

The Triservice Anaesthetic Apparatus

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Summary

The Triservice anaesthetic apparatus is a draw-over system using ambient air as the primary carrier gas. Its modules are a self-inflating bag, a vaporiser, a supplementary oxygen regulator and a ventilator; each is described. The outputs of halothane and trichloroethylene were measured with changes of temperature, continuous and intermittent gasflows and with alteration in barometric pressure. The output of oxygen from the Houtonox regulator was measured and the effect of the oxygen supplementation on the inspired oxygen concentration determined. The resistance to airflow of the apparatus was also measured and the effect of extreme cold observed.

The merits, limitations and the way in which the equipment may be used are discussed. A carrying case with equipment for 10 anaesthetics is illustrated.

Key words

*Anaesthetic techniques; **inhalation.***

Equipment

Inhalational anaesthesia cannot as yet be completely supplanted by intravenous agents. There is, therefore, still a requirement for a portable anaesthetic apparatus for use in military or major disasters, which must be small and light enough to be carried by a fully laden anaesthetist of a parachute field surgical team, and yet is sufficiently versatile to be expanded to meet the more sophisticated requirements of a field or base hospital.

Many portable anaesthetic machines have been designed for the developing countries, domiciliary work, field use or the armed services on active service. The main design features of such apparatuses have been reviewed in detail by Boulton¹ and by Dardel;² these tend to be of two types, complete draw-over units, such as the EMO,³ Fluoxair,^{4,5} and Portablease,⁶ or scaled-down hospital continuous-flow machines such as the Soper,⁷ Enderby,⁸ and Marrett.⁹ Demand-flow machines drawing medical gases from cylinders have also been described.^{10,11}

The draw-over system, in which the patient's ventilation draws ambient air—often supplemented with oxygen and sometimes with nitrous oxide—over the surface of the

volatile anaesthetic agent in a vaporiser, has certain inherent advantages over continuous-flow or demand-flow systems for portable anaesthetic machines. Ambient air is normally used as the carrier gas and there is no dependence on a compressed oxygen supply; the transport of heavy oxygen cylinders is therefore reduced to a minimum or even rendered unnecessary altogether in an emergency and there is no danger of hypoxia from failure of the oxygen supply. The draw-over apparatus is a non-rebreathing system; this minimises bacterial contamination and avoids the problem of disinfection of a circle or similar system.

The EMO system for ether (EMO vaporiser plus Oxford inflating bellows—OIB),^{3, 12} which may be considered to be the forerunner of modern draw-over systems, is still widely used in static civilian hospitals in developing countries and by many armies as a field apparatus, but it is now being replaced for military use because flammable ether is dangerous to use in some military environments and for transport by air, and because the EMO is a heavy and bulky vaporiser, which can be difficult to carry.

The Fluoxair^{4,5} apparatus overcame the hazards of ether by employing halothane or chloroform, but halothane is not an outstanding anaesthetic when used as a sole inhalational agent for the spontaneously respiring patient because it is only weakly analgesic and tends to cause hypotension, and trichloroethylene in air is not a sufficiently strong hypnotic to be used alone for general anaesthesia although it is powerfully analgesic. The combination of halothane with trichloroethylene brings together the virtues of both agents and obviates the difficulties of using either agent on its own for spontaneously respiring anaesthetised patients. It must be emphasised, however, that either halothane or trichloroethylene by itself is satisfactory in low concentrations if the patient has also been given a muscle relaxant and ventilation is being controlled.

The 'Triservice' anaesthetic apparatus (Fig. 1) described in this paper is manufactured by Penlon Ltd, Abingdon, England. It has twin-vaporisers which permit both the non-explosive agents, halothane and trichloroethylene, to be administered together or singly, by spontaneous respiration, or by manual or controlled ventilation, and with or without oxygen supplementation. The apparatus has been designed on a modular basis so that the various components can be used or replaced independently.

