

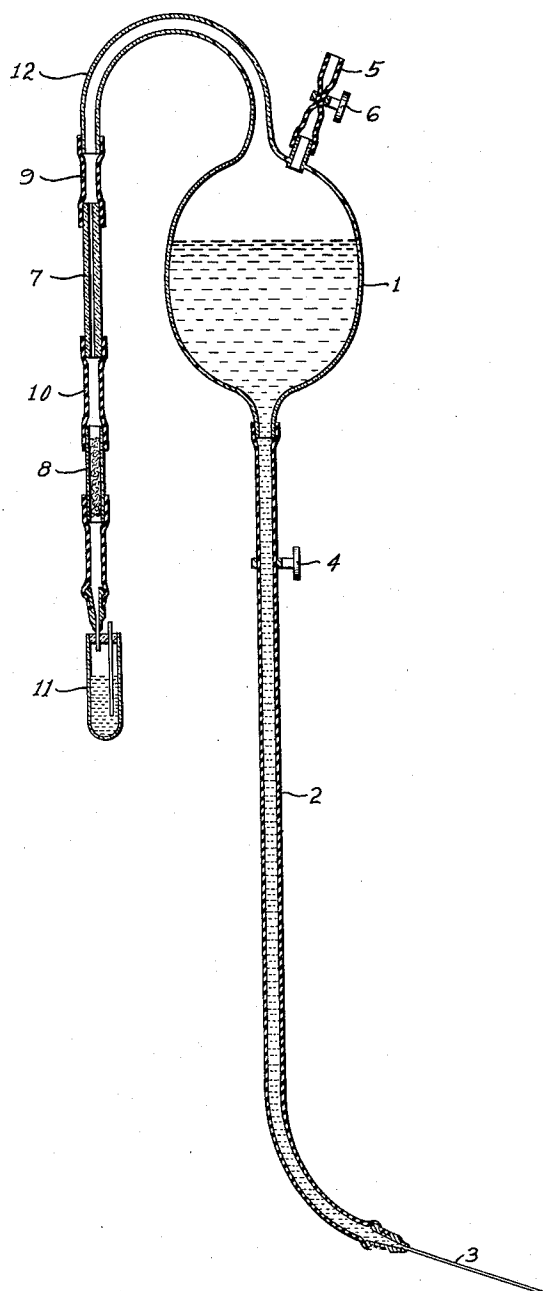
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APPARATUS FOR INJECTING MEDICINAL SOLUTIONS

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APPARATUS FOR INJECTING MEDICINAL SOLUTIONS

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This invention relates to an apparatus which is suitable for use in continuously injecting medicinal solutions into a patient at a slow, substantially constant rate.

In continuous injection (i. e., the infusion into a patient of liquids containing medicinals such as penicillin), a constant and slow rate of injection is as a rule desired so that only a small volume of liquid is injected per unit of time. Slow speed of injection is achieved by decreasing the speed of flow of the liquid from the injection apparatus. This is usually achieved by narrowing the bore of the tube through which the liquid flows, by means of a screw clamp. Since the bore of the tube through which the liquid flows is narrowed down to a very high degree, impurities in the liquid easily clog the tube. As a result, frequent control and adjustment of the speed of flow is necessary in order to insure a fairly constant rate of injection.

It is therefore an object of the present invention to provide an apparatus for injecting medicinal solutions, from which apparatus the liquid will flow substantially freely through the outlet tube.

It is also an object of the present invention to provide an apparatus for injecting medicinal solutions which need be adjusted at less frequent intervals.

The aforementioned and other objects are accomplished in accordance with the present invention by providing an apparatus having a reservoir adapted to hold a supply of the medicinal solution, which reservoir has in communication therewith an outlet line for the solution and also in communication therewith an air inlet line having therein a capillary tube.

For a more complete understanding of the apparatus of the present invention, reference is made to the accompanying drawing which illustrates in diagrammatic form the invention in a preferred embodiment. The apparatus in the drawing shows a container or reservoir 1 for the bulk of the liquid to be injected, having a flexible connection tube 2 and an exit tube 3 through which the liquid may flow with the aid of gravity to the body of the patient. The exit tube 3 is shaped in the form of a hypodermic needle such as is usually used by physicians. On the connection tube 2 there is placed a screw clamp 4, the function of which will be explained hereinafter. The container 1 is also supplied with a flexible filling tube 5 which is closed by a screw clamp 6 when the apparatus is being used. The tubes numbered 12, 9, 7, 10 and 8 together make up the air intake or air inlet of the apparatus. Before

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the atmospheric air enters the capillary tube 7, it is purified by passing through the filter 8; a tube which may for example contain cotton as a filtering material. The container may be supplied with additional supply tubes 5 and/or with additional exit tubes 2 and 3 not shown on the drawing.

