A MODIFICATION OF THE BIRD MARK VIII VENTILATOR TO DELIVER CONTINUOUS POSITIVE PRESSURE BREATHING AND INTERMITTENT MANDATORY VENTILATION

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THE IMPORTANCE of continuous positive pressure breathing (C.P.P.B.) and intermittent mandatory ventilation (I.M.V.) is well established in modern ventilatory technique.¹⁻³ Most medical manufacturers now offer devices which can be added to existing equipment. Usually these are complicated, heavy, and expensive. The homemade version utilizing a water bottle and other plumbing⁴ is cumbersome and not always practical. In an effort to overcome these problems a circuit was constructed which would deliver C.P.P.B. and which allows the addition of I.M.V.⁴ The circuit is lightweight with only a single tube attached to the patient airway.

In order to clarify the mechanics, this paper will deal with C.P.P.B. and I.M.V. under two separate headings.

CONTINUOUS POSITIVE PRESSURE BREATHING (C.P.P.B.)

A Bain Breathing Circuit^{*6} is used to deliver the gas mixture. The rotameters deliver the desired $F_{I_{O_2}}$ and total fresh gas flow. Adequate humidity is supplied by a Cascade Humidifier.[†] A Bird Mark VIII ventilator is employed and by use of the negative phase option, positive pressure is added to the expiratory cycle. This positive flow, directed through an injector (Figure 1, 14) generates the necessary flow for C.P.P.B. as read on the manometer (Figure 1, 12). To avoid pressure build-up in the ventilator, a separate dump valve and a directional valve (Figure 1, 2 & 4) is used, as outlined by Wrigley.⁷ Thus the ventilator is used to deliver the humidified mixture to the patient, while providing positive pressure against the exhaled volume in the apnoeic phase to produce C.P.P.B. The pressure of the C.P.P.B. is regulated by adjusting the negative phase generator control of the Mark VIII ventilator.

INTERMITTENT MANDATORY VENTILATION (I.M.V.)

To add the option of I.M.V. the gas flow from the humidifier is passed through a T piece alongside of the main manifold (Figure 2). A restriction, placed between the supply line and the reservoir bag, allows the main flow to travel to the patient. The resulting spill-over, with adequate flow settings, will keep the bag distended

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FIGURE 1. Diagram of the manifold, showing the gas input and valve arrangement. (1) Bird Mark VIII ventilator. (a) Negative phase line to injector, (b) Positive flow to exhalation valves. (2) Dump valve for ventilator. (3) Restricted orifice. (4) Directional valve. (5) Patient exhalation valve. (6) Rotameter - air - oxygen. (7) Cascade humidifier. (8) Reservoir bag. (9) Restriction at inlet. (10) Directional valve. (11) Pressure relief valve (40 cm optional). (12) Manometer, patient system pressure. (13) Bain breathing circuit. (14) Injector, Bird negative venturi #1757.

as it acts as a reservoir for spontaneous ventilation. The suggested flow rate of 12 l/min affords carbon dioxide elimination as measured with an infrared CO_2 analyzer during the I.M.V. mode with normal subjects at rest (Figure 3). The measurements are taken at the mouth during spontaneous and I.M.V. ventilation.

SUMMARY

A Bird Mark VIII ventilator was modified to produce a simple and inexpensive C.P.P.B. and I.M.V. circuit. A Bain Breathing Circuit allowed the manifold to be placed near the ventilator. The negative pressure and flow to the injector produce C.P.P.B. The continuous flow of the Mapleson D Modification furnished constant inflow to provide humidified fresh gas to the reservoir and the patient circuit for I.M.V. An accompanying graph illustrates suggested flow rates and CO_2 elimination (Figure 2).

RÉSUMÉ

Des modifications simples et peu coûteuses peuvent être apportées aux Bird Mark VIII, en vue de fournir une ventilation avec "PEEP" et une ventilation du

FIGURE 2. Detail of valve arrangement for I.M.V. Numbers correspond to those of Figure 1.

FIGURE 3. Average percentage CO_2 measured in five subjects, breathing on I.M.V. for 25 minutes. A mean of 5.7 per cent CO_2 exhaled indicates approximately 40 torr pa.

type "à inspiration intermittente obligatoire" (I.M.V.). Le malade respire dans un circuit de Bain relié à la valve expiratrice du Bird branchée directement à l'appareil. Le débit gazeux utilisé normalement dans un Bird Mk VIII pour obtenir une pression négative expiratoire, est dirigé tout près de la valve expiratrice; la turbulence créée permet de produire plus ou moins de *peep* en variant ce débit. L'interposition d'un sac réservoir entre le circuit de Bain et la valve expiratrice, et l'addition d'un débit continu de gaz frais humidifiés au circuit de Bain, permet d'obtenir une ventilation à "inspiration intermittente obligatoire."

Un graphique suggère des débits gazeux assurant l'élimination efficace du CO₂.

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