A COMPACT ANAESTHETIC APPARATUS FOR EMERGENCY USE

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SINCE WORLD WAR II there has been considerable interest in the development of a compact, versatile anaesthetic apparatus for use in emergency situations The familiarity achieved by anaesthetists in the armed forces of Great Britain and Canada with the simple but efficient Oxford Vaporizer Mark I has contributed greatly to this interest

During the past few years emphasis on the danger of a massive nuclear strike on this continent and the consequent need for adequate civil defence planning, coupled with the introduction of several new anaesthetic agents, of which halothane is the most prominent and one of the most versatile, has intensified this interest and has resulted in the introduction of several systems of equipment

Planning for national survival has led government agencies and individual clinicians to search for a compact, rugged apparatus which can be stockpiled in quantity and which can provide safe anaesthesia in emergency situations, even in the hands of relatively untrained personnel The projected stockpiling of "packaged hospitals" by the Emergency Health Services and by the Canadian Forces Medical Services has lent further impetus to the project

Most of the apparati developed have been adaptations of existing equipment, not designed primarily for emergency use but capable of being used in the emergency situation The best-known apparatus of this type is the combination of Oxford Bellows and E M O Ether Inhaler, the successor to the Oxford Vaporizer of World War II This combination continues in use and is the mainstay of anaesthetists in many parts of the world and in a variety of situations

This paper describes an apparatus designed primarily for emergency situations, but also well adapted for ordinary use in the small hospital or wherever a portable unit is desirable It is designed to use halothane and air with the addition of oxygen if desired and available and may be attached to the E M O Ether Inhaler if a change to ether anaesthesia is indicated

This apparatus was designed by Cyprane Ltd of England, on the basis of the work done by the Anaesthesia Department of the National Defence Medical Centre, Ottawa, in planning for an emergency hospital programme[1] and to meet requirements suggested by the consultants in anaesthesia to the Canadian Armed Forces and the Emergency Health Services of the Government of Canada

The apparatus used for this assessment was provided by Canam Surgical Services Limited of Toronto

DESCRIPTION OF APPARATUS

The unit is shown diagrammatically in Figure 1 It is a complete portable anaesthetic apparatus for the administration of halothane in air to which oxygen

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Can Anaes Soc J , vol 12, no 3, May, 1965

