AN AUTOMATIC BREATHING ATTACHMENT TO BOYLE'S APPARATUS

A PRELIMINARY REPORT

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The device described has been designed primarily as a small attachment which could be brought quite easily into the circuit of any standard Boyle's machine, thereby making the machine suitable for use as an automatic breathing apparatus in addition to its normal purpose.

The apparatus is actuated by gas pressure alone, and is particularly useful in chest surgery, where respiration may have to be controlled for long periods of time, and also in
FIG. 1

An automatic breathing attachment to Boyle’s machine.
any operation where the attention of the anaesthetist is temporarily diverted elsewhere—such as the setting up of a transfusion—in a patient with inadequate respiratory excursion. It may be used for short or long periods of time, and also in conjunction with Trilene, since no soda-lime is used.

The drawings (figs. 2 and 3) are very slightly modified from those of a home-made prototype which has been in constant use at this hospital for the last 3 years in over 900 major operations.

The apparatus, which can be left as a permanent part of the Boyle's machine, is attached by plugging it in between
the last anaesthetic bottle and the bag-mount (fig. 1). The combined machine continues to function as a straightforward Boyle's apparatus for all normal purposes, the usual gas flow passing through the attachment without actuating it. However, should respiration need aiding at any time the apparatus is brought into use merely by closing off the respiratory valve at the face-piece and the re-breathing bag, while at the same time increasing the total gas flow to the maximum the Boyle's machine will give, when the automatic action will commence.

On machines fitted with the Coxeter "bobbin" dry flow meter units, the gases are turned up to 10 litres of oxygen and ten litres of nitrous oxide per minute, but on machines equipped with Rotameter units the necessary flow is obtained by opening to the full both oxygen and nitrous oxide by-pass taps during the automatic action. The attachment is, however, intermittent in type, there being no gas flow during the period of expiration. The consumption of gases is therefore little more than one-half of the above flows. The rate of respiration can be adjusted as desired between 2 and 50 respirations per minute, while intra-pulmonary pressures can be varied at will between 1 and 30 centimetres of water. Considerable variations in both rate and intra-pulmonary pressures are thus possible within these figures.

A water manometer is clipped to the Boyle's machine so that lung pressures can be observed and adjusted during the period of use of the attachment. In order to determine what is the best pressure to use, the patient's lungs are inflated a few times by squeezing the re-breathing bag by hand and noting on the manometer the pressure needed for adequate inflation. The bag is then shut off and the machine set to work at this pressure.
In the case of an adult with a respiratory rate of about 18 per minute and lying on a level table, intra-pulmonary pressures are usually kept below 12 centimetres of water. Should the surgeon wish for a quieter field for a short period of time, as he may do during chest surgery, the lung pressure can be dropped to, say, 5 centimetres of water or less, the rate being kept the same or increased as desired. If a perfectly still but inflated lung is called for, this can be obtained by allowing a suitable leak from the valve at the face-piece (in which case the lung would remain inflated at the pressure behind the leaking valve) or, if preferred, the re-breathing bag can be brought temporarily into the circuit and steady manual pressure exerted on it in the usual way. On closing the expiratory valve and bag-mount the breathing attachment automatically takes over control of respiration once again.

It is found that when spontaneous respiration is returning, an irregular movement of water in the manometer occurs. If it is desired that normal respiration should be resumed the bag-mount and the valve at the face-piece are opened and the gas flows reduced to normal figures. The apparatus then functions once more as a standard Boyle’s machine. Very quiet and smooth anaesthesia can be maintained on a mixture of approximately 50 per cent gas and oxygen with, if necessary, any supplementary agent which may be favoured. The patients remain well oxygenated throughout the operation.

The apparatus consists essentially of two stout rubber diaphragms A and B, which act alternately on a central sliding spindle C (fig. 3). This lateral movement of the spindle disturbs the balance of an eccentric cam D which thus moves instantly from one extreme position to the other. The cam is attached to a gas valve E, which in one phase
allows mixed gases to pass via the narrow rubber tubing F
directly to the endotracheal tube or face-mask, while in its
other phase the valve completely cuts off the gas supply,
and by the same movement complete expiration is permitted
by the opening of a large-bore expiratory valve G, built
into the apparatus, the expired air passing up the corrugated
rubber tube H and escaping by means of vents in the casing
of the attachment. The respiratory circuit is thus unidirec-
tional, so that dead-space and carbon dioxide retention are
reduced to a minimum. In the prototype, change of rate
and depth of respiration are controlled by two screw-clips J
and K only. When used as a straightforward Boyle's
apparatus the patient breathes along the corrugated tube to
the re-breathing bag in the usual way, but fresh gases are
admitted near the face-piece.

The machine has been in use for over 3 years and during
that time no ill effect attributable to it has been noted; on
the contrary the patients have been improved by the
adequate and even respiratory exchange maintained when-
ever respiratory depression occurred.

The prototype is still in daily use, but the designs are now in
the hands of Mr. A. Charles King, who is making the apparatus
for me, and to whom I am very greatly indebted. I should also
like to express my grateful thanks to the Surgical Staff, both past
and present, at Morriston Hospital for their kind co-operation,
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