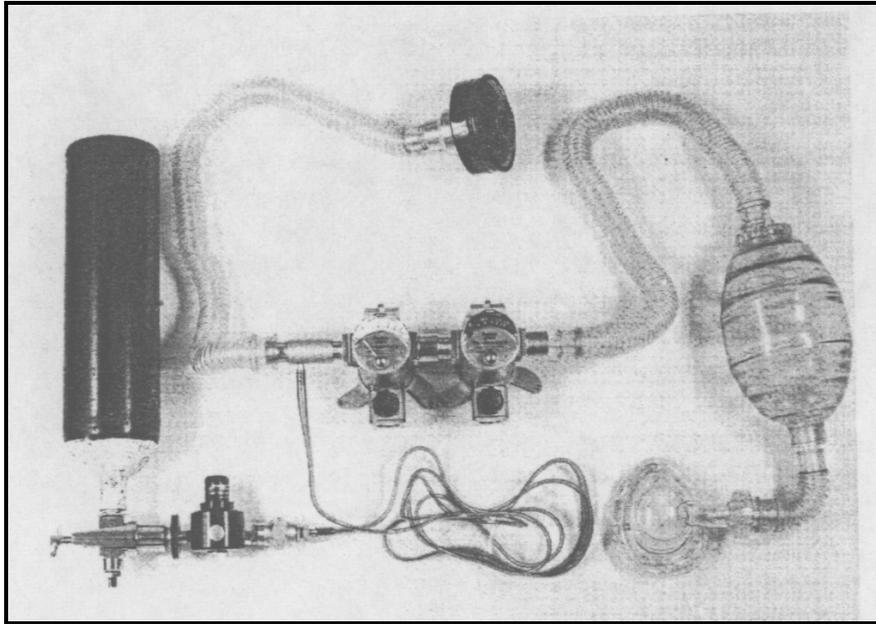
The Triservice anaesthetic apparatus

The modules of the apparatus (Fig. 1) are: a manual inflation system, two identical vaporisers which can be used for any non-flammable anaesthetic agent (and, specifically, for halothane and trichloroethylene), an oxygen supplementation system, and a mechanical ventilator.

The manual inflation system

A standard commercially developed and marketed bag-valve-mask resuscitator for

advanced life support during cardiopulmonary resuscitation is used as the manual inflation system (Fig. 1). The Resusci Folding Bag Mark 2' (Laerdal), lends itself particularly well to use in this modular anaesthetic system. ¹³⁻¹⁷



This self-inflating bag satisfies all the requirements of the USA National Heart Association! National Research Council for apparatus for cardiopulmonary resuscitation and emergency cardiac care.¹⁸ It is made of transparent green polyvinyl chloride. The valve housing and conical connectors are of a hard green plastic and the actual valve flaps are made of silicone rubber. This construction gives good storage characteristics.

There are two transparent contoured face masks with inflatable face pads (adult and child) with standard 22-mm inlet tapers and these readily allow an airtight seal to be achieved with most patients. A 22-mm external/i 5-mm internal elbow adaptor is supplied for use with 15-mm and 22-mm standard tracheal tube connectors.

The short extension tube (0-15 m) fits between the anaesthetic valve and the bag, helping to keep the bag away from the patient's face and facilitating manually controlled ventilation or surgery around the head and neck. It also tends to reduce the tug and movement of the endotracheal tube during manually controlled ventilation.

The transparent mask and valve assemblies enable spontaneous ventilation to be monitored by observing movements of the 'fish-tail' valve and condensation of the expired breath. The bag and valves, which are virtually impossible to assemble incorrectly, are easily dismantled for cleaning. They may be washed or disinfected in any solution used for plastics. Ethylene oxide is suitable for sterilising the whole apparatus, or the hard parts alone can be autoclaved.

The resuscitator will function at temperatures down to -40° Celsius, although there is some loss of efficiency and frozen condensation of pulmonary water vapour on the valve at these low temperatures which may be troublesome.

The whole assembly packs very neatly, together with four Guedel airways, into a plastic box 0.14 x 0.23 x 0.15 m. The resuscitator, complete in its box, weighs 125 kg.

The Laerdal valve has a low resistance to airflow on inspiration and expiration and does not jam, either as a result of high gas flows being directed into the bag or in the presence of vomitus and debris. It is designed as a true dual purpose one-way, non-return valve, which will function during spontaneous or controlled ventilation; its dead space is minimal and the outlet to the patient is constructed to the 22-mm external and 15-mm internal international standards.⁹ It has been redesigned to change the direction of flow through a right angle and enables any standard face mask or an endotracheal tube without a right angle adaptor to be used. A cover can also be fitted over the expiratory valve which allows expired gas to vent through a port for connexion to an anti-pollution system.