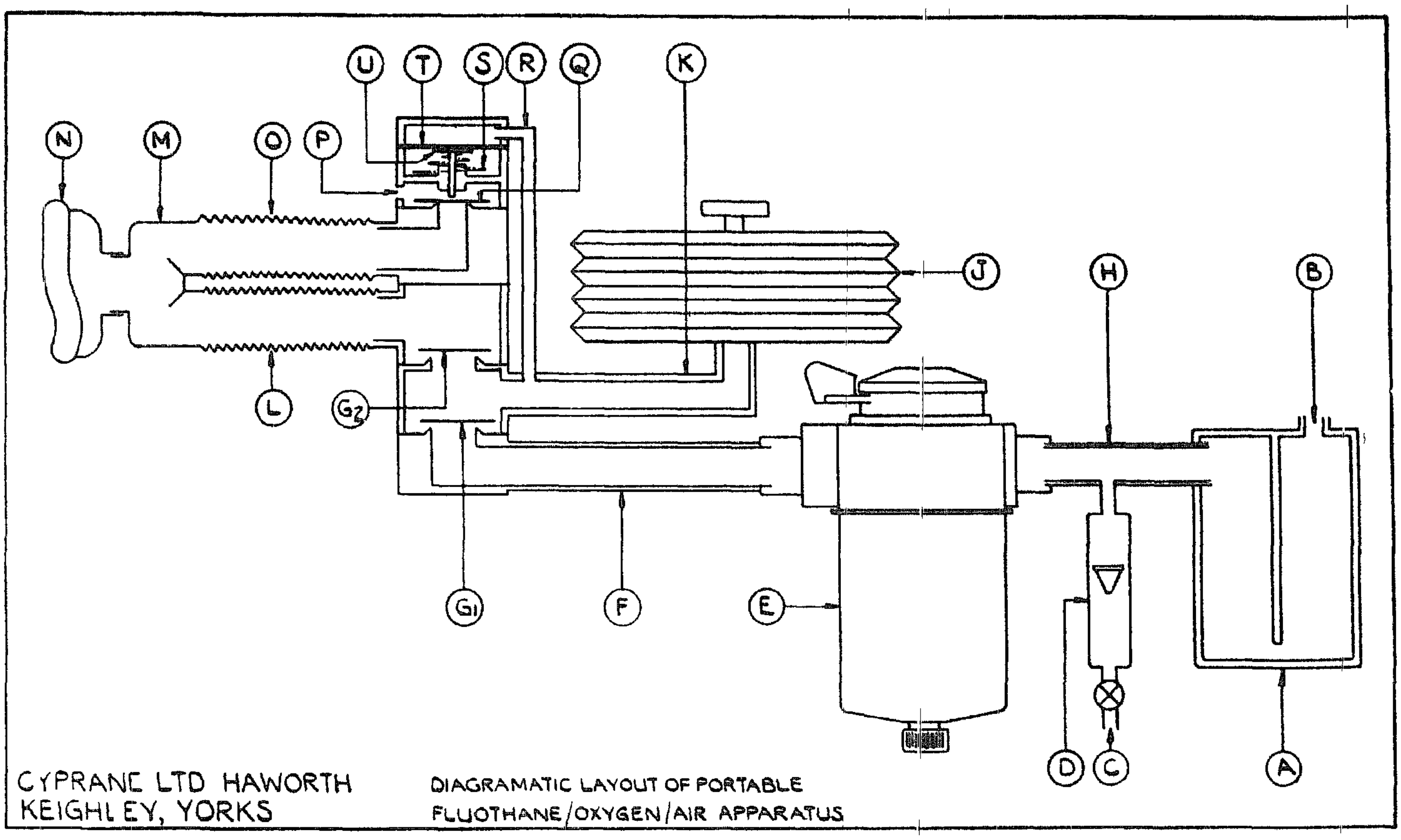

FIGURE 1 Diagrammatic layout of the Haloxair A, oxygen economizer—a rigid reservoir for containing induced oxygen between breaths, B, air inlet to economizer, C, oxygen supply and fine control valve, D, oxygen flowmeter calibrated from 1 to 3 litres/minute, E, halothane vaporizer—calibrated from 0 5% to 5 0%, F, connection tube, G1, directional valve, G2, non-return valve, H, connection from economizer to vaporizer, J, bellows (Oxford type—fitted with internal spring), K, bellows connection, L, corrugated tube leading to face-piece, M, Y-piece onto which the face-piece is fitted, N, face-piece, O, corrugated expiration tube leading to expiratory port, P, expiratory port, Q, expiratory valve, R, expiratory valve pressure loading tube, S, spring supporting U and T, T, rubber diaphragm, U, push rod operated by rubber diaphragm T

can be added economically No provision is made for use with any of the anaesthetic gases This allows the inclusion of extra supplies of oxygen in the "packaged hospital unit" by effecting a saving in space and weight requirements An adapter is supplied with the unit so that industrial oxygen cylinders can be connected to it

The unit is designed for both spontaneous and controlled or assisted respiration, and can be used as a resuscitation apparatus as well as an anaesthetic machine The change from spontaneous to controlled respiration is quickly and easily made and an Oxford-type bellows (J) gives very positive control There is a certain amount of resistance to both inspiration and expiration depending largely on the vaporizer setting (Table I) It should be noted that the values

TABLE I

RESISTANCE TO RESPIRATION IN THE HALOXAIR

Vaporizer dial setting	Pressure in cm H_2O	Flow rate in L /min *
Off	0 6	20
1%	0 6	20
3%	0 7	20
5%	0 9	20

*Expiratory resistance at 20 L /min flow is 1 1 cm H_2O

given in the table were obtained in the anaesthesia laboratory of the Toronto General Hospital and are somewhat lower than the resistance values given by the manufacturer For purposes of comparison the resistance to respiration of a 9 5 mm endotracheal tube is 0 6 cm H_2O at 20 l/min flow and the expiratory resistance 0 5 cm H_2O

The vaporizer (E) is temperature-compensated and is calibrated with halothane from 0 5 to 5 0 per cent It is non spillable and if accidentally inverted it will not deliver a sudden excessive concentration of halothane

