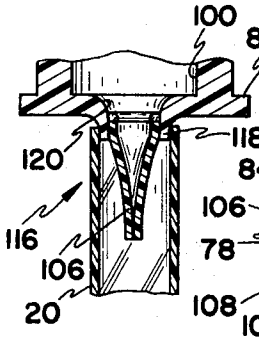


FIG. 9

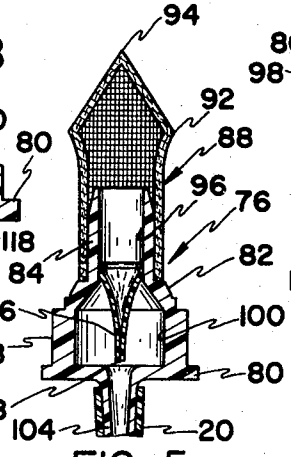


FIG. 5

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DRIP CHAMBER AND METHOD

BACKGROUND

1. Field of the Invention

The invention relates to medical infusion apparatus and more particularly to a novel infusion fluid drip chamber and method.

2. The Prior Art

It is well known to use drip chambers with infusion apparatus for accommodating visual observation of the rate at which infusion fluid is conducted into a patient. Conventional drip chambers are normally a generally cylindrical enlargement of an infusion tube and are in direct open communication simultaneously with a source of infusion fluid and with the end of the infusion tube used to penetrate the patient's circulatory system. A constricted opening in the drip chamber causes the fluid to flow through the chamber in droplets. It has been common practice to place a filter within the drip chamber to filter the fluid droplets as they fall by gravity through the chamber.

The rate at which the fluid drips through the chamber is most frequently determined by a pinch valve or the like located on a portion of the infusion tube between the drip chamber and the fluid source.

Frequently, it is necessary or desirable to force infusion fluid such as blood into the patient at a rapid rate. This is particularly true where physical injury to the patient has caused loss of a dangerous volume of blood. Until this present invention it has be necessary to use auxiliary pumping apparatus for delivering the fluid to the patient. For example, a hypodermic syringe can be used to rapidly inject the fluid. If the fluid is plasma, isotonic saline or the like, it becomes necessary to perform repeated venipunctures in order to rapidly inject the increased fluid volume. The use of the hypodermic syringe is not a safe way of rapidly infusing a large volume of whole blood because use of the hypodermic syringe causes hemolysis of the blood cells.

BRIEF SUMMARY AND OBJECTS OF THE INVENTION

The present invention, including apparatus and method, includes a flexible drip chamber having an interiorly confined control unit and spaced unidirectional valves so that infusion fluid is pumped when the chamber is finger-squeezed to force fluid within the chamber into an attached infusion tube and thereafter expanded to draw fluid from the source into the chamber.

It is therefore a primary object of the present invention to provide an improved drip chamber and method.

It is another object of the present invention to provide a novel drip chamber and method which accommodate safe, forceful pumping of infusion fluid into a patient.

These and other objects and features of the present invention will become more fully apparent from the following description and appended claims taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a schematic representation of infusion apparatus shown infusing fluid into a patient's arm;

FIG. 2 is a perspective illustration of a presently preferred drip chamber embodiment of the invention;

FIGS. 3–6 are longitudinal cross sections respectively taken along lines 3—3, 4—4, 5—5 and 6—6 of FIG. 2;

FIG. 7 is a cross sectional illustration of another presently preferred unidirectional valve embodiment of the invention;

FIG. 8 schematically illustrates the method of pumping fluid through the drip chamber; and

FIG. 9 is still another unidirectional valve embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference is now made to the several embodiments of the invention as illustrated in the Figures, like parts being designated with like numerals throughout.

THE STRUCTURE

The infusion apparatus generally designated **16** conveys infusion fluid from a source such as a bottle **18** through a conventional infusion tube **20** to an intravenous needle **22** which has previously been properly placed within the vein of a patient's arm **24**. Infusion fluid, as used herein, means isotonic saline, blood, plasma or any other biologically acceptable fluid used for medical treatment of patients. The bottle **18** is normally suspended in the air so that the fluid contained thereby falls by force of gravity through the infusion tube **20**. Preferably, a drip chamber generally designated **26** is interposed between the infusion tube **20** and the bottle **18**.