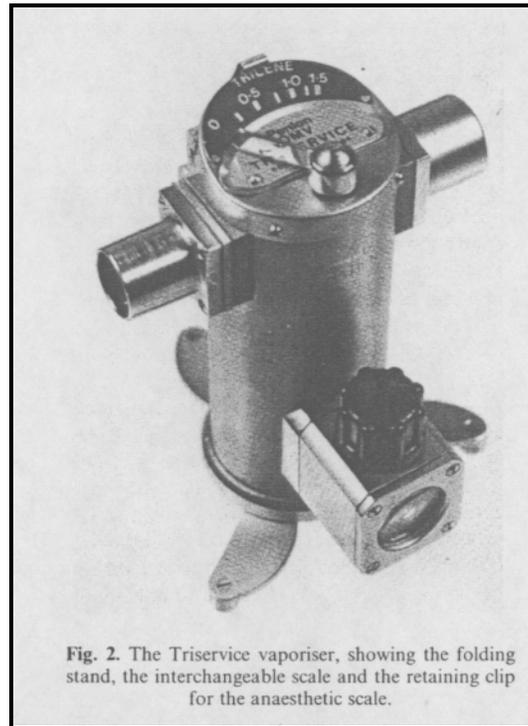
The Laerdal self-inflating resuscitation bag has a very good 'feel' which allows differences in the pulmonary compliance and pressure to be assessed easily.⁷ It is also easy to compress, especially when the 01 5-m extension tube is used between the bag and valve; this reduces user fatigue during prolonged controlled ventilation.

The dimensions of the bag, when inflated, are 04 m in length by 013 m in diameter, giving a volume of 25 litres, and it folds into a cylinder 013 m in diameter by 006 m in depth. A maximum stroke volume in excess of 1100 ml at a rate of up to 70 cycles per minute³ may be achieved. An oxygen adaptor may be attached to the rear of the bag which 'allows oxygen to be administered to a maximum of 35%¹⁴ and if a 075-m extension tube is attached as a reservoir, up to 65% oxygen can be administered.⁴⁷ The oxygen inlet is blocked off with a small cap when the device is used with an anaesthetic draw-over apparatus.

The oxygen adaptor can be unscrewed and replaced by an antigas respirator cannister (NATO Stock No. A2/4240-99-135-3662) to enable the resuscitator to be used in a nuclear or chemically contaminated environment.

The ends of the 0-15-m and 075-m extension tubes are fitted with cagemount socket and cone taper connections (231 mm nominal taper). The use of these cagemount connectors prevents incorrect assembly of the bag and valve and permits direct fitting of the 075-m tube to the outlet of the vaporiser; this is supplied with cagemount tapers so as to be compatible with back-bar mounted equipment of anaesthetic machines constructed to the international standard.⁹

The vaporizer



The Triservice vaporiser (Fig. 2) has been developed from the Oxford Miniature Vaporiser (OMV).^{2°} It is mostly constructed of stainless steel; consequently virtually any anaesthetic liquid can be used without corrosion.

The body is that of the OMV 50 and holds 50 ml of a volatile anaesthetic agent. A conventional filler/drainage system with sight glass is fitted.

'Forlife' antifreeze, which solidifies without expansion at about -400 Celsius, is used in the fluid reservoir in the base of the vaporiser to act as a heat store to assist temperature stabilisation, and to reduce the danger of mechanical distortion in exceptionally cold areas, such as a cargo hold of an aircraft; the reservoir is sealed and normally does not require maintenance.

A folding stand is permanently fixed to the base of the Triservice vaporiser. It is constructed of three plates which swing out to provide a stable base for the vaporiser when it is used independently on a flat surface.

The head of the vaporiser contains the same concentration regulation system as the original OMV. Gases to be inspired are either drawn or blown over through the top ports of the vaporiser. The proportion of gases passing through the vaporising chamber or bypassed direct to the vaporiser outlet is controlled by a tubular slide valve in a stainless-steel housing

The concentration is altered by moving a pointer registering against an engraved scale marked in degrees. The Triservice version of the OMV has a spring clip system with a reversible scale label; this is calibrated on one side for use with halothane, and on the other for trichloroethylene. The scale labels are calibrated in figures which approximate closely enough for clinical purposes over a range of operating room temperatures ranging from 20 to 30°C. The scale label for halothane is marked from 0 to 45% and that for trichloroethylene from 0 to 15%. The pointer has been designed for ease of packing and to prevent accidental displacement in use.

