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New Low Resistance Respiratory Valve

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Abstract. Fabrication at DIPAS of a low resistance respiratory valve from totally indigenous materials costing Rs. 500/- is reported here. Experimental data reveal that the dead space in the valve is 230 ml and the pressure drop across the valve (i.e. the resistance) at a flow rate of 240 litres per minute is 1 cm of water.

1. Introduction

Measurement of a volume of air, particularly the flow rate of inspired air and expired air is difficult. Some of the difficulties were overcome by using Rudolf valve. McKerrow & Otis[1] developed a low resistance respiratory valve for hyperventilation. This was of great advantage to the respiratory physiologists for measuring airflow during inspiration and expiration. Several organisations abroad tried to modify the low resistance respiratory valve with varying degrees of success. In India, however, similar modifications met with failure as far as the functional capability of the valve was concerned and therefore no production was attempted.

In an institute of physiology, such valves are daily required by respiratory physiologists. Import is expensive and often time consuming. Moreover, these days, our country is laying greater emphasis on indigenous production. Because of these factors, an attempt was made to design and fabricate a low resistance respiratory valve. The methodology, the working principle and the technical knowhow were known and the materials required were locally available.

It was observed by Muller & Bastert[2], Matheson *et al.*[3] and McKerrow & Otis[1], that the measurement of maximum voluntary ventilation is influenced by the resistance of the measuring instrument. The measuring instrument (the respiratory valve) should offer minimum resistance to ventillation.

The valve produced was a simple cylindrical container made of perspex, incorporating perspex sheets with rubber valves. It was designed as per requirement. The resultant gadget was evaluated for its functional capability. In appearance, the valve was similar to that produced by the McKerrow & Otis[1] the functional capability was better, the dead space was 230 ml.

2. Materials and Methods

The respiratory valve is shown in Fig. 1 and 2. The materials used are perspex for cylinder, tubes and sheets and India rubber for inspiratory and expiratory valves.

The respiratory valve is a hollow perspex cylinder (length 55 mm; inner dia 110 mm; wall thickness 10 mm). It is covered at the top with a perspex disc 120 mm dia thickess 7 mm. means of four fine screws. The bottom is closed by fixing a perspex plate of similar dimensions with the help of chloroform. The inner space is divided into two equal parts by fixing a partition running through the diameter

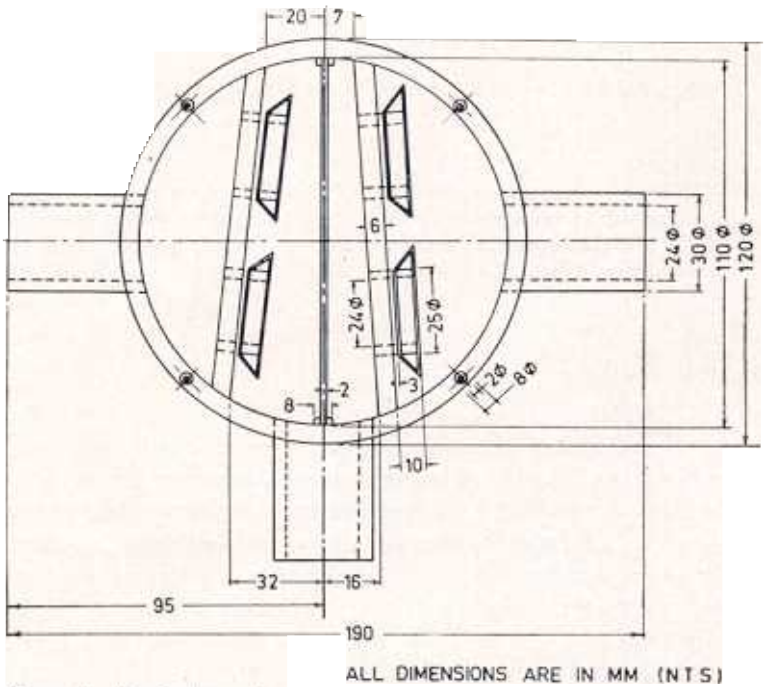

Figure 1. Respiratory valve

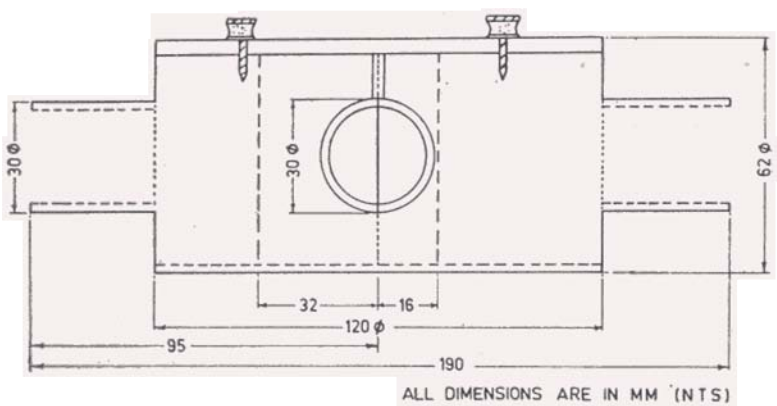

Figure 2. Side view.