The drip chamber **26** is best illustrated in FIG. **2** and preferably comprises a cylindrically shaped sleeve **28** which is formed of transparent plastic material with memory, the sleeve **28** being elongated and terminating in upper and lower ends **30** and **32** respectively. An annular collar **34** is situated adjacent the end **30**, collar **34** having four radially projecting ribs **36**. The sleeve **28** is heat sealed or otherwise connected to the collar **34** and ribs **36** in a fluid-tight relation.

The collar **34** circumscribes a portion of conduit **38**. A portion of the conduit **38** projects out of the sleeve **28** through the collar **34** and comprises a conically tapered tip **40** which is used to penetrate the rubber seal (not shown) in the neck **42** (FIG. **1**) of the bottle **18**. The exposed portion of conduit **38** has at least one elongated slot **44** which allows fluid within the bottle **18** to enter the interior of conduit **38**. Conduit **38** is integrally connected to and in fluid communication with the interior of a control unit generally designated **46**. The control unit has spaced annular discs **48** and **50** which urge the sleeve **28** outwardly away from the cylindrical central portion **52** of the unit **46**. Central portion **52** has opposed annular bosses **58** and a transverse bore **54** opening to the exterior of the unit central of each boss **58**.

A spool valve **56** is reciprocably situated within the bore **54**, the spool valve **56** having a transverse through-bore (not shown) which is incrementally displaced into and out of alignment with the hollow interior of conduit **38**. Thus, the amount of fluid flowing from the bottle **18** through the conduit **38** to the interior of sleeve **28** may be selected by finger-squeezing the sleeve **28** between discs **48** and **50** to axially displace the spool valve **56** until the desired drip rate is achieved, as will be subsequently more fully described.

As shown in FIGS. **3** and **4**, the interior of central portion **52** is in open communication with the open end **39** of a terminal projection **60** disposed through an aperture **62** in the disc **50**. The projection **60** has opposed inwardly tapered sides **64** which converge to a point **66**. The projection **60** is annularly reduced adjacent the tapered sides **64** so as to form a recess **68**. A length of highly flexible rubber tubing **70** is concentrically surmounted upon the recess **68** and preferably bonded to the projection **60** in the position illustrated in FIGS. **3** and **4**. The tube **70** is substantially longer than the recess **68** so that the free end **72** is allowed to flex and bend.

The sloping sides **64** cause the flexible tube **70** to converge toward the free end **72**. The projection **60** and tube **70** cooperate to form a unidirectional flutter or flap valve which closes to the solid line position illustrated in FIG. **3** when the pressure exterior of the valve is greater than the pressure exerted by the fluid within projection **60** and which opens to the dotted line position of FIG. **3** when the pressure exterior of the tube **70** drops below the pressure exerted by the fluid within the projection **60**. When the tube **70** opens to the dotted line position, fluid is allowed to flow through the opening **74** in the free end **72** of the tube.

Reference is now made to FIGS. **5** and **6** wherein a second unidirectional valve assembly generally designated **76** is illustrated. Valve assembly **76** comprises a valve housing **78** which is cylindrical in configuration and which is adapted to telescopically receive the sleeve **28**. An annularly enlarged flange **80** integral with the housing **78** provides a seat for the sleeve **28** and, preferably, the sleeve **28** is bonded or otherwise sealed in fluid-tight relation to the housing **78**. Housing **78** has a coni-

cally tapered intermediate portion **82** which merges with an outwardly projecting boss **84**. The tapered intermediate portion **82** defines an annular shoulder **86** upon which a filter cone **88** is disposed. The filter cone **88** is preferably formed of a mesh fabric material having a cylindrical base **90** which telescopes tightly over the boss **84**. Cone **88** also has outwardly directed corners **92**, the sides of the cone converging to an apex **94**. The configuration of the filter is particularly advantageous because maximum filtration can be accomplished with a minimum of exposed surface area of the filter material. The filter removes fibrin and clot material which may exist in blood communicated through the drip chamber **26** and also serves to insure that foreign particles which may exist in other intravenous fluid material do not enter the infusion tube **20**.

