A TRUE CIRCLE CONVERSION OF THE "C-M" ABSORBER UNIT

BY

T. A. BROWN AND M. A. WOODS

North Down Group of Hospitals, Northern Ireland

The advent of halothane has led to some revival of interest in inhalation anaesthesia with spontaneous respiration, muscular relaxation being obtained by deepening the plane of narcosis rather than by the use of specifically relaxant drugs. In cases so conducted significant alveolar accumulation of carbon dioxide must follow the inevitable respiratory depression. This is especially so when a completely closed circuit technique is used—probably due to the absence of the flushing effect produced in the respiratory tract by the high gas-flow normally employed in semi-closed systems.

A series of more than 5,000 patients having closed circuit halothane anaesthesia was closely observed. The inclusion of the halothane vaporizer in the circuit precluded assisted respiration and minute volumes of 3 litres and less were not uncommonly encountered. No untoward cardiovascular effects were observed. Nevertheless, respiratory acidosis during anaesthesia can never be regarded as beneficial and every effort should be made to ensure that, in closed-circuit systems, the atmosphere inhaled by the patient contains as little carbon dioxide as possible. This is achieved by using an efficient system of absorption.

Probably the most common closed-circuit machines in this country are the "C-M" units, marks 1 and 2. About 1,750 of these were distributed in the British Isles before the design was superseded by the Boyle II circle absorber (Bracken, 1960). The units are robust, convenient and efficient in all but one respect. Due to the method used to embody the to-and-fro principle of carbon dioxide absorption, a deadspace of about 160 ml occurs above the soda lime canister (Bracken, 1960). At the end of each expiration, this space contains mainly exhaled gases untouched by soda lime and therefore rich in carbon dioxide. Inspiration draws towards the lungs a mixture of this unaltered exhalation and gases from the rebreathing bag which have passed twice through the soda lime. Some carbon dioxide is therefore re-inhaled.

To get an approximate estimate of the extent of this re-inhalation, a conscious volunteer breathed from a "C-M" unit. Basal oxygen was supplied and the freshly filled absorber was turned full on. A carbon dioxide analyzer working on the colorimetric principle was interposed between the unit and the inspiratory hose. At the end of 5 minutes quiet respiration the analyzer showed that the inspired atmosphere contained 3 per cent carbon dioxide. During the respiratory depression of deep halothane anaesthesia, tidal volume may fall to 100 ml or less. In such circumstances the deadspace in the "C-M" unit furnishes a large proportion of each inspiration, and the level of inspired carbon dioxide exceeds 5 per cent, which is the highest reading possible with the colorimetric analyzer used.

Therefore, although laboratory experiments with an artificial lung show an advantage in absorptive efficiency from the use of the to-and-fro method (Adriani and Rovenstine, 1941), it is technically difficult to reproduce this advantage under working conditions with the "C-M" absorber as originally designed.

It must be accepted that a true circle system, which can contain no deadspace, is more efficient during anaesthesia.

Any "C-M" unit can be easily converted to the true circle principle by slightly altering the relative positions of its components as follows. The soda lime canister is removed from its usual position. The tapered stub at its upper end is plugged into the socket in the unit which normally receives the mount of the patient's expiratory hose. The screwcap at the bottom of the canister is modified as described and illustrated below, and the expiratory hose mount plugged.
into it. The absorber control drum on the unit is turned permanently to the mark “Off” to avoid gross leakage of the circulating gases.

In use, all the patient’s expirations must now pass through the absorber canister on their way to the rebreathing bag, and a unidirectional flow of the circulating gases is ensured.

Repetition of the previously mentioned experiment with a conscious volunteer breathing from the converted unit demonstrated a considerable gain in absorptive efficiency. No carbon dioxide could be detected in the inspired atmosphere after 5 minutes, showing the inhaled percentage of this gas to be less than 0.3 per cent (the lowest concentration measurable with the analyzer used).

Similar investigations during deep closed circuit anaesthesia with halothane failed to detect any carbon dioxide in the inspired atmosphere even at the lowest minute volumes.

**MECHANICAL DETAILS**

A circular disc of copper or brass about \(\frac{1}{8}\) inch thick and 2\(\frac{1}{2}\) inches in diameter (fig. 1a) is reinforced by brazing to one side of it a brass nut or bush about \(\frac{1}{2}\) inch thick and 2 inches in diameter (fig. 1b). A hole is now reamed through the centre of this assembly to fit snugly a standard female hose connector (fig. 1c) which is brazed into position with its small end flush with the plain side of the brass disc. The plain side of the disc is then sweated on to the outside of the screw cap of the soda lime canister and a ring washer is cut from resilient plastic sheet to fit closely over the threads of the screw cap. This must be thick enough to give a gastight joint when the cap is screwed on to the canister.

As the canister is used in the horizontal position, incomplete filling with soda lime will lead to the exhaled gases taking the line of least resistance by passing over the top of the soda lime rather than through it. A domestic nylon pot scrubber compressed between the screw cap of the canister and the soda lime readily solves this difficulty and causes little added resistance to respiration (Robson and Pask, 1954).

**FIG. 1**

Showing modified canister in position.
SUMMARY
The design of the "C-M" absorber is such that there is an appreciable deadspace (circa 160 ml) at the mouth of the soda lime canister. Experiments are described which show that, in anaesthesia with quiet respiration, this deadspace may lead to a serious increase in carbon dioxide in the inhaled atmosphere, even exceeding 5 per cent in certain circumstances.

A simple modification of the unit is described. By altering the position of the soda lime canister, so that it becomes monophasic instead of biphasic, the deadspace is removed and carbon dioxide accumulation is prevented.

ACKNOWLEDGMENTS
We are greatly indebted to Dr. A. Bracken of British Oxygen Research and Development Ltd., for information relating to the Coxeter-Mushin absorber units, to J. MacGouran, M.S.R., for the photograph, and to Mr. M. Stevenson of our hospital engineering staff who undertook the modifications to the canisters.

REFERENCES

FACULTY OF ANAESTHETISTS OF THE ROYAL COLLEGE OF SURGEONS IN IRELAND
At a meeting held in the Royal College of Surgeons in Ireland on Friday, July 8, 1960, the President of the College, Mr. T. G. Wilson, inaugurated a new Faculty of Anaesthetists. The first Board of the Faculty consists of:

Dr. Thomas James Gilmartin, Dean
Dr. Victor Ormsby McCormick, Vice-Dean
Dr. Joseph Augustine Woodcock, Hon. Sec.
Dr. Patrick Joseph Drury Byrne
Dr. Patrick Joseph Nagle
Dr. Ethel Sheila Kenny
Dr. Paul Finbar Murray
Dr. Geoffrey Raymond Davys
Dr. John Wharry Dundee
Dr. Samuel Harold Swan Love

After admitting the Board members as Foundation Fellows in the Faculty, the President also admitted the following Foundation Fellows:


The following Foundation Fellows were also conferred in absentia:


The Honorary Fellowship in the Faculty was then conferred by the President on Dr. John Gillies, who was introduced by the Vice-Dean, Dr. McCormick, and upon Dr. Geoffrey Stephen William Organe, who was introduced by Dr. Drury Byrne.