An oxygen flowmeter (D) is incorporated into the unit Oxygen is introduced between the vaporizer and an oxygen economizer (A) which is simply a rigid reservoir for containing the oxygen between breaths i.e during the patient s expiratory phase The flowmeter has a fine adjustment valve and is attached by a 3 ft length of flexible tubing to an oxygen reducing valve which includes a cylinder contents gauge and a pin index yoke so that it can be attached to standard medical oxygen cylinders (Fig 2) Figure 3 shows the unit attached to a standard oxygen cylinder and with the E M O Ether Inhaler fitted to the air inlet

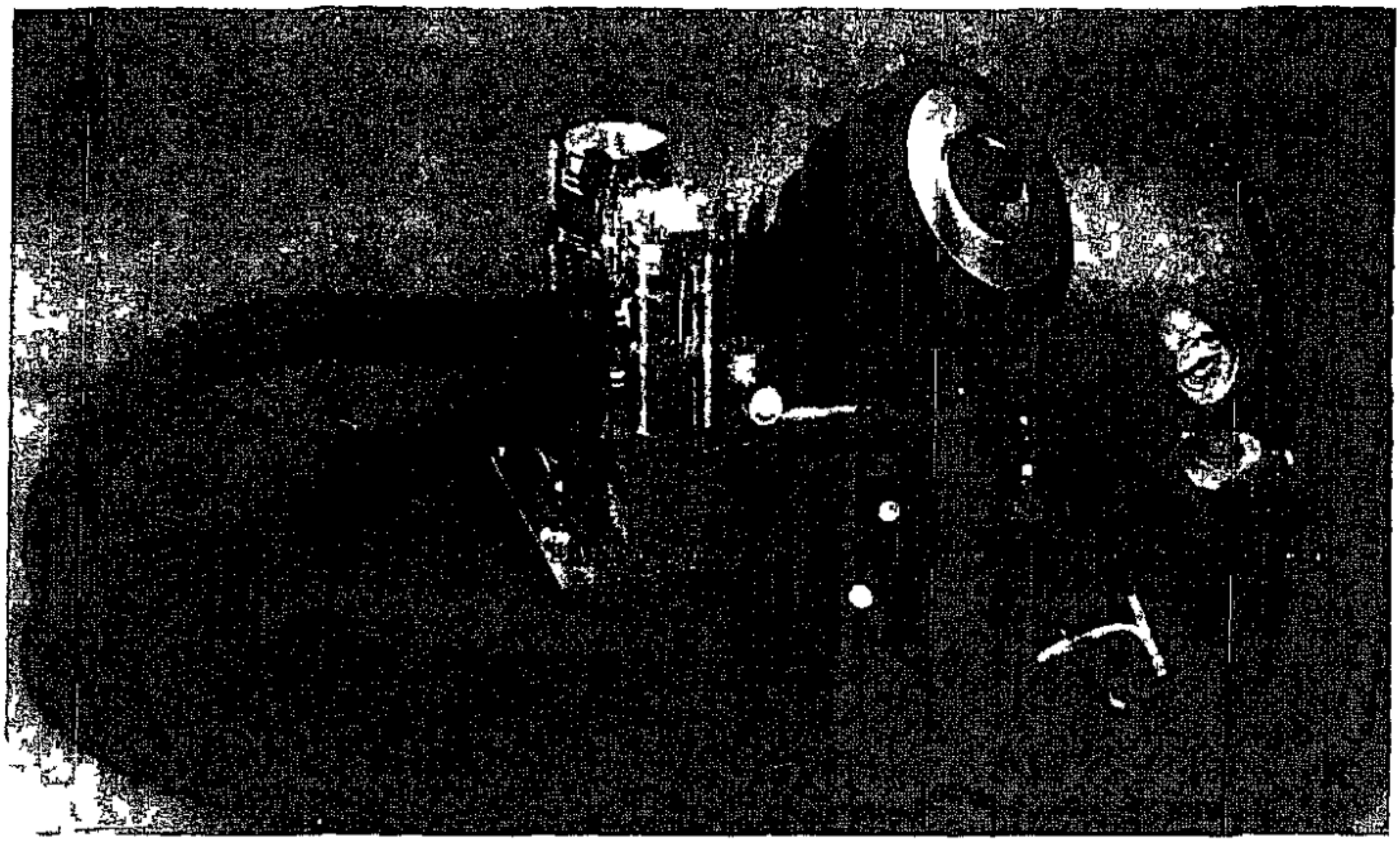

FIGURE 3 The Haloxair with an oxygen cylinder attached and with the E M O Ether Inhaler