A cagemount (23.1 mm nominal taper) connector is bolted to each end of the standard concentration assembly.⁹ The back of the cone connector on the inlet port is pin-indexed to prevent incorrect connexion.

The vaporiser may be tilted through 60° in use without spillage of anaesthetic agent or alteration in the delivered concentration of the anaesthetic agent.²¹

A bracket is bolted to the rear of the vaporiser to enable it to be attached to an off-line mounting block, an operating table, a wall rail or other equipment incorporating a standard rail system.²²

The external finish is vapour-blasted to give a matt appearance in order to prevent undue light reflection in the field. The direction of gas flow and the serial number are engraved on the surface. The NATO stock number²³ is incorporated on the top cover plate.

The oxygen supplementation system

An oxygen supplementation system (Fig. 1) was specially designed for this anaesthesia apparatus as there was no commercial system that satisfied the specification required. Oxygen supplementation is required, in low dosage, to increase the inspired concentration of oxygen to prevent hypoxaemia due to pulmonary arteriovenous shunting during anaesthesia, and in high dosage, for resuscitation, pre-oxygenation and one-lung anaesthesia.²⁴

The supply of oxygen in cylinders may be limited under emergency conditions; in order to conserve stocks, the two lowest possible flow rates to achieve the above were chosen: namely, 1 litre per minute and 4 litres per minute. Fig. 3 gives the expected oxygen concentrations of the inspired gas with different minute volumes using the 075-rn Laerdal extension tube.

The Houtonox oxygen flow control device (Fig. 4) was developed from the Novox resuscitator.²⁵ The regulator consists of a single-stage reducing valve

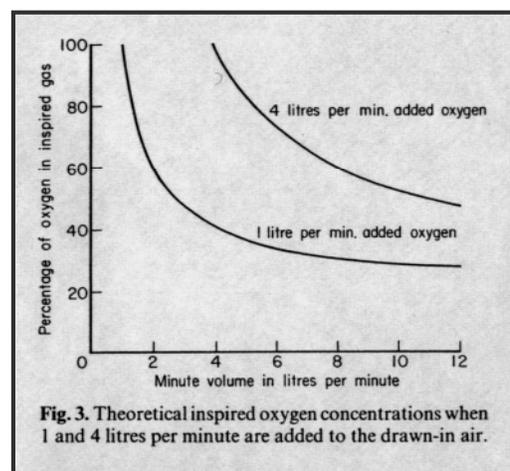


Fig. 3. Theoretical inspired oxygen concentrations when 1 and 4 litres per minute are added to the drawn-in air.

(Harris 101—Harris Europa) and a flow regulator with an oxygen pin-index fitting for the inlet. Adaptors are provided for conversion to bull-nose cylinder fittings and medical gas cylinders of other countries.²⁶ A cylinder contents gauge is fitted; this simple and strong device is spring operated and four rings appear when full, three rings at three-quarters full, two rings at half full, one ring at quarter full and none when empty.

The flow regulator is attached to the outlet stage of the reducing valve (Fig. 1). It has a plate in which two holes are drilled, one hole allows a flow rate of 1 litre per minute and the other allows a flow rate of 3 litres per minute; by rotating the plate, it is possible to have either just the 1-litre hole connected, or both the 1-litre and 3-litre holes connected giving a total flow of 4 litres per minute. The two flows are preset during manufacture but, at that time, could be altered to suit particular requirements by altering the diameters of the holes.

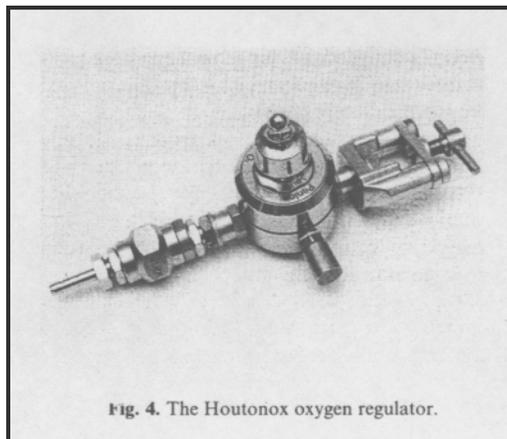


Fig. 4. The Houtonox oxygen regulator.

The device is sturdy, has a good degree of accuracy, and the flow rates are independent of the position of the regulator. Turning the oxygen on or off must be done at the cylinder; a spanner fitting most cylinders is provided.