of the tube. It is 2 mm thick sheet fitted on grooves made on the circumference wall. A round opening (dia 30 mm) is made on one side of the cylinder in such a way that the end of the partition divides this opening into two equal semicircles. A perspex tube (outer diameter 30 mm, wall thickness 6 mm, length 35 mm), is fitted in this opening. This is the mouth piece. Two similar tubes are fitted in similar opening on the circumference wall of the cylinder. These tubes are equidistant from the mouth piece and an imaginary line passing through their centre passes through the diameter of the main cylindrical valve. The tube on the left side of the mouth piece is for the inspired air and is called the inspiration tube. Similarly by the tube on the right side is for the expired air and is called the expiration tube.

The left half of the cylinder is for inspiration and the right half for expiration. A plate 6 mm thick is placed on the left half and fixed on the wall in such a fashion that one end of it is 32 mm away from the partition at the mouth piece side, the other end being 20 mm away from the partition on the opposite wall. Each of these plates are fitted with two tubes each of perspex 10 mm long the inner and outer diameter being 24 and 25 mm respectively. These tubes are fitted in the two apertures made on the plates. The apertures are made in such a way that they divide the plate into three equal parts. The wall thickness of the tubes is 1 mm. A groove is made on each of the tubes 2 mm away from the plates. On these grooves are fitted the India rubber valves. The valves open on one side only. During inspiration the inspiration valves are open and the expiration valves are closed (because of negative pressures). The opposite phenomenon happens during expiration. The rubber valves are made from India rubber sheet of 4 mm thickness. Due to negative pressures the valves do not allow any leakage of air when they are closed; also they offer little resistance during its opening even at lower flow rate.

3. Experimental Setup

Experiments were carried out for measuring the resistance of the respiratory valve by using air blower, flow rate meter, and water manometer (Fig. 3). Static characteristics

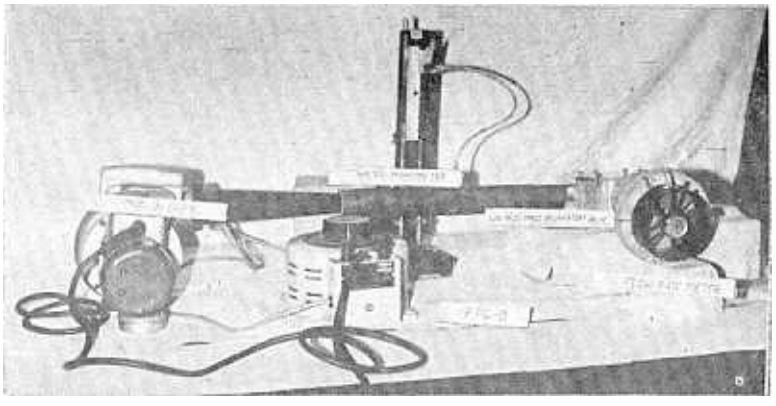

Figure 3. Experimental set up for measuring the resistance of the respiratory valve.

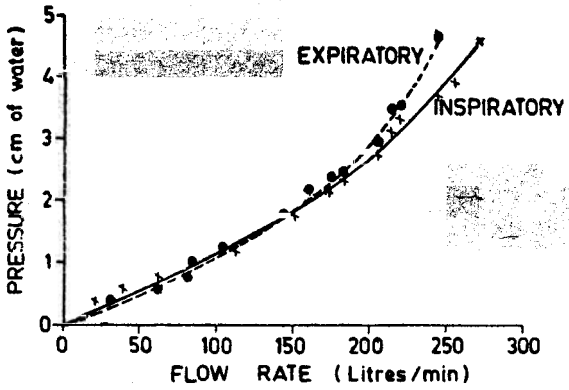

Figure 4. Static characteristics of low resistance respiratory valve.

were drawn between pressure : 0 to 5 cm of water and flow rate 20 to 250 litres per minute. The characteristics were drawn both for expiration and inspiration (Fig. 4). The curves drawn exhibited non-linear characteristics. At normal flow rate both exhibited identical resistance. The pressure drop across the two ends was 1 cm of water at a flow rate of 240 litres/minute. The dead space of this new low resistance respiratory valve was found to be 230 ml.

4. Conclusion

The fabrication of low resistance respiratory valve at Workshop and Instrumentation Section of DIPAS was satisfactorily done from locally available indigenous materials. The cost of material for one valve was significantly low viz. Rs. 500/-. Experimental data revealed that the dead space was 230 ml and pressure drop was 1 cm for water at a flow rate of 240 litres per minute.

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