During spontaneous breathing using air only the unit functions on the draw over principle As the patient inspires air is drawn through the inlet (B) the economizer (A) the halothane vaporizer (E) valves G1 and G2 and the corrugated tubing (L) to the face piece (N)

The bellows (J) is fitted with an internal spring Therefore a portion of the inspired air will come from the bellows but this will be only a small percentage of the total inspired volume As the patient expires the non return valve (G2) closes and all of the expired air passes out through valve Q There is no re breathing at any time with this apparatus

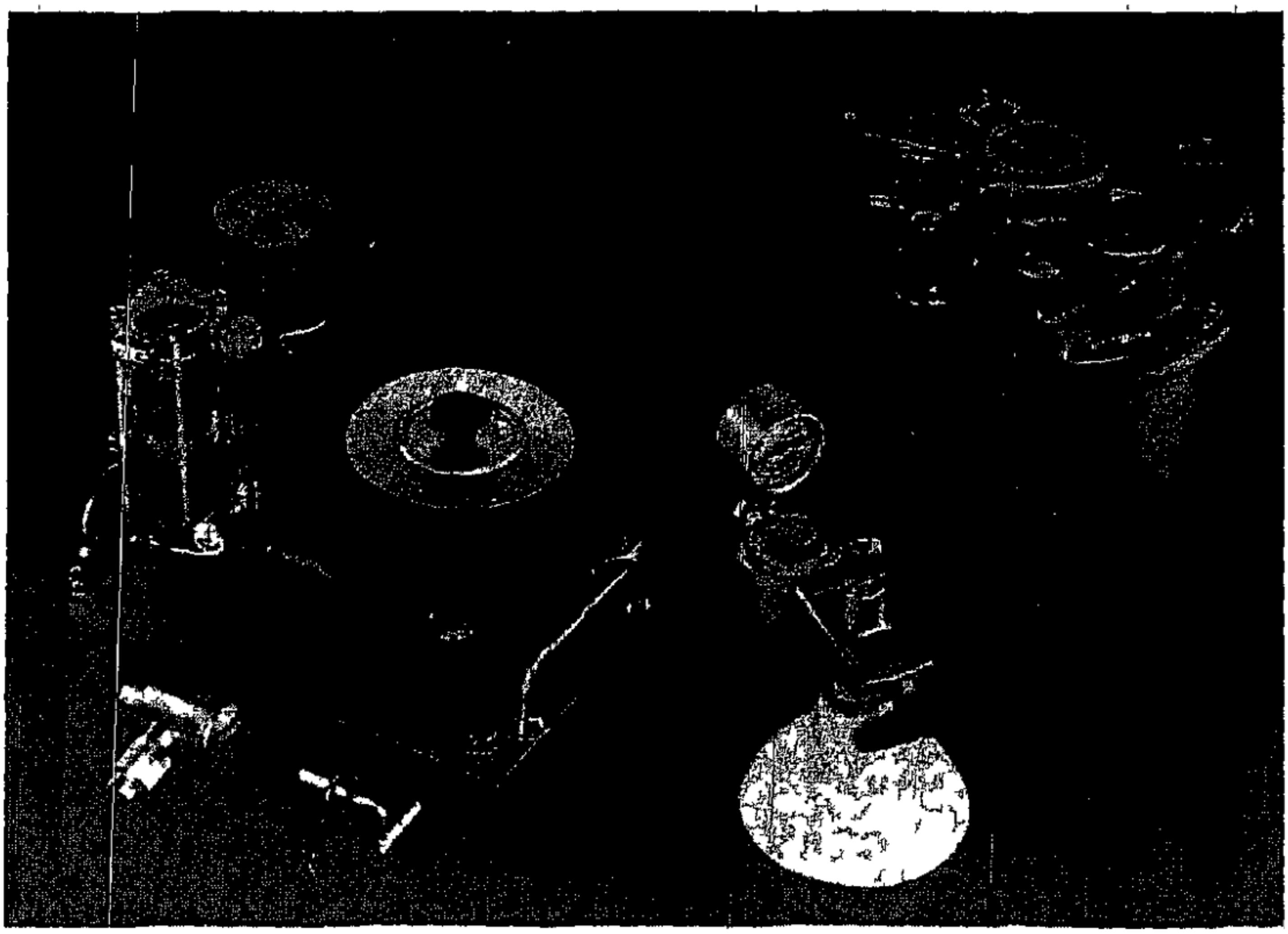

FIGURE 3 The Haloxair with an oxygen cylinder attached and with the E M O Ether Inhaler fitted to the air inlet

