Jan. 4, 1966 J. BERNSTEIN 3,227,173

VALVE FOR PARENTERAL LIQUID FEED APPARATUS

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FIG. 1

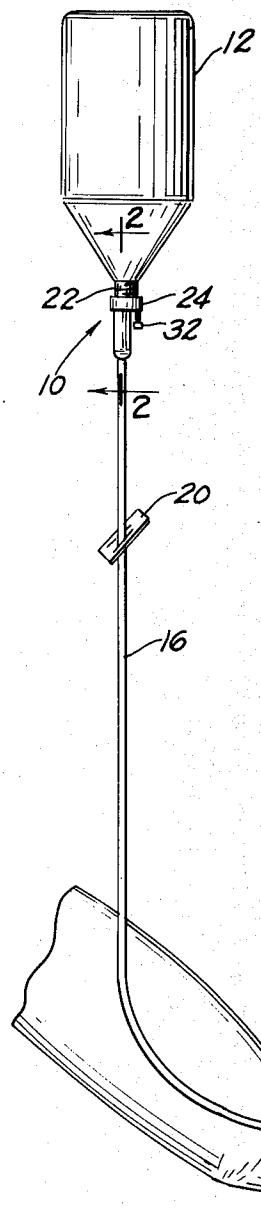


FIG. 2

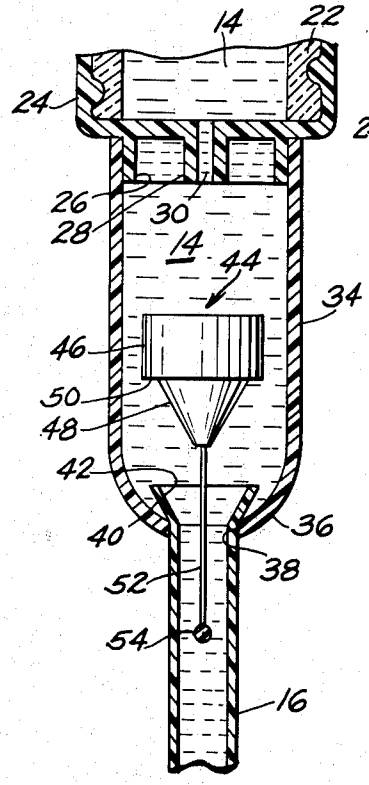
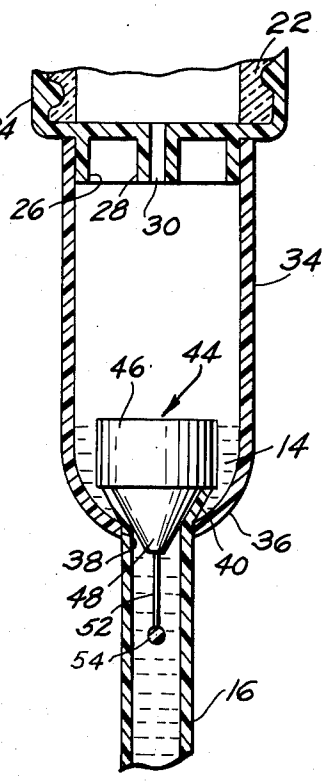