The oxygen from the outlet of the regulator is fed through a flexible tube into a T-piece adaptor designed by Brigadier C.D. Sanders (Fig. 1) with cagemount tapers attached to the vaporiser; alternatively for resuscitation oxygen can be fed directly into the T-piece and reservoir at the rear of the Laerdal Resusci bag, with the 075-rn length of open tubing with cagemount adaptors attached to the oxygen adaptor on the bag as an oxygen reservoir.

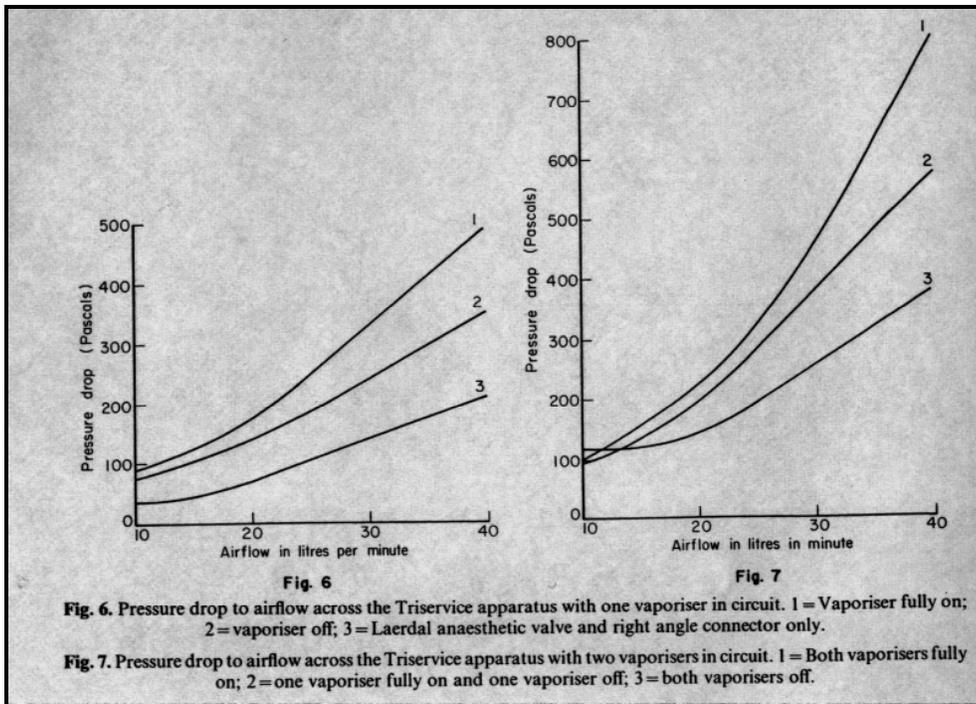
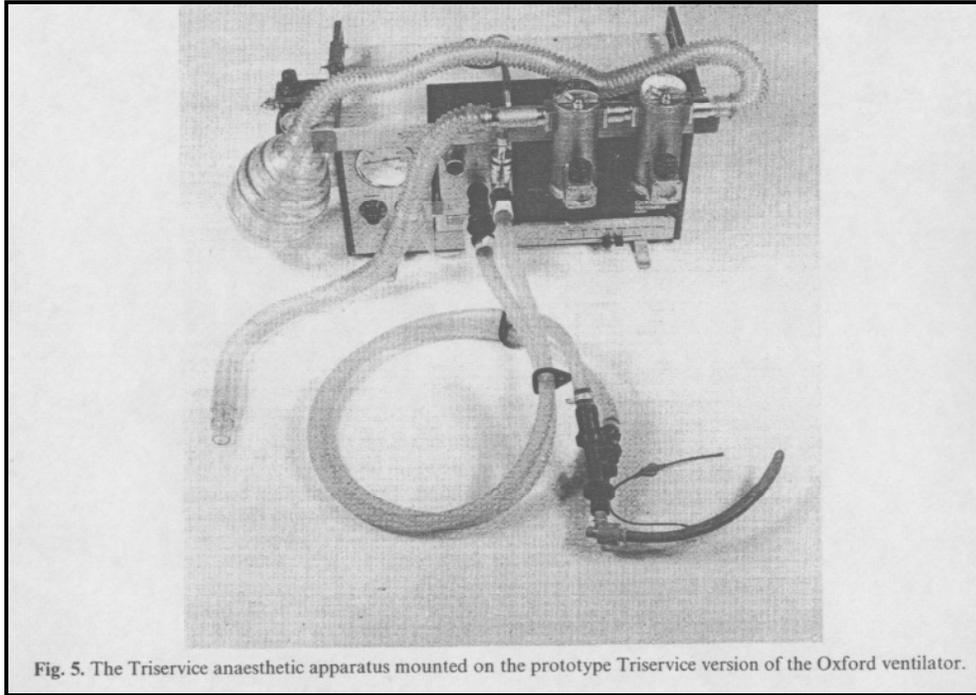
The ventilator

