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The Design of Four Anaesthetic Scavenging Devices

D. G. MOYES, P. CLEATON-JONES, P. A. FOSTER

SUMMARY

The design and functional characteristics of four anaesthetic scavenging devices available in South Africa are described.

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The removal of waste anaesthetic gases has become recommended practice.[1,2] Many devices have been designed, but descriptions of their function are not available. We therefore describe four devices currently available in South Africa.

DESCRIPTION OF EQUIPMENT

Examples of the four devices are shown in Fig. 1, and Fig. 2 shows their mode of action in diagrammatic form. All the devices have an indicator bag and are activated by high-pressure and high-flow suction. They are all de-

Department of Anaesthesia, Baragwanath Hospital and University of the Witwatersrand, Johannesburg
D. G. MOYES, M.B. CH.B., M.R.C.S., L.R.C.P., F.F.A.
Dental Research Institute of the South African Medical Research Council, Johannesburg
P. CLEATON-JONES, B.D.S., M.B. B.CH., PH.D., D.A.
Department of Anaesthesia, Tygerberg Hospital and University of Stellenbosch, Parowvallei, CP
P. A. FOSTER, M.B. CH.B., F.F.A., D.A.

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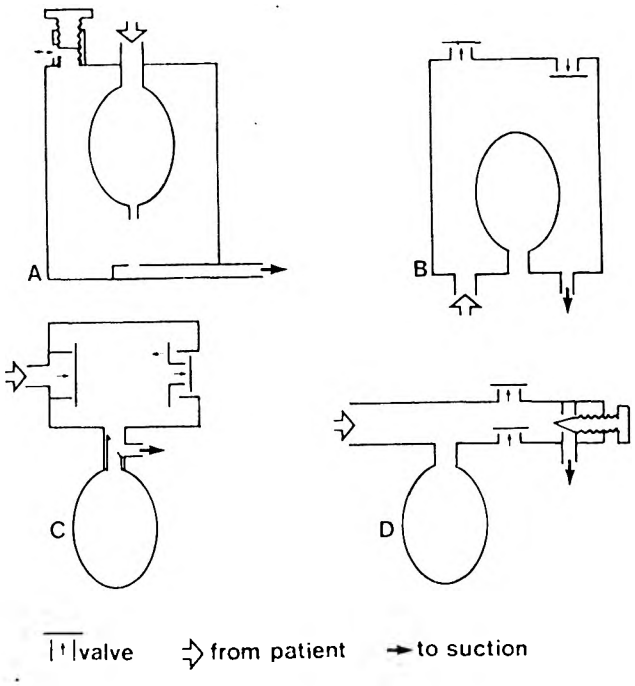

Fig. 2. Function of the scavenging systems in diagrammatic form. The direction of gas flow, suction and valve operation are indicated. (A — Carstens system, B — Gardner box, C — Stellenbosch valve, D — Ventex system.)

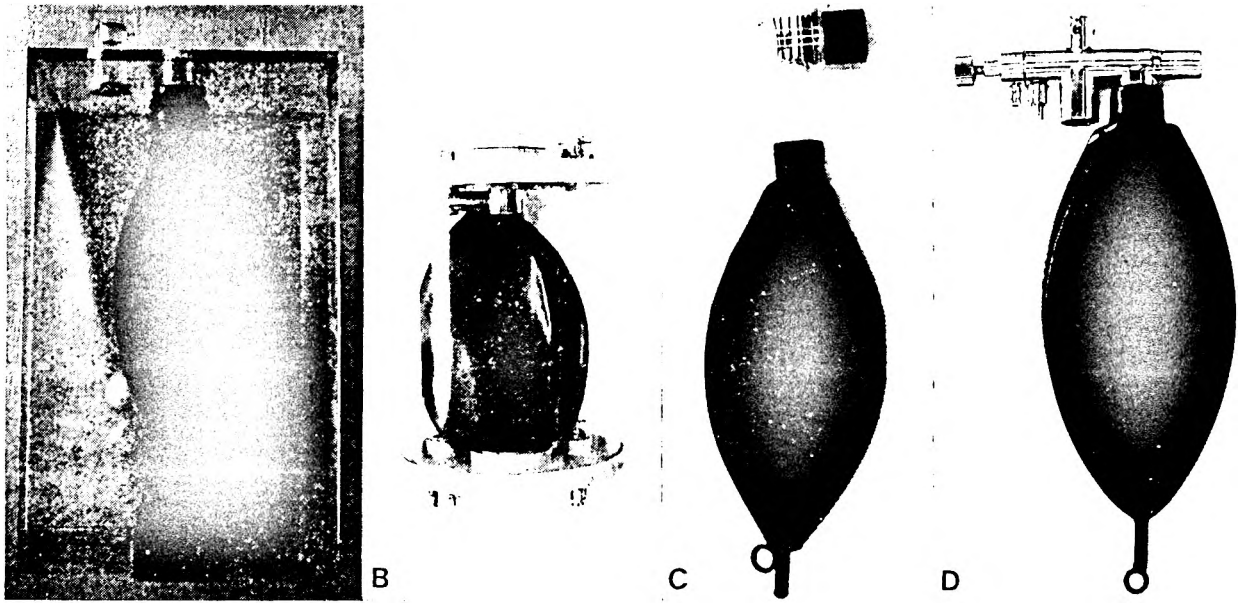

Fig. 1. The four scavenging devices: A — Carstens system, B — Gardner box, C — Stellenbosch valve, D — Ventex system.

signed to remove expired gases after passage through the customary expiratory valve. The expiratory valve is hooded in a manner similar to the BOC hooded valve (Medishield, Harlow, England) and acts as a one-way spring-loaded flap valve. All the systems have safeguards against excessively high and low pressures being transmitted to the patient circuit.