FIG. 3



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VALVE FOR PARENTERAL LIQUID FEED APPARATUS

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FIG. 4

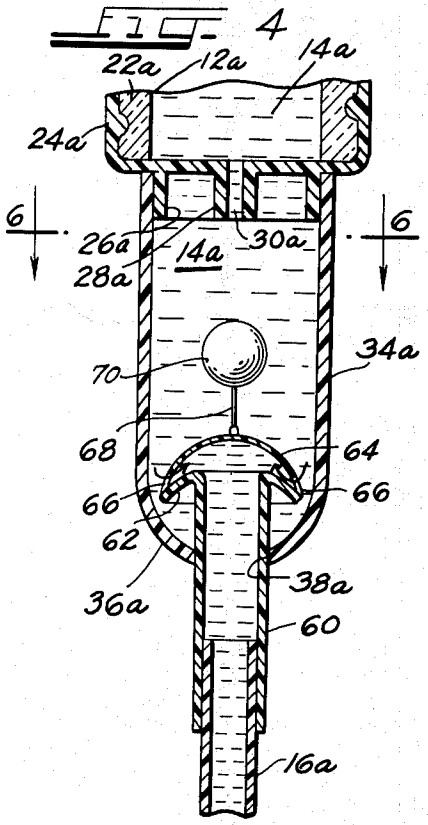


FIG. 5

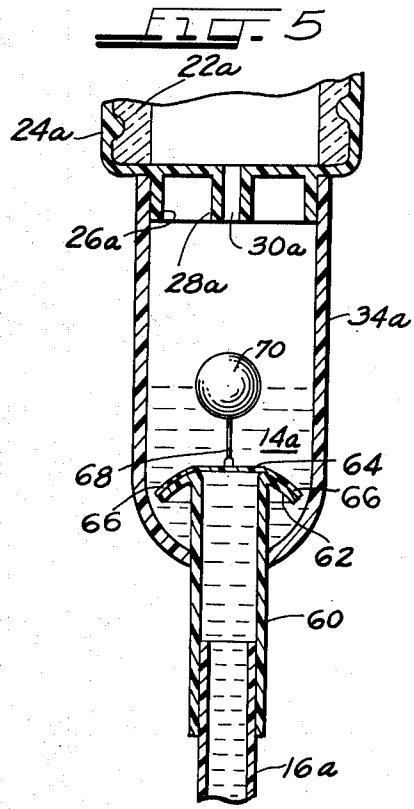
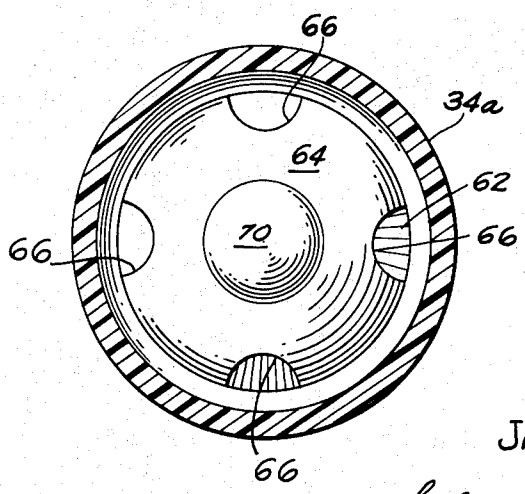


