VOLUME-PRESSURE CHARACTERISTIC OF THE "ONE GALLON" RESERVOIR BAG

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In the course of an investigation of expiratory valves in anaesthetic apparatus (Mushin and Mapleson, 1953), it was remarked that physiological considerations make it desirable for the valve to open and pass large flows for a small pressure drop. At the same time it was pointed out that in the usual semi-closed system, if this pressure drop was too small, the reservoir bag would not fill sufficiently for the patient to be able to draw the required tidal volume.

It was therefore thought of interest to determine the volume-pressure characteristic of reservoir bags. This was done with the apparatus shown in figure 1.

The apparatus was connected as shown and made air tight. By syphoning off water, the bag was completely emptied of air, this point being indicated by the manometer just beginning to show a negative pressure. Measured quantities of water were then poured into the funnel and admitted to the system by opening the tap. The pressure and temperature were noted after each addition. When a pressure of about 20 cm. of water had been attained, the process was reversed by syphoning off measured quantities of water. The point at which the bag was again just empty was determined. It was found that the loss of air through leakage in the course of a cycle of operations never exceeded 20 ml. or less than 1 per cent of the maximum volume passed into the bag. The temperature was maintained constant to within 1°C by judicious adjustment of electric fires, doors and windows in the room.

From a practical point of view it is not so much the volume of the bag which is of interest, but the volume which its contents would occupy when expanded to atmospheric pressure without change of temperature. This, the value used in the graph of figure 2, could be determined with sufficient accuracy by correcting for pressure, but without correcting for temperature or water vapour content variations.

One cycle of operation was performed on each of three bags. Bags 1 and 2 were

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Fig. 1

Apparatus for determining volume-pressure characteristic of reservoir bag.

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new and unused; bag 3 had been in use in theatre for some time. The results are shown in figure 2, where the pressures plotted are the means of the values for increasing and decreasing volumes. It is apparent that for volumes up to about 2 litres, where the bag appeared to be just taut, the pressure remains quite low (less than 1 cm. of water). Beyond this volume the pressure increases very rapidly, attaining a value of 20 cm. of water for a volume of between 2.9 and 3.2 litres depending on the particular bag used.

Two conclusions may be drawn from these graphs. Firstly, the so-called "one gallon" bag shows a sharp pressure rise when its contents exceed 2 litres (about half a gallon). Secondly, any expiratory valve which opens at a pressure of less than 1 cm., or at any rate 0.5 cm. of water may prevent adequate filling of the reservoir bag, so that it does not contain sufficient gas to supply the tidal volume of the patient.

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REFERENCE