This invention is concerned with intravenous administration equipment and more particularly with a novel drip meter, filter and pump arrangement for administering blood intravenously.

It often occurs when a transfusion of blood is being administered, that it becomes necessary to accelerate the delivery of blood to the recipient. Disclosed and claimed herein is a novel and improved apparatus for effecting this result.

One feature of the invention is that it provides a pumping arrangement separate from the drip meter and filter. Another feature is that a valve is provided between the pump and the drip meter-filter, which closes when the pump is utilized preventing the drip meter and filter from becoming flooded.

A further feature is the provision of a pump having a chamber with a flexible wall and a floating check valve in the chamber, the valve closing when the valve is compressed to force liquid through the outlet. Yet another feature is that the pump has a rigid end member with an inlet therethrough and a floating check valve carried in the pump chamber adjacent the inlet, the check valve seating on the end member to close the inlet when the flexible wall is compressed, forcing liquid through the pump chamber outlet.

Yet another further feature is the provision of a combined drip tube and filter comprising an upper section of a transparent material having an inlet member extending therethrough providing a visible drip, a lower section having an outlet tube connected thereto, and an upwardly opening cup-shaped filter supported within the lower section. Further features and advantages will readily be apparent from the following specification and from the drawings, in which:

**FIGURE 1** is a broken view, partially in section, illustrating the intravenous administration equipment;

**FIGURE 2** is an enlarged sectional view of the pump chamber; and

**FIGURE 3** is an enlarged transverse sectional view taken along line 3--3 of **FIGURE 1**.

Transfusions of parenteral liquids, including blood transfusions, are normally given at a relatively slow rate which is determined by counting the drops of liquid formed in a drip meter. However in emergency cases, and this is particularly true in the case of blood transfusions, situations may arise where it is necessary to accelerate the speed of infusion at least for a short period of time. It may then be desirable to return to the slower infusion rate.

Turning now to **FIGURE 1**, an infusion set is shown, including a combined drip meter and filter indicated generally as 10 and a pump chamber indicated generally as 11. The drip meter-filter is provided with a sharpened cannula 12 which may be inserted through the rubber stopper of a container of infusion liquid. Flexible tubing 13 is connected to the outlet of pump chamber 11 and may have secured to the end thereof a suitable infusion needle (not shown).

The drip meter and filter 10 includes an upper section 14 of rigid transparent plastic formed integrally with the sharpened cannula 12 which projects from the upper end thereof. The cannula also extends inwardly of upper section 14 providing a drip forming extension 15.

A lower section 16, also of rigid transparent plastic, is joined to the upper section by an annular intermediate section 17 having a central flow passage 18 therethrough. The intermediate section is provided with annular channels into which the ends of the upper and lower sections are secured. The underside of the intermediate section is provided with an inner annular channel in which an upwardly opening cup-shaped filter element 19 is carried, the filter being of any suitable material such as a fine woven fabric mesh. The bottom end of the lower section 16 is provided with a flange 16a over which is snapped a resilient rubber fitting 20 which may be recirculated longitudinally of the drip meter-filter assembly 10 to effect a pumping action, starting the flow of liquid. A short piece of rigid plastic tubing 23 is received in the outlet opening of fitting 20 and has secured thereto a section 24 of flexible plastic tubing. A suitable flow control device (not shown) such as that disclosed in copending Thompson and Barton application, Serial No. 504,398, filed April 28, 1955, now Patent No. 2,935,088, may be provided and is preferably attached to tubing section 24.

The flexible pump chamber 11 includes an upper rigid end member 25 provided with a hollow boss which is inserted into the connecting tubing 24. A similar rigid end member 26 is provided at the lower end of the pump chamber and has a hollow boss to which is connected outlet tubing 13. The wall 27 of the pumping chamber is preferably of a transparent flexible, resilient plastic material so that it may readily be deformed by manual pressure and will on release return to its original cylindrical shape.