FIG. 6



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FIG. 7

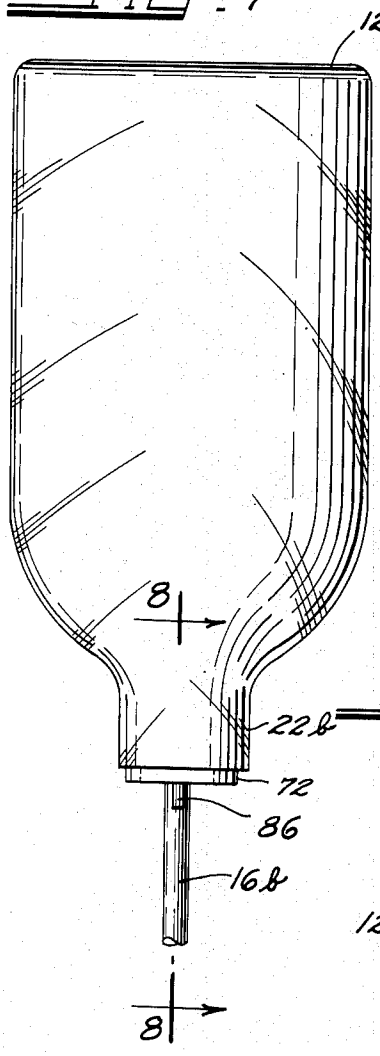


FIG. 8

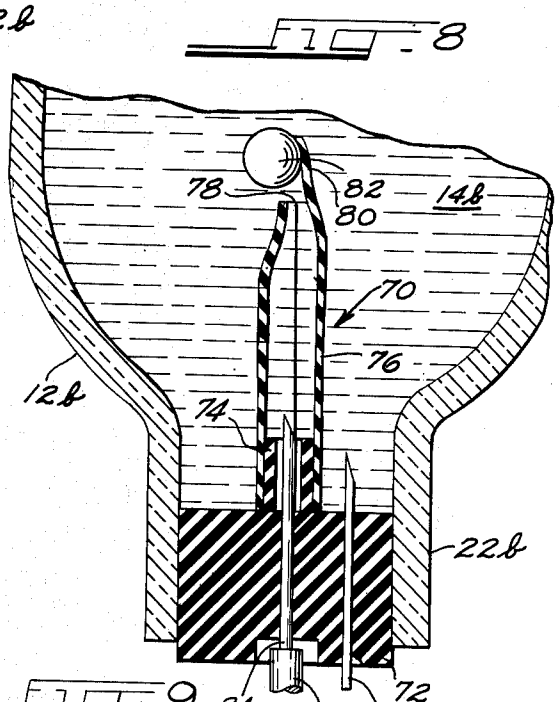
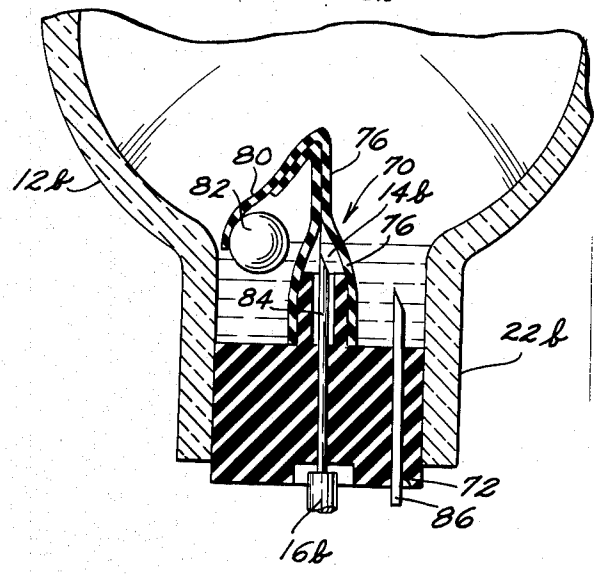


FIG. 9



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VALVE FOR PARENTERAL LIQUID FEED APPARATUS

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Filed June 19, 1963, Ser. No. 289,141
1 Claim. (Cl. 137—192)

This invention relates generally to apparatus for the injection of parenteral solutions, and more particularly to an improved check valve for such apparatus designed to be maintained in a normally closed position and operating in a manner to ensure the sealing off of the liquid feed line after the prescribed supply of solution has been exhausted but before the admission of any air thereto. This application comprises a continuation-in-part of my patent application, Ser. No. 246,491 filed Dec. 21, 1962, and entitled Parenteral Liquid Feed Apparatus with Magnetically Influenced Positive-Acting Check Valve, now abandoned.

The invention disclosed in my aforementioned co-pending patent application comprised a parenteral liquid feed apparatus with a magnetically influenced float type check valve. Magnetic means was provided for influencing the float valve to ensure seating of the same in sufficient time to seal off the liquid feed line after the prescribed supply of solution had been exhausted but before the admission of any air into the feed line. This was to ensure against air embolism which might result in death of the patient.

As was indicated by my aforementioned co-pending patent application, intravenous solutions are generally administered by gravity feed from an elevated and inverted bottle or similar container of the solution. The solution from the bottle is fed into the vein of the patient through a feed tube and a hypodermic needle. A pinch valve is usually associated with the tube for adjusting the rate of flow, or even cutting off the same altogether. In the simple gravity liquid type system in which no automatic check valve was provided, it was essential that the attending nurse or doctor terminate the injection before the admission of any air into the feed tube following the exhaustion of the supply of solution. Failure to do this could result in air embolism and the death of the patient.