Carstens System (Fig. 1A and Fig. 2A)

This system was designed by Carstens[3] at Baragwanath Hospital. Gas from a hooded valve passes into an open bag situated in a chamber. Negative pressure is applied to the chamber and the gas is extracted to the outside via the main suction system. Excess negative pressure will cause the bag to collapse. Inadequate suction will cause the pressure in the chamber to rise and cause a positive blow-off through the two-way valve.

Gardner Box (Fig. 1B and Fig. 2B)

The system, designed by Gardner of Gardner Co. (Oxford, England) consists of a box containing a bag open to the atmosphere. Waste gas from a hooded valve passes into the box and is extracted by the main suction. The manufacturers supply a variable flow restrictor in the suction outlet and the recommended setting is 12 l/min. In the event of inadequate suction, the bag will collapse and the positive valve will open and gas will spill. If the suction pressure is excessive, the bag will expand and air will be entrained through the inlet valve.

Stellenbosch Valve (Fig. 1C and Fig. 2C)

This valve was designed by Foster[4] of the University of Stellenbosch. The unit consists of a body housing two valves which are held against their seats by a common spring, and which open to admit air to the body. There is a differential of 0,5 cm H_2O between the opening of the two valves. A reservoir body and a controlled suction port open into the body. On applying suction, the lower pressure valve opens first and entrains atmospheric air until a pressure of 0,5 cm is developed across the other valve which is connected to the shrouded expiratory valve of a breathing circuit. The valve then toggles, closing the air entrainment port, admitting expired gas to the reservoir bag from which it is removed by the scavenge line. Movement of the bag indicates that the system is working.

In the event of scavenge line failure, gases may pass through the valve to the atmosphere through a third pressure relief valve. The valve adjusts automatically to very large variation of the scavenge gas flow from the minimum required to handle the volume escaping from the breathing circuit up to 100 l/min. There is a collar to adjust the suction applied. It is manufactured from high-impact polycarbonate with adaptor rings to fit shrouded valve outlets of various diameters and is small enough to be held in the closed hand.

Ventex System (Fig. 1D and Fig. 2D)

This system was designed by Cornish of Allan Cornish (Pty) Ltd, Johannesburg. The waste gases flow into a reservoir bag and are extracted into the main suction via a variable spindle valve. Excessive pressure causes the bag to distend and the positive disc valve to open. Excessive suction causes the bag to collapse and air is entrained via the negative disc valve.

CONCLUSIONS

Four currently available scavenging systems are described. All depend on an efficient high-volume, high-pressure suction. The amount of suction is variable in the Stellenbosch and Ventex systems. This protects against excess use of theatre suction in those institutions where a separate suction for scavenging is not provided. However, during spontaneous breathing, this may lead to the need for regular adjustment should the minute volume vary. In the Gardner box, the flow is restricted on a fixed basis. To alter the setting, the suction tube has to be disconnected and the restrictor varied with an Allen key. The Carstens system has no restriction on suction flow and, in use, air is usually entrained through the valve.

The use of an indicator bag allows visual assessment of the functioning of the system and in the Ventex and Stellenbosch systems the degree of distension of the bag allows regular adjustment of the suction to prevent excessive high or low pressures. The Gardner box bag is open to atmosphere and distends with high suction and collapses with low suction. This may initially cause confusion since distension of the bag is customarily connected with high pressure. A modification of the Carstens box replaces the open-ended bag with a Perspex reservoir opening into the outside chamber. This cancels out the advantage of the visual assessment of the system, but obviates the need to replace the rubber bag, which deteriorates rapidly in contact with anaesthetic gases.

Sterilization of the systems depends on the materials used and the ease of dismantling. The Carstens system is constructed of Perspex and cannot readily be disassembled. Gas sterilization is required. The Gardner box can easily be dismantled and cleaned.

The respective parts may be autoclaved or chemically sterilized. The Stellenbosch valve is also easily dismantled and is suitable for heat and chemical sterilization. The design does not allow reversal of the valve system during reassembly. The Ventex system is made of metal and is suitable for autoclaving.

In the Ventex and Gardner systems, a flap valve is employed. Use of these systems, except in the upright position, can cause the valves to open and to leak. The valves of the Carstens and Stellenbosch devices function normally, independent of the position of the device. These systems must be tested in clinical and laboratory settings before they are accepted or condemned.

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