Turning now to **FIGURE 2**, it will be seen that inlet end member 25 is provided with an annular groove 25a within which the flexible pump chamber wall 27 is secured. A depending flange 25b extends downwardly inside the chamber wall 27 and carries at its lower extremity a valve support ring 28. The valve support ring includes arms 29 which extend inwardly and terminate in an annular inner ring 30 defining an opening 30a. A disk-shaped check valve 31 is carried on the arms 29 of the valve support ring and is provided with a stem 31a which extends through the guide opening 30a. The valve 31 is preferably of a material which has a specific gravity slightly less than that of the blood being administered.

A suitable material is gum rubber containing three-fourths of a percent of paraffin. When the pump is operated by compressing the wall thereof check valve 31 immediately seats and the liquid contained within the pump chamber is forced out through the tubing 13 to the patient.

The administration equipment is preferably used in the following manner. After the blood to be administered is properly mixed, a suitable air filter is inserted through the stopper of the dispensing container. The flow control for the dispensing apparatus is closed and the sharpened end of cannula 12 inserted through the outlet of the container stopper. The bottle of solution is then inverted and suspended from a suitable support. With the flow regulator still closed, rubber fitting 20 is manipulated to fill the lower half inch or so of filter chamber 16. The filter itself need not be completely filled or covered with liquid. An infusion needle may then be secured to the end of outlet tubing 13, the flow regulator opened to fill both the tubing 24 and 13 and, when the transfusion began in the usual manner. The rate of administration may be adjusted by use of the flow regulator.

Should it become necessary to accelerate the administration, the flow regulator should be opened completely and the flexible wall 27 of the pump chamber squeezed and released until the pump chamber is filled. The rate of transfusion will then be determined by the operator's...
manipulation of the pump chamber. After the necessary accelerated transfusion, and very often only a few operations of the pump are necessary, the administration may be returned to a slow rate by proper adjustment of the flow regulator. Unless the pump has been used for an extended period of time, the pumping operation will not flood the drip meter-filter chamber and the regular infusion procedure may be resumed immediately. If, however, the pump is used for an extended period and the drip chamber and filter flood, this flooding may be eliminated by merely tipping the blood container and drip meter-filter unit to a horizontal position and manipulating fitting 20 to pump some of the blood back into the bottle. The regular administration procedure may then be resumed.

The inner wall 14a of the upper section or drip chamber 14 is preferably coated with a silicone grease. This substantially reduces the entrapment of air in the blood during pump back and permits instant view of the drop formation at extension 15.

It is important that the check valve 21 float in the blood to insure speedy and tight closing of the pump inlet when the pump is operated. This not only increases the pressure applied on the blood in the outlet tubing 13 but also reduces the danger of flooding the drip and filter chambers. However, in order to insure a proper flow of the liquid past the check valve under normal operating conditions (that is when the pump is not being used) tubing 24 should be of sufficient length to provide an adequate head or pressure of liquid above the valve to overcome the buoyancy thereof. With the gum rubber check valve previously described, six inches has been found to be a suitable length for tubing 24.

While we have shown and described certain embodiments of our invention, it is to be understood that it is capable of many modifications. Changes therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed in the appended claims.

We claim:

1. A gravity intravenous liquid administration set, comprising: a combined drip tube and filter including an upper section of transparent rigid material having an inlet tube connectable with a source of liquid and extending into the upper section providing a drip, a lower section of transparent rigid material adapted for connection with a conduit, an annular intermediate section having the upper section secured to one side and the lower section secured to the other side thereof and having a central flow opening therethrough, and an upwardly opening cup-shaped filter suspended from said intermediate section and extending within said lower section; a conduit connected with the outlet of said lower section; a flexible pump chamber having an inlet connected with said conduit at a point spaced from said combined drip and filter chamber; and a floating check valve in said pump chamber for closing the inlet thereof when the pump chamber is operated to force liquid through the pump outlet.

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