If it is desired to supplement the air with oxygen the oxygen flow is set by adjusting valve C During expiration the oxygen flow passes through the tube H to the economizer (A) This displaces the air in the economizer through inlet B As the patient inspires he draws pure oxygen from the economizer first and then air via inlet B

The percentage of oxygen received by the patient depends on the rate of flow of oxygen and the patient s minute volume For example if oxygen is flowing at the rate of 1 litre per minute the patient will receive 30 per cent oxygen if his minute volume is 8 litres but if his minute volume is only 5 litres he will receive 36 per cent oxygen

During spontaneous respiration the movement of the bellows (J) is not a true indication of the tidal volume since most of the inhalation is obtained from the economizer and the air inlet

A measurement of tidal volume and minute volume may be obtained by fitting a Wright respirometer to air inlet B as shown in Figure 4 The reading obtained will be accurate if air is the only gas in use but will not be accurate if oxygen is added because this fraction of the inhaled gases will not be included in the measurement

The unit as supplied by the manufacturer is known as the Haloxair It is contained in a hardwood case specifically designed to ensure adequate protection of the machine compactness portability and storage space (Fig 5) The case

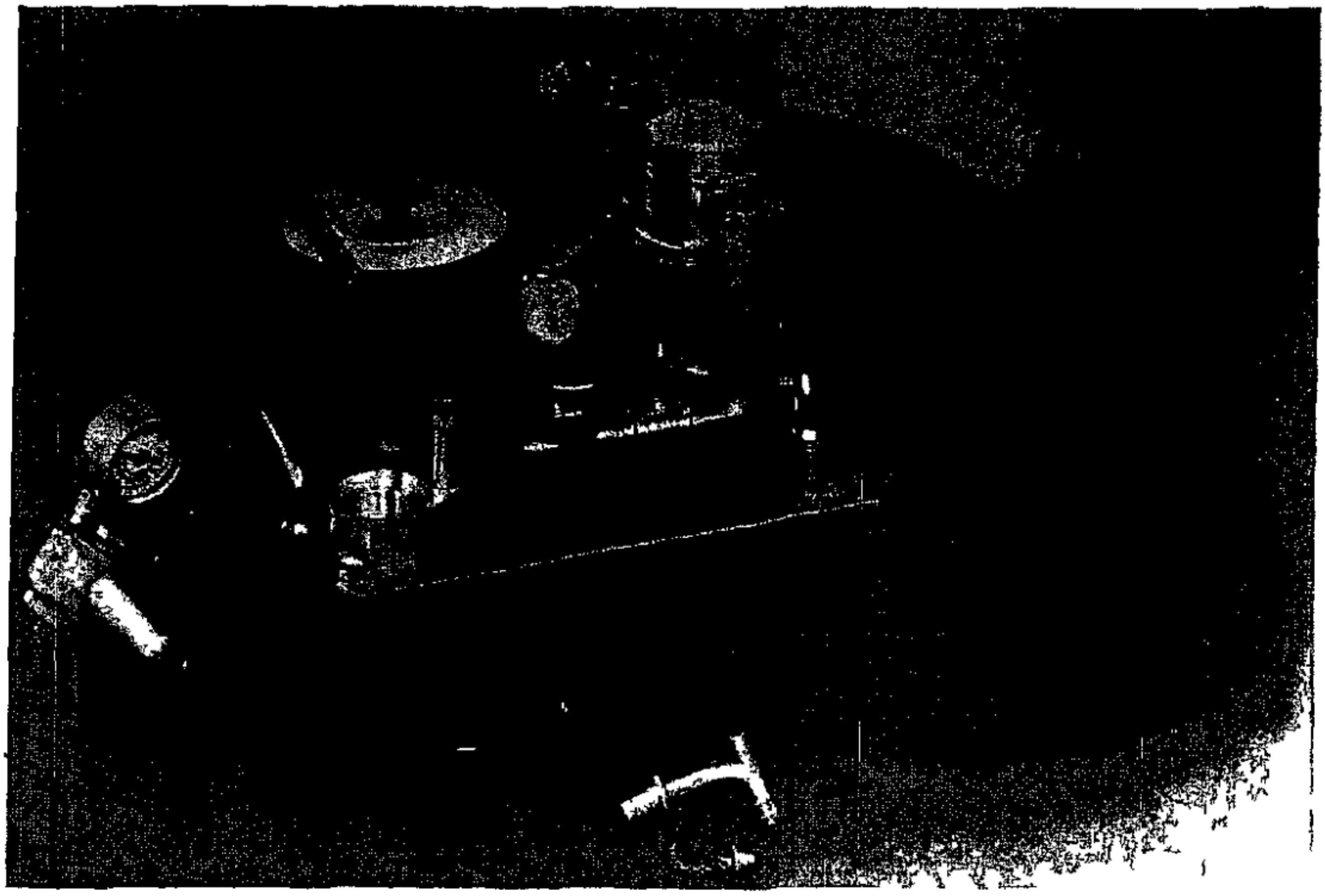

FIGURE 4 The Haloxair with a Wright respirometer fitted to the air inlet