To overcome this problem, I provided a float valve which could be positioned either in the bottle of solution or in the plenum chamber intermediate the solution container and the feed tube. It could also be located in a chamber or tube positioned anywhere in the feed tube system. The float valve had magnetic-responsive material contained therein and a magnet was positioned below the valve seat. The magnet was movable into operative position, and was so designed that it would attract the float valve and cause it to be seated on the valve seat prior to complete exhaustion of the liquid in the plenum chamber or container. This ensured against admission of any air into the feed tube.

Although the above-described valve was indeed positive acting and efficient, the necessity for providing comparatively expensive magnetic means and for incorporating metallic magnetic-responsive material in the float valve proved to be somewhat objectionable for various reasons.

It is therefore an important object of this invention to provide improved valve means for parenteral liquid feed apparatus which will overcome both the objections of the prior art devices, as disclosed in my aforementioned co-pending patent application, and also the above-described disadvantages of the magnetically-influenced check valve comprising the subject matter of my aforementioned co-pending patent application.

To achieve these desirable results, I have provided check valve means which is normally urged to a closed position

and which is opened only when a pre-determined amount of liquid is present in the chamber within which the valve seat and valve are contained. Again, the valve seat and valve may be contained either in the bottle or within the plenum chamber positioned below the neck of the bottle containing the solution. Similarly, it may be positioned in a chamber or tube located anywhere in the feed tube system.

Another important object is to afford an intravenous liquid feed apparatus which includes a positive acting check valve having the advantages of a float valve in permitting accurate dispensing of all of the liquid as prescribed but which avoids the disadvantages of the simple float valve systems described above. The invention thus insures a positively accurate and efficient seal of the feed tube in every case.

Still another object is to afford an intravenous liquid feed apparatus of the character described which may be fabricated as a complete unit or set including a suitable cap to be connected to the bottle of solution.

Yet another object is to provide an intravenous liquid feed apparatus of the character described which is relatively inexpensive and thus may be discarded after use. In this manner, all problems of sterilization for later use are avoided.

Still a further object is to afford an intravenous liquid feed apparatus of the character described in which all parts having contact with the administered solution, including the valve, may be made of readily sterilizable, non-toxic and inert materials.

Another object is to provide a valve embodiment, the closure of which does not depend upon the seating of a ball, thereby reducing the possibility of inadvertent opening of the valve due to accidental movement or tipping of the valve chamber.

Yet a further object is to provide an intravenous liquid feed apparatus of the character described which is simple to use and yet is most trustworthy and efficient for the purposes intended.

With the foregoing and other objects in view which will appear as the description proceeds, the invention consists of certain novel features of construction, arrangement and a combination of parts hereinafter fully described, illustrated in the accompanying drawings, and particularly pointed out in the appended claim, it being understood that various changes in the form, proportion, size and minor details of the structure may be made without departing from the spirit or sacrificing any of the advantages of the invention.

For the purpose of facilitating an understanding of my invention, I have illustrated in the accompanying drawings preferred embodiments thereof, from an inspection of which, when considered in connection with the following description, my invention, its mode of construction, assembly and operation, and many of its advantages should be readily understood and apreciated.

Referring to the drawings in which the same characters of reference are employed to indicate corresponding or similar parts throughout the several figures of the drawings:

FIG. 1 is an elevational view of an intravenous liquid feed apparatus embodying the principles of this invention;

FIG. 2 is a fragmentary enlarged sectional view taken on the plane of line 2—2 in FIG. 1, viewed in the direction indicated and illustrating the relationship of parts at the initiation of, or during, the flow of liquid;

FIG. 3 is a similar view illustrating the relationship of parts with the valve seated and sealing off the feed tube;

FIG. 4 is a similar view, but illustrating another embodiment of the valve, and again illustrating the relationship of parts at the initiation of the flow of liquid;

FIG. 5 is a similar view of the same embodiment illustrating the relationship of parts with the valve seated and sealing off the feed tube;

FIG. 6 is a further enlarged sectional view taken on the plane of line 6—6 in FIG. 4 of the drawings and viewed in the direction indicated;

FIG. 7 is an elevational view of an intravenous liquid feed bottle in which is inserted a cork with another embodiment of the valve;

FIG. 8 is an enlarged fragmentary sectional view of the embodiment of FIG. 7 and illustrating the valve embodiment in the open position; and

FIG. 9 is a similar fragmentary view of the same embodiment but showing the valve in the closed position.