The apparatus just described operates essentially in the following fashion. The liquid in the container 1 flows by means of gravity through the connection tube 2 and through the exit tube 3 to the body of the patient. When equilibrium has been reached, the air in the container 1 is at a pressure less than atmospheric and the volume rate at which the liquid flows from the container 1 will equal the volume rate at which air is drawn from the atmosphere into the container 1 through the capillary tube 7. The rate at which the air enters the container 1 will be substantially constant, and will depend primarily upon the internal diameter of the capillary tube, but also upon the length thereof and upon the difference in air pressure between the two ends of the capillary tube 7. A very fine degree of regulation of the rate of flow of liquid may be made by a change in the vertical distance between the liquid level in the container 1 and the exit tube 3. The influence of the dimensions of the other parts of the apparatus on the rates of the flow of the air and liquid may, for all practical purposes, be disregarded, since all these parts possess a very large diameter in comparison with the diameter of the capillary tube.

In making the apparatus ready for use, liquid is added to the container 1 through the supply tube 5 while the screw clamp 6 is open and the screw clamp 4 is closed tight. Then, when an injection is being made using the apparatus, the supply tube 5 is closed tight by means of the screw clamp 6, and the screw clamp 4 on the connection tube 2 between the container 1 and the exit tube 3 is held wide open.

The particular dimensions chosen for the apparatus, particularly the diameter and length of the capillary tube, will depend upon the rate at which it is desired that liquid will flow from the apparatus. For example, an apparatus having a capillary 0.005 cm. in diameter and 8.67 cm. long will deliver liquid at the rate of about 100 ml. per day, when the vertical distance between the liquid level in the container and the exit tube is 100 cm. When the aforementioned vertical distance is reduced to 50 cm., the apparatus will deliver liquid at the rate of about 50 ml. per day. Likewise, when the length of the 0.005 cm. diameter capillary is increased to 17.33 cm. and the vertical distance is held at 100 cm., the apparatus will de-

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liver liquid at the rate of 50 ml. per day. Furthermore, when a capillary 0.01 cm. in diameter and 8.67 cm. long is used and the vertical distance is held at 100 cm., the apparatus will deliver about 1600 ml. per day. As a general rule, according to Bernoulli's law which is well known in the field of hydraulics and hydrodynamics, the rate of flow from an apparatus will be proportional to the fourth power of the diameter of the capillary, will be proportional to the vertical distance between the surface of the liquid in the container and the exit tube, and will be inversely proportional to the length of the capillary tube.

Various modifications may be made in the apparatus specifically described. Thus, the flexible connection tube 9 between the container 1 and the capillary tube 7 may be closed off with a screw clamp (not shown) when the container 1 is being filled through the supply tube 5. This will prevent the liquid from flowing back into the capillary tube 7. Alternatively, a filter of non-absorbable cotton or a valve may be inserted in the connection tube 9 for the same purpose. In addition, a small bubble counter 11 may be inserted either before, between, or after the inlet tubes 8, 10, 7 and 9. The rate at which the ingoing air bubbles through this bubble counter provides a measure of the rate at which the air is entering the apparatus, and consequently of the rate at which the liquid is flowing from the apparatus. Glycerine is a liquid suitable for use in such a bubble counter. Still other modifications may be made by those skilled in the art.

I claim:

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1. An apparatus suitable for use in continuously injecting medicinal solutions into a patient at a slow, substantially constant rate comprising a reservoir adapted to hold a supply of the medicinal solution, the reservoir having in communication therewith an outlet line for the solution and an air inlet line having a capillary tube therein, said capillary tube forming the sole means for regulating the discharge of solution through the outlet line.

2. An apparatus suitable for use in continuously injecting medicinal solutions into a patient at a slow, substantially constant rate comprising a reservoir adapted to hold a supply of the medicinal solution, the reservoir having in communication therewith an outlet line for the solution and an air inlet line having therein a capillary tube and air filtering means, said capillary tube being between said filtering means and said reservoir and forming the sole means for regulating the discharge of solution through the outlet line.

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