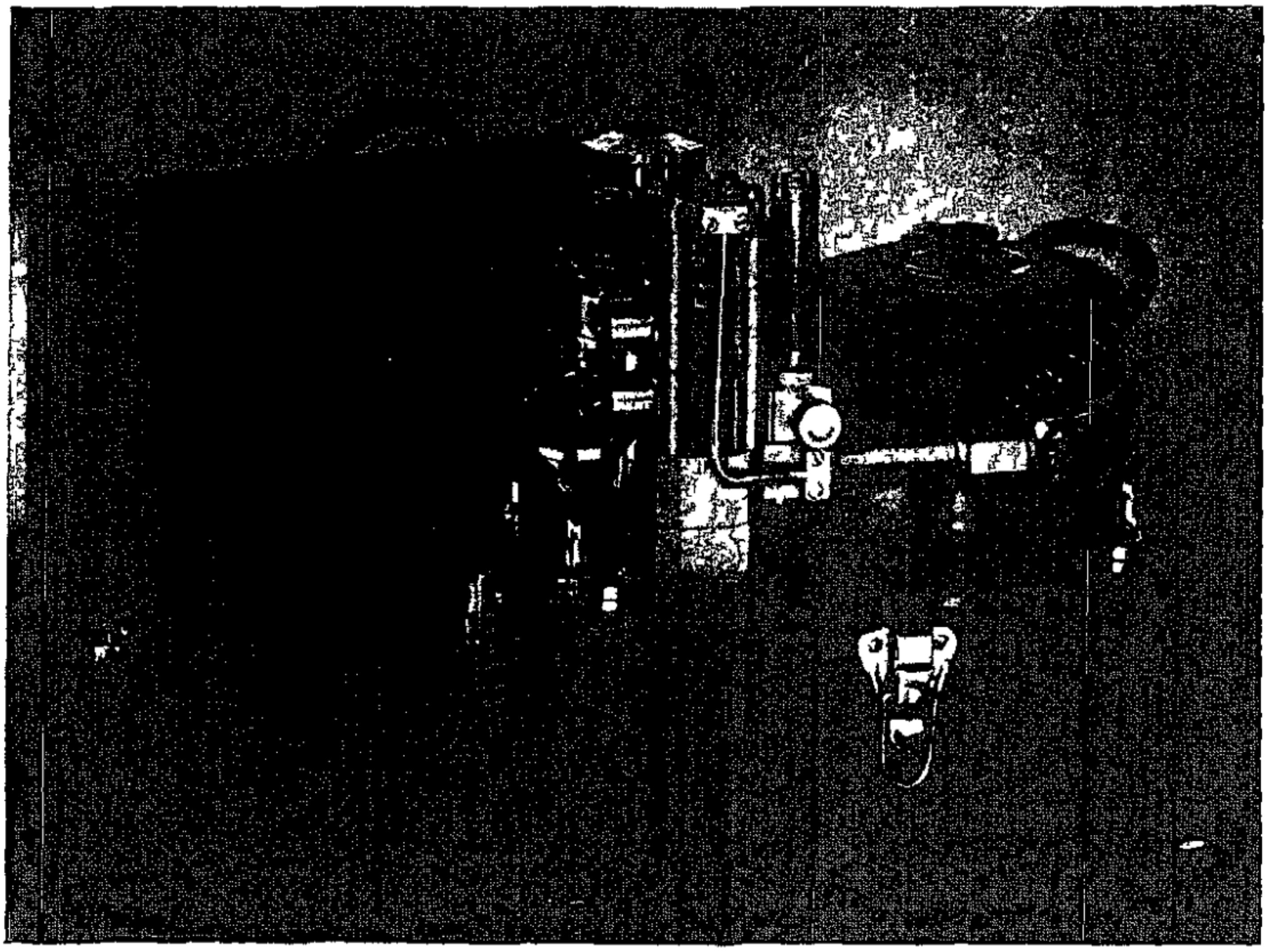

FIGURE 5 The Haloxair and its hardwood case

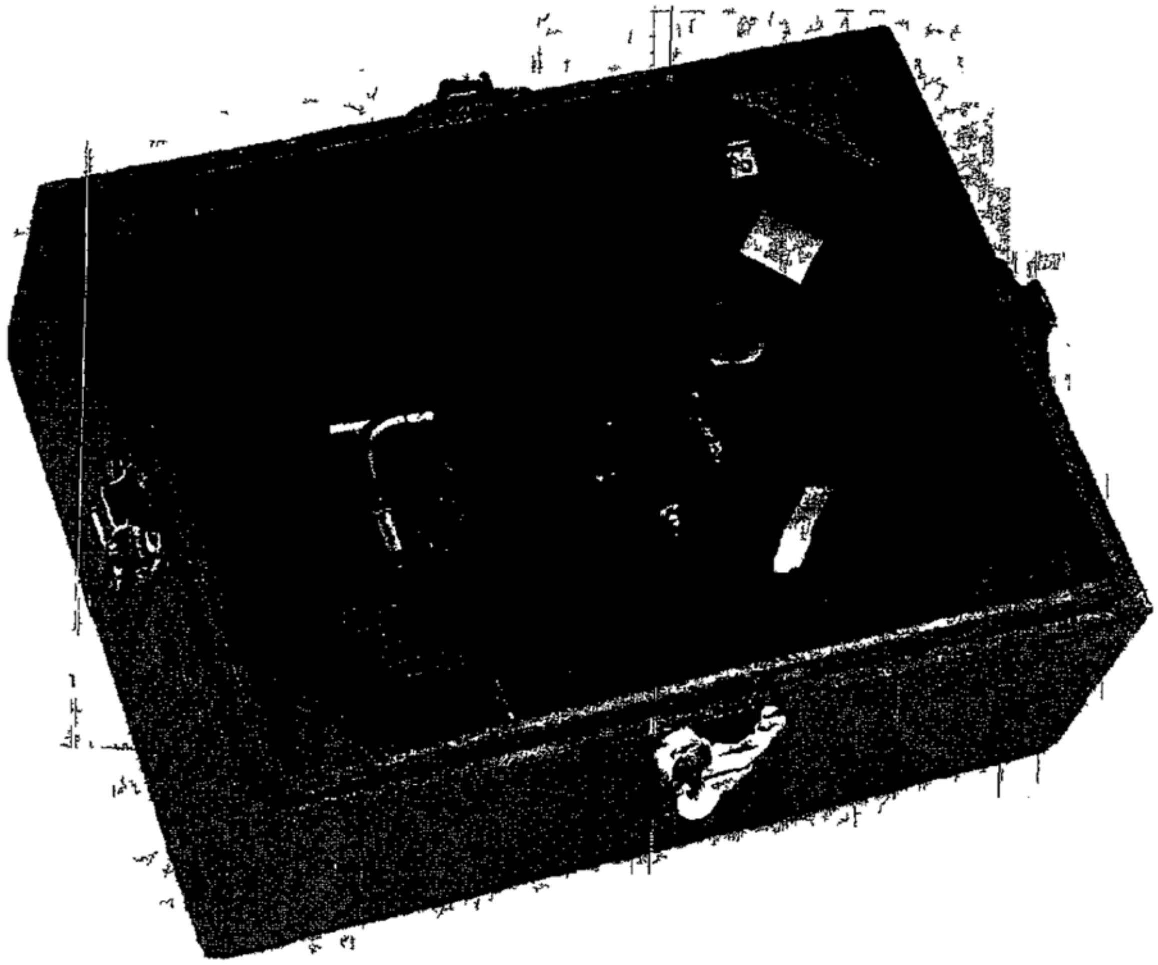

FIGURE 6 The base of the Haloxair case showing storage of tubing masks and adapters

is 14 in high 12½ in long and just under 10 in in width The unit itself weighs 18 pounds With the case and all necessary tubing face pieces Y piece an endo tracheal adapter and oxygen tank adapters the total weight is 27 pounds The corrugated tubing masks and adapters are all stored in the base of the case (Fig 6) which is of very sturdy construction and can if necessary be used as a stand for the Haloxair unit The packaging of the unit is ideal for its inclusion in the packaged hospital units of the Canadian Armed Forces and the Emer gency Health Services