A ventilator is not an essential part of the Triservice anaesthetic apparatus but it might be of great value in less mobile locations to relieve the anaesthetist, or for the resuscitation of war gas-casualties. The Oxford ventilator (Penlon)²⁷ has been modified for use with the Triservice anaesthetic apparatus.

The ventilator is powered by a pneumatic motor using non-respired compressed gas; this allows the machine to be run from a compressor, such as that provided for tyre inflation on army trucks, from compressed gases from cylinders or from a pipeline. It is a volume-cycled flow-generator with a continuously variable ratio of inspiration to expiration. The patient system, either adult or child size, is completely detachable for autoclaving.

The Triservice version of the Oxford ventilator has a standard rail, mounted on the back by means of special brackets; this accommodates the vaporisers and inflation system,

the latter plugging into the air inlet of the ventilator. Manual ventilation is performed by connecting the selfinflating Laerdal Resusci bag direct to the patient.



Experimental assessment of apparatus performance

Resistance to airflow

The resistance to airflow of the Triservice anaesthetic equipment (Fig. 1) was measured with a manometer as a complete assembly at 10, 20, 30, and 40 litres per minute continuous airflow.

The results are shown in Figs 6 & 7 for both one and two vaporisers in the circuit, either turned fully on or off. The resistance of the Laerdal anaesthetic valve with an angle connector is also given.

It was found that, with one vaporiser in the circuit, the pressure drop increased from just below 100 Pa at 10 litres per minute flow to 360 Pa at 40 litres per minute with the vaporiser closed, or approximately 500 Pa with the vaporiser fully open; with two vaporisers in series and using the same flows, the pressure drop ranged from about 100 Pa pressure at 10 litres per minute flow to approximately 600 Pa, with the vaporisers closed, to 800 Pa with the vaporisers both open.

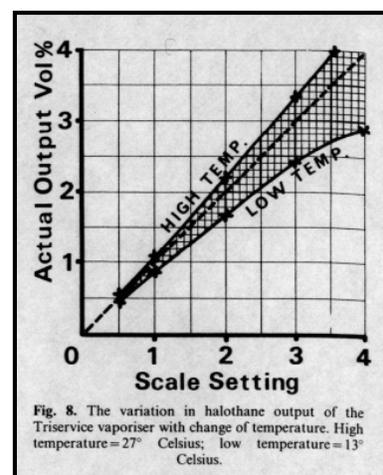
Vaporiser output

Effect of temperature. The Triservice OMV scale labels are calibrated at an ambient temperature of 22° Celsius with a continuous airflow of 4 litres per minute.

Three Triservice vaporisers were tested for variations in vapour output of halothane and trichloroethylene at different flow rates and temperatures. The middle temperature range variation can be expected to be similar to the original OMV which was examined in detail by Parkhouse,² Jensen,²⁸ Wakai,²⁹ and Linde.³⁰

An interference refractometer utilising a cell length of 279 mm was used for the measurement of the vapour concentrations. Practically all the gas from the vaporiser was passed directly through the test cell for the low flows but, for the high flows, the output was split so that only a few litres per minute passed through the test cell; as a control, some measurements were also made using an ultraviolet absorption meter (Hook & Tucker)³¹ and a few with a Narkotest (Drägerwerk).³²

The carrier gas used was either room air, appropriate corrections being used for the humidity, or compressed air from a cylinder. Continuous and intermittent flow rates were measured. A Palmer sine pump, set at a respiratory rate of 20 breaths per minute and a tidal volume of 300 ml, was used in the temperature variation tests to imitate an average ventilatory pattern of an anaesthetised patient breathing spontaneously. The tidal volume was varied from 400 ml to 1000 ml at a rate of 20 breaths per minute in the flow variation tests.



The complete environment of the vaporisers and analytical equipment was kept at the test temperature for the low, normal and warm runs but, for the hot runs, the vaporisers were surrounded by a metallic heat screen; this kept them at the test temperature whilst the analytical equipment remained at 27° to 29~ Celsius to reduce the necessary corrections for the analysis to a minimum.

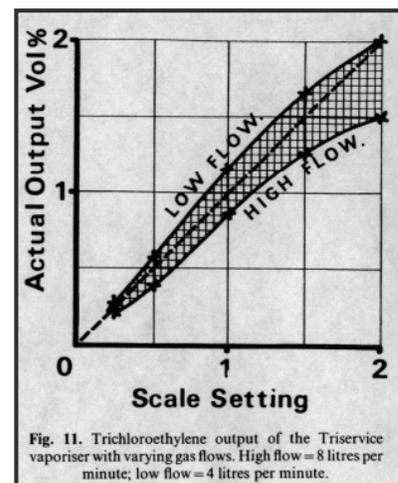
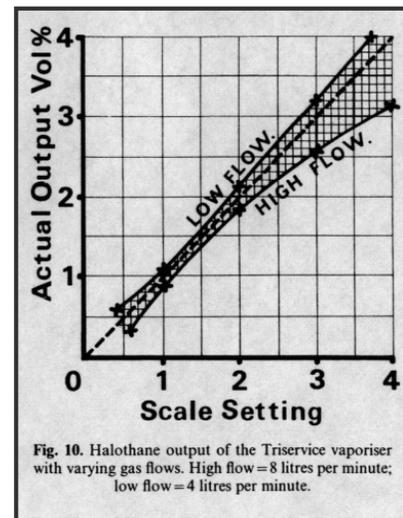
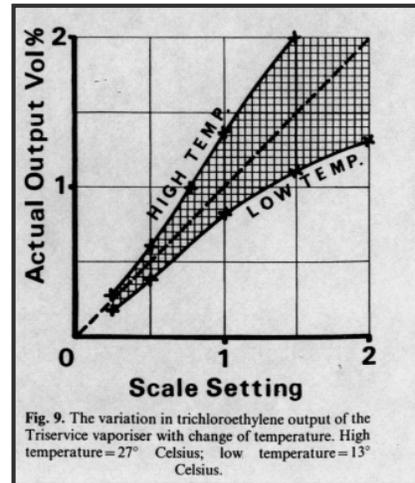
The results are displayed graphically in Figs 8, 9, 10 & 11.

Effect of barometric pressure. The output of a vaporiser may vary with atmospheric pressure.^{6,33} There is an increase in output as the barometric pressure falls with increasing altitude. Theoretically an 'ideal' vaporiser would give double the output at 6000 m (50 kPa=0.5 Bar) than it would give at sea level (100 kPa=1 Bar). The vapour outputs at pressures from 65 kPa (4000 m) to 100 kPa were measured and are given in Fig. 12

Triservice OMV output with various agents. Concentrations for chloroform, methoxyflurane and enflurane relative to the permanent angular scale engraved beneath the detachable halothane/trichloroethylene label at 20Celsius were measured in addition to those for halothane and trichloroethylene. These are shown in Fig. 13. Enflurane has proved satisfactory as a sole, spontaneously respired draw-over anaesthetic,³⁴ even at the concentration of 3.6% which can be produced by the Triservice OMV after an intravenous induction. The concentrations of methoxyflurane (0.6%) delivered by the vapouriser would not be sufficient to maintain anaesthesia by spontaneous respiration but would be enough for controlled ventilation with a muscle relaxant- however, two vapourisers can be placed in series to produce a total of 1.2%

Oxygen supplementation

The oxygen concentration was measured at the patient-end of the apparatus, using a paramagnetic oxygen analyser (Servomex, type OA 272).³⁵ The respiratory pattern of a patient was simulated using a Beaver Ventilator Mark 2 (British Oxygen Company Ltd) with respiratory rates from 11 to 24 cycles per minute and tidal volumes from 250 ml to 1000 ml, so varying the minute volumes between 25 and 12 litres per minute. The



resultant oxygen concentrations were measured supplementing with both 1 and 4 litres per minute of added oxygen into the 0.75m Laerdal extension tube. The experimental results are shown in Fig. 14 and should be compared with the theoretical values given in Fig. 3.