Referring to FIG. 1 of the drawings, the reference numeral **10** indicates generally a parenteral or intravenous liquid feed aparatus embodying the principles of the invention. The apparatus **10** is shown connected to a bottle or similar container **12** containing a suitable liquid **14** which is being administered. The opposite end of the apparatus comprises a feed tube **16** made of flexible rubber, plastic or the like, and a cannula or hypodermic needle **18** connected to the free end of the tube, said needle being inserted into the arm of a patient as illustrated. A simple pinch valve, such as the slotted plate **20**, may likewie be mounted on the tube **16** for controlling the rate of flow in the well known manner. The bottle **12** is provided with the customary neck **22** which may be externally screw threaded as indicated in FIGS. 1 and 2 of the drawings.

A cap **24** made of hard rubber or suitable plastic or similar material is threadedly engaged with the bottle neck **22**. Integrally formed with, or otherwise suitably connected to, the cap **24** is an annular depending collar **26** which may be made of a softer flexible material, such as rubber or the like. Centrally positioned within the collar **26** is a nipple **28** which communicates with the interior of the bottle **12** by means of a central passageway or orifice **30** formed therethrough. The cap **24** may also contain a conventional vent tube such as **32** which functions in the usual manner to admit air into the bottle for facilitating the flow of the liquid **14** therefrom.

Tightly fitted over, or connected to, the collar **26** may be a small volume (1 or 2 cc.) plenum chamber **34** which may be transparent and made of glass, although a semi-rigid but non-breakable transparent plastic is preferred. The chamber **34** is generally cylindrical in cross-section with a curved or relatively conic section **36** formed at the bottom thereof. The conic section **36** is formed with a central opening **38** formed at the bottom thereof. The tube **16** is inserted through said opening **38** and is adapted to fit therein in water-tight relationship. The upper end of the tube **16** may be formed with a funnel-shaped, outwardly-flaring, top portion **40**. It will be appreciated that said funnel-shaped portion **40** affords an annular valve seat **42** adapted to cooperate with a novel float valve indicated generally by the reference numeral **44**.

The float valve **44** may be of any suitable shape and size but as illustrated in FIGS. 2 and 3 comprises a cylindrical portion **46** with a depending inverted conical section **48**. Said conical section **48** is complementary in shape and size to the valve seat **42** for reasons which will be disclosed as the description proceeds. It should also be noted that the upper base of the conical section **48** is smaller in dimension than the adjacent base of the upper cylindrical portion **46** thereby affording a marginal shoulder **50**. Similarly, the reason therefor will become apparent as the description proceeds.

The float **44** is anchored to the tube **16** by suitable spring or elastic means such as a length of elastic cord **52**, one end of which is affixed to the bottom of the float cone **48** and the other of which may be anchored to a spider or bridge **54** positioned within the tube **16** in spaced relationship with the top thereof, as shown in FIGS. 2 and 3 of the drawings. The length of the cord **52** is short

enough so that the float valve **44** is ordinarily seated in closed position in the valve seat **42** of the funnel portion **40** of the tube **16** in the manner shown in FIG. 3 of the drawings. When so seated, it will be noted that the conical section **48** of the float valve is seated so that the sides thereof fit snugly within the valve seat **42**. Further closure is afforded by the seating of the shoulder **50** on the top edges of the funnel portion **40**. It should be noted that the bridge **54** does not excessively interfere with the flow of liquid through the tube **16**.