Clinical Use

A good emergency anaesthesia apparatus should be simple to understand and to operate as well as being simple in construction[1] During the past two years the Haloxair has been used to anaesthetize a number of patients 12 to 85 years of age for a variety of surgical procedures at the Toronto General Hospital both emergency and elective No major adjustment of our usual methods was ever necessary In two cases the change was made to ether and air using the E M O Ether Inhaler connected to the Haloxair

The personnel involved in this assessment adapted readily to the Haloxair and quickly learned to exploit all its features The induction techniques were those ordinarily used by the author and his associates and in addition a number of inductions were made using only halothane and air. Maintenance of anaesthesia was, in most cases, uneventful after we became accustomed to the absence of the analgesic effect of nitrous oxide and to the fact that the Haloxair employs a "demand flow" and "draw-over" type of non-rebreathing circuit.

Certain clinical observations were made during the assessment of this machine.

During induction, using only halothane and air, it was found preferable to assist respiration manually with the bellows from the beginning of anaesthesia and even before placing the mask directly on the patient's face

Whatever the technique of induction used and whether or not the patient was intubated it was found advisable to assist respiration for a few minutes, usually until the patient was quiet and the concentration of halothane could be reduced to maintenance levels

At maintenance concentrations of halothane (1–2%) the patients breathe spontaneously without difficulty since the respiratory resistance at these levels is low with this apparatus If higher concentrations of halothane are required, as when the patient shows signs of being too lightly anaesthetized, respiratory resistance is higher, but the patient has the necessary energy and force to overcome this resistance

Concentrations of halothane up to 5 per cent are often necessary during induction of anaesthesia Maintenance concentrations, too, are higher than those usually required when halothane is used in a vehicle of nitrous oxide and oxygen. This seems to indicate that even in 50 per cent concentration with oxygen, as frequently used with halothane in a direct flow system, nitrous oxide exhibits a considerable degree of analgesic effect

Movement of the Haloxair bellows is not an adequate indication of tidal volume and minute volume If it is desired to monitor respiration during anaesthesia with this machine a Wright respirometer can be mounted directly onto the air inlet As noted in the description of the unit, the readings on the Wright respirometer will be inaccurate if oxygen is introduced to the system The error, however, is clinically insignificant and does not decrease the usefulness of the instrument, which may be considerable, especially to the inexperienced anaesthetist

During spontaneous breathing with the Haloxair using halothane and air only, hypoxia may develop because of depression of respiration Slight cyanosis was observed in a number of our cases although respiration appeared to be adequate. The addition of oxygen to the system at the rate of 1 litre per minute quickly corrected the situation in every case and thereafter its use became routine.

Like any other non-rebreathing valve system, the Haloxair exhaust valve can jam This is most likely to occur if the patient coughs during light anaesthesia The bellows becomes distended and the patient, though attempting to breathe, is unable to blow off the accumulated gases The situation is easily remedied by opening the system momentarily at any metal-to-rubber connection Although jamming appears less likely to occur than with the Ruben Valve or the Fink Valve, it can be dangerous if uncorrected.

These observations emphasize the point that an anaesthetized patient must not be left unattended. Even under emergency conditions, when one anaesthetist must manage more than one case at a time, it is important that someone be deputized to keep each case under close observation at all times

SUMMARY

The Haloxair, a new anaesthetic apparatus using halothane in air or in air and oxygen, is described The apparatus is designed especially for emergency use or where portable, compact equipment is desirable A clinical trial of the unit is reported with observations on its special features

RÉSUMÉ

Nous présentons un nouvel appareil (l'haloxair) pour anesthésie à l'halothane-air ou halothane-air-oxygène Cet appareil est destiné surtout aux urgences ou aux circonstances qui exigent un matériel facilement transportable Nous décrivons ses premiers essais en clinique ainsi que ses principales caractéristiques

REFERENCE

1 McNALLY, N H, NEILY, H H, & BENOIT, J Anaesthesia for Emergency Hospitals Canad Anaesth Soc J 9 524 (1962)