THE JOHANNESBURG A-D CIRCUIT SWITCH
A valve device for converting a co-axial Mapleson D into a co-axial Mapleson A system

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SUMMARY
A simple valve device is described for a co-axial tubing anaesthetic system which enables selection of the circuit characteristics of either a modified Mapleson A system for spontaneous breathing or a modified Mapleson D system for controlled ventilation. Thus, the system allows an economical fresh gas flow to be used during either controlled or spontaneous ventilation. The mode of ventilation may be changed during anaesthesia without adjusting the patient tubing or the attachment of the system to the anaesthetic machine.

The characteristics of the Mapleson D anaesthetic system enable economy of fresh gas flow during controlled ventilation. However, during spontaneous ventilation a high fresh gas flow is required to prevent rebreathing of alveolar gas. The Mapleson A system, in contrast, is economical only during spontaneous ventilation.

An anaesthetic system using co-axial tubing has been described by Ungerer and le Roux (1978) which enables a modified Mapleson D or a modified Mapleson A system to be selected by interchanging the positions of the fresh gas inlet and the relief valve. We describe a switching valve known as the "Johannesburg A-D circuit switch" which simplifies the selection of either the Mapleson A or Mapleson D characteristics of the system referred to above.

DESCRIPTION
A prototype valve and co-axial circuit are shown in figure 1. The outer tube consists of light-weight corrugated p.v.c. tubing of 25 mm internal diameter (i.d.). The inner tube is smooth-walled and has an i.d. of 12.5 mm and an outside diameter (o.d.) of 15 mm. Both tubes are 1.5 m long. Disposable tubing was used in the prototype.

The separate components of the switching valve are shown in figure 2. A mobile switch disc (5) contains two 12.5-mm, bean-shaped channels. When rotated to position "A" the switch disc connects the fresh gas inlet port (1) to the lumen of the outer tube via port 2. In this position port 3 is connected to port 4, which allows excess gas to be vented from the inner tube through the relief valve, thereby producing the characteristics of a co-axial Mapleson A system. By rotating the switch disc through 90° to position "D", the order is reversed so that fresh gas is directed to the inner tube via ports 1 and 3 and excess gas reaches the relief valve from the outer tube via ports 2 and 4. The system thus has the characteristics of a co-axial Mapleson D system.

DISCUSSION
The behaviour of the co-axial Mapleson D anaesthetic system (Bain system) during controlled ventilation with low fresh gas flows has been studied extensively (Bain and Spoerel, 1973; Spoerel and Bain, 1975;


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Henville and Adams, 1976). The system may be used for patients of all ages where controlled ventilation is required, and is especially useful when access to the patient is limited. The tubing produces minimal drag on the tracheal tube and the system facilitates scavenging of waste gas. Controlled ventilation using a fresh gas flow of 70 ml kg\(^{-1}\) and a minute volume of 140-160 ml kg\(^{-1}\) allows normocarbia to be maintained. During spontaneous ventilation, however, a high fresh gas flow of three times the minute volume is required to prevent rebreathing (Conway, Seeley and Barnes, 1977).

The Mapleson A (Magill) system is ideal for spontaneous ventilation requiring fresh gas flows of 70–80 ml kg\(^{-1}\) (Kain and Nunn, 1968; Norman, Adams and Sykes, 1968). A co-axial Mapleson A system was designed by Lack (1976) in order to facilitate scavenging of waste anaesthetic gas. An early prototype of this system proved to have high resistance to breathing and required a relatively great fresh gas flow during spontaneous ventilation (Barnes et al., 1976).

Subsequently, Ungerer and le Roux (1978) have shown that, by using wide-bore co-axial tubing consisting of an outer tube of 27 mm i.d. and an inner tube of 12.5 mm i.d., the co-axial Mapleson A system would behave in a manner similar to the Magill system, requiring a similar fresh gas flow during spontaneous ventilation and having an acceptable resistance to breathing. It was shown that by interchanging the positions of the fresh gas inlet and the relief valve, the system could be converted to a co-axial Mapleson D system.

The Johannesburg switching valve provides additional advantages for such a co-axial system: a change from the Mapleson A system to the Mapleson D system is effected simply by movement of the switch disc lever; the attachment of the apparatus to the anaesthetic machine need not be altered; the position of the relief valve remains constant, enabling scavenging to be continuous; clear markings guard against the possibility of selecting the wrong system in clinical use.

The switching valve has wide-bore channels which minimize resistance to gas flow. Using a water manometer and a 30 litre min\(^{-1}\) flow of air from a calibrated rotameter, the pressure decrease across the length of the inner tube and switching valve fitted with a Medishield shrouded relief valve was 254 Pa (2.6 cm H\(_2\)O) which represents the expiratory resistance of the co-axial Mapleson A system. The inspiratory resistance of the co-axial Mapleson A system was 49 Pa (0.5 cm H\(_2\)O) at 30 litre min\(^{-1}\) flow.

**Fig. 2.** Exploded isometric view of the valve. 1 = Fresh gas inlet port. A standard 22-mm taper fixes the system to the anaesthetic machine gas outlet. 2 = Port through which fresh gas passes to outer tube with switch in position "A". Excess gas exits through same port when switch is in position "D". 3 = 15-mm taper port through which fresh gas passes to inner tube with switch in position "D". Excess gas is vented from the inner tube and this port when switch is in position "A". 4 = 12.5-mm diameter channel leading to relief valve. 5 = Mobile switch disc with lever and containing two 12.5-mm bean-shaped channels. 6 = Transparent plastic sleeve with relief valve mount which holds components in place. A slot limits movement of the lever-operated switch disc.
CONVERSION OF MAPLESON D INTO MAPLESON A

As a dangerous situation may develop if the inner tube of a co-axial system becomes disconnected, a firm 15-mm taper joint is used for the junction of the inner tube and switching device. The joint is always visible through the clear plastic outer housing.

The components may be cleaned and sterilized without dismantling. However, should separation be necessary, they are keyed to prevent incorrect reassembly.

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REFERENCES