Operation of the apparatus **10** may now be appreciated from the following description. When it is desired to administer liquid by injection into a patient, the cap or ordinary closure member of the bottle **12** is removed and the cap **24** threadedly connected thereto. The bottle **12** may now be inverted so that the liquid **14** from the bottle flows into the plenum chamber **34** through the orifice **30** of the nipple **28**. As the plenum chamber fills with liquid, the float **44** exerts sufficient buoyant force upwardly to overcome the downwardly directed force exerted on the float by the elastic cord **52**. Thus, the float **44** rises (stretching the elastic cord **52**) unseating the valve and thereby opening the same and permitting the liquid from the plenum chamber to flow down through the tube **16**. The needle **18** is, of course, inserted into the arm of the patient and the pinch valve **20** may likewise be adjusted to regulate the rate of flow of the liquid through the feed tube **16**.

As the supply of liquid **14** nears exhaustion, the liquid level in the chamber **34** begins to recede. As the liquid recedes, the elastic cord **52** contracts and the float valve **44** settles until the same is firmly seated in the seat **42**. It is important to note that the buoyancy of the float valve **44** and the elasticity of the cord **52** are such that the seating of the float valve occurs while there still remains a small amount of liquid in the chamber **34**. The combination of the contracting action of the elastic cord **52** urging the valve **44** to a normally seated or closed position and the small remaining amount of liquid in the chamber, doubly ensures against the entry of air into the feed tube **16**.

In FIGS. 4, 5 and 6 of the drawings, there is illustrated a modified form of the invention in which similar parts are identified by like numerals with the added suffix "*a*." In this embodiment, the upper end of the tube **16***a* has a tubular sleeve **60** fitted over the top thereof so that a portion of said tube protrudes through the opening **38***a* into the plenum chamber **34***a*. The upper end of the sleeve **60** is formed with a downwardly sloping annular flange **62**. A rubber or other suitable elastic membrane **64** is stretched thereover with the marginal edges thereof secured to the marginal edges of the flange **62**. The membrane **64** is formed with semi-circular indentations or cut-out portions **66** opening to the outer edges of the membrane and flange. These cut-out portions are not secured for reasons which will become apparent as the description proceeds. Affixed to the center of the membrane **64**, by any suitable means such as non-elastic cord **68**, is a float **70**, the function of which likewise will become apparent as the description proceeds.

In operation, the membrane **64**, being stretched over the flange **62**, is normally deflated and taut enough so that the same bears against the top surface of the flange **62** and across the top opening of the sleeve **60**. This relationship of parts ensures a water-tight closure of said tube, thereby preventing the admission of any liquid into the sleeve **60** and the liquid feed tube **16***a*. The closed position of the apparatus is illustrated in FIG. 5 of the drawings. As the bottle **12***a* is inverted, in the manner described in connection with the first embodiment, the liquid **14***a* enters the plenum chamber **34***a* through the orifice **30***a* of the nipple **28***a*. This exerts sufficient buoyant force so that the float **70** rises, drawing up with its membrane **64**, to the position shown

in FIG. 4 of the drawings. As this occurs, the liquid enters through the cut-out portions **66** and flows between the raised membrane **64** and the flange **62**, as illustrated by the arrows in FIG. 4 of the drawings. The liquid of course then enters the sleeve **60** and the feed tube **16***a* so that the same may be fed to the patient in the manner described in the previous embodiment.

In FIGS. 7, 8 and 9 of the drawings, there is illustrated a further modified form of the invention in which similar parts are identified by like numerals, but this time with the added suffix "*b*." In this embodiment, the valve **71** is shown mounted on a bottle stopper **72** inserted directly into the neck **22***b* of the bottle **12***b*. As in the case of the other embodiments, the specific location of the valve in the liquid feed system is not liimted. The valve could be as readily positioned in a plenum chamber suspended from the bottle **12***b*, as illustrated in FIGS. 1 through 5 of the drawings, or if preferred could be positioned in a separate chamber or tube which, in turn, might be positioned anywhere in the liquid feed system.

Directing attention to FIGS. 8 and 9 of the drawings, it will be noted that the bottle stopper **72** (which may be made of rubber or any other suitable material) may be formed with a tube-like protuberance **74** over which may be fiitted the lower end of a soft flexible tube **76** having a top opening **78**. The tube **76** may be formed with an upwardly protruding tab or finger **80** which may merely comprise an integral portion of the tube wall. It will be noted, however, that the tab **80** protrudes above the top opening **78**. Attached to, or intergrally formed with, the upper portion of the finger **80** is a ball **82**, the function of which will become apparent as the description proceeds.

Inserted into the upper end of the feed tube **16***b* may be a hollow hypodermic needle **84**. As shown in FIGS. 8 and 9, this hypodermic needle may be inserted through the stopper **72** so that the same protrudes into the tube **74**. A second hypodermic needle **86** may be inserted through the stopper **72** to afford an air vent similar to the vent tube **32** of the prior embodiments.

The operation of this valve embodiment will now become apparent with attention directed to FIGS. 8 and 9 of the drawings The liquid **14***b* in the container **12***b* exerts buoyant forces on the ball **82** so that the same floats sufficiently to maintain the tab **80** and the walls of the tube **76** in a substantially vertical plane or position. In this position, the valve inlet **78** is maintained in an open condition, thereby permitting the fluid **14***b* to pass through the tube **76**, the hypodermic needle **84** and enter the attached liquid feed tube **16***b*.

However, when the supply of liquid **14***b* is depleted to the point shown in FIG. 9 of the drawings, the ball **82**, floating downwardly on the surface of the liquid **14***b*, causes the upper portion of the flexible tube **76** to bend sufficiently to close the opening **78** thereby cutting off the supply of liquid to the feed tube **16***b*. Again, it will be noted that the valve closes before the entire supply of fluid **14***b* is exhausted, thereby ensuring against the entry of air into the feed tube **16***b*. As a matter of fact it will be noted that a small amount of liquid remains inside the tube **76**, doubly ensuring that no air enters the intravenous feed tube system.

Since the above described valve embodiment does not depend upon the seating of a ball or similar member, it is especially positive acting and fool-proof. Thus, inadvertent tipping or accidental movement of the apparatus will not prevent the flexible tube from bending and closing off the valve opening. Likewise, once closed, such accidental movement will not indavertently open the valve.

From the foregoing description and drawings, it should be apparent without further description that I have provided a novel parenteral or intravenous liquid feed apparatus having positive acting check valve which is normally in the closed position, and which ensures an efficient sealing-off of the feed tube slightly before the entire supply of liquid is exhausted. The valve is so designed that it does not open until liquid is actually present in the plenum chamber and the entrance to the feed tube. It is further designed so that it closes before all of the liquid in the plenum chamber, container or valve tube (depending on the embodiment) is exhausted. This ensures positively against the entrance of any air into the feed tube. However, it still permits dispensing of the full prescribed dosage. The apparatus and the action of the valve is completely trustworthy so that an injection may be left unattended, once begun, without any apprehension. Moreover, the entire apparatus may be inexpensively made as a unitary discardable kit for ease of use and sterilization.

It is believed that my invention, its mode of construction and assembly, and many of its advantages should be readily understood from the foregoing without further description, and it should also be manifest that while preferred embodiments of the invention have been shown and described for illustrative purposes, the structural details are nevertheless capable of wide variation within the purview of my invention as defined in the appended claim.

What I claim and desire to secure by Letters Patent of the United States is:

A parenteral liquid feed apparatus comprising a bottle of liquid, a stopper positioned to close the mouth of said bottle, said stopper having a short tube protruding into said bottle, a flexible tube mounted on said short tube, said flexible tube having an opening adjacent the top thereof, a finger protruding from the wall of said tube above said opening, a buoyant ball attached to the upper end of said finger, and a liquid feed tube fluidly connected to said flexible tube whereby the flow of liquid from said bottle into said liquid feed tube may be controlled by said flexible tube.

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