The housing **78** is interiorly hollow comprising cylindrical bore **96** in the boss **84** which diverges outwardly at **98** to the diametrally enlarged cylindrical bore **100**. The bore **100** is in open communication with a hollow conduit **102** interior of a downwardly projecting male coupling **104**. The infusion tube **20** is press-fit upon the male coupling **104** as illustrated in FIGS. **2** and **6**.

A highly flexible synthetic tube **106**, which may be substantially the same as rubber tube **70** above described, is bonded to the periphery of the bore **96** so as to project into the bore **100**. The tube **106** functions as a flutter valve so that when fluid pressure within the bore **100** is greater than the fluid pressure conducted through the bore **96**, the valve **106** will be collapsed, thereby preventing fluid from backing to the interior of sleeve **28**. Conversely, when the pressure within the sleeve **28** is greater than pressure in the bore **100**, fluid will flow freely through the opening **108** to the infusion tube **20**.

Alternatively, the unidirectional valve embodiment illustrated in FIG. **7** and generally designated **110** could be used. The valve **110** differs from the valve **76** in that the rubber tube **106** has been replaced with a buoyant spherical ball **112**. The ball **112** has a diameter which is smaller than the diameter of bore **100** and larger than the diameter **96**. Thus, as fluid **114** is backed up into the bore **100**, the ball **112** will seat at the juncture of bore **96** and diverging bore **98** as shown in FIG. **7** thereby preventing the fluid **114** from flowing interior of the sleeve **28**.

Another presently preferred unidirectional valve embodiment is illustrated in FIG. **9** and is generally designated **116**. The valve **116** differs from the valve embodiment **76** in that elongated male coupling **104** is replaced with a shorter male coupling **118** upon which is telescoped the infusion tube **20**. If desired, the infusion tube may be bonded or otherwise permanently attached to the male coupling **118**. The opening **120** between the bore **100** and the exterior of male coupling **118** provides a location for bonding the rubber tube **106** in a manner substantially identical to the bonding of tube **106** in the bore **96** as above described. In the FIG. **9** embodiment, the tube **106** projects directly to the interior of the infusion tube **20** and assumes an "open" or "closed" position depending upon the pressure within the tube **20**.

THE METHOD

With continuing reference to FIGS. **1–6** and with particular reference to FIG. **8**, the method of the present invention will now be described. The described embodiments of the invention accommodate a regulated, continuous drip from the flutter valve **70** into the interior of sleeve **28**. The rate at which the fluid drips into the sleeve **28** will depend upon the particular position of spool valve **56** within the bore **54**. Once the position has been set, it is protected from inadvertent displacement by the radially projecting discs **48** and **50**.

When it is desired to change or otherwise adjust the setting of spool valve **56**, the fingers may be positioned between the discs **48** and **50** and the sleeve **28** thereafter squeezed between the fingers until the spool valve **56** can be manually displaced in either axial direction to adjust the drip rate.

Frequently, it is desirable to accelerate the flow of fluid through the infusion tube **20** into the patient's arm **24** (FIG. **1**). This is accomplished by first partially filling the sleeve **28** with fluid **114** as shown in FIG. **8**. Thereafter, the thumb and forefinger **122** and **124**, respectively, may be placed on opposite sides of the sleeve **28** and the sleeve squeezed as shown in FIG. **8**.

As the sleeve **28** is forcefully collapsed, the pressure interior of sleeve **28** will be sufficiently great to force open flutter valve **106** (FIGS. **5** and **6**) or to force the ball **112** (FIG. **7**) away from its seated position so that fluid will be forced into the tube **20**. At the same time, the increased pressure within the sleeve **28** will force the flutter valve **70** to the collapsed or closed position as shown in solid lines in FIG. **3**, thereby preventing air within sleeve **128** from being conducted to the interior of the bottle **18**. Thus, since air is confined within the sleeve **28**, substantial pressure can be developed within the sleeve **28** by collapsing the sleeve only a relatively small amount.

After a volume of fluid has been forced into the infusion tube **20**, the fingers may be removed from the sleeve **28** thereby allowing the sleeve, by force of the memory of the material forming sleeve **28**, to return to the configuration illustrated in FIG. **2**. As sleeve **28** expands to the FIG. **2** configuration, the pressure interior of sleeve **28** will be substantially reduced thereby allowing fluid to flow through conduit **38** and valve **70** in a stream to the interior of sleeve **28**. At the same time, the reduced pressure within the sleeve **28** will cause the flutter valve **106** to collapse as shown in FIGS. **5** and **9** or, if the FIG. **7** embodiment is used, the ball **112** will seat. Thus, fluid within the valve **20** cannot be drawn again into the interior of the sleeve **28**.

When equilibrium pressure is reached within the sleeve **28**, fluid will again assume a continuous constant drip from the flutter valve **70** to the interior of sleeve **28** and flutter valve **106** will allow fluid to pass slowly into the tube **20**. Alternatively, the ball **112** will be unseated at equilibrium pressure so that fluid will flow into the tube **20** as described above. It is clear that repeatedly squeezing and releasing the sleeve **28** will cause the fluid to flow, pulsating under pressure through the infusion tube **20** into the patient's arm **24**. Thus, the present invention provides unitary structure and simplified method for pumping infusion fluid through an infusion tube under pressure and, when pumping is no longer necessary, a uniform drip flow will be conducted through the infusion tube **20**.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. A drip chamber for use with intravenous infusion apparatus comprising:

an elongated tube of flexible material with memory in fluid communication with a source of infusion fluid through an upper end coupling and in fluid communication with an infusion tube through a lower end coupling,

a first one-way valve delivering fluid from the source to the interior of the tube,

second one-way valve delivering fluid from the interior of said tube to the infusion tube, and

flow rate regulating means located within said tube interposed between said upper end coupling and said first one-way valve and formed with upper and lower radial flanges extending transversely of said tube and a central portion of lesser diameter than said flanges extending longitudinally of said tube between said flanges formed with axial and transverse intersecting bores and having a finger-positionable flow regulating member positioned

within said transverse bore to regulate the rate of flow of fluid to said first one-way valve.

2. The drip chamber of claim 1 wherein said tube is manually deformable intermediate said first and second one-way valves to permit manual pumping of fluid through said drip chamber.

3. A drip chamber for use with intravenous infusion apparatus comprising:

an exterior wall of flexible material with memory formed into a closed sleeve, the sleeve being adapted to be in fluid communication with a source of intravenous fluid through an upper end coupling and adapted to be in fluid communication with an infusion tube through a lower end coupling, the upper and lower end couplings forming a fluid-tight seal in the respective sleeve ends;

a first one-way valve delivering fluid from the source to the interior of the sleeve;

a second one-way valve delivering fluid from the interior of the sleeve to the infusion tube;

at least one of said one-way valves comprising a unidirectional flap valve, the lumen of which is normally occluded and is selectively additionally occluded by collapsing of the walls of the flap valve as a result of pressure on the outside of the walls of the flap valve, the lumen being selectively dialated by pressure on the inside of the walls of the flap valve, and flow rate regulating means located within said sleeve interposed between said upper end coupling and said first one-way valve and formed with upper and lower radial flanges extending transversely of said tube and a central portion of lesser diameter than said flanges extending longitudinally of said tube between said flanges formed with axial and transverse intersecting bores and having a finger positionable flow regulating member positioned within said transverse bore to regulate the rate of flow of fluid to said first one-way valve.

4. A chamber is defined in claim 3 wherein the second valve comprises a ball check valve and the first valve comprises said flap valve.

5. A chamber as defined in claim 3 wherein each one-way valve comprises one said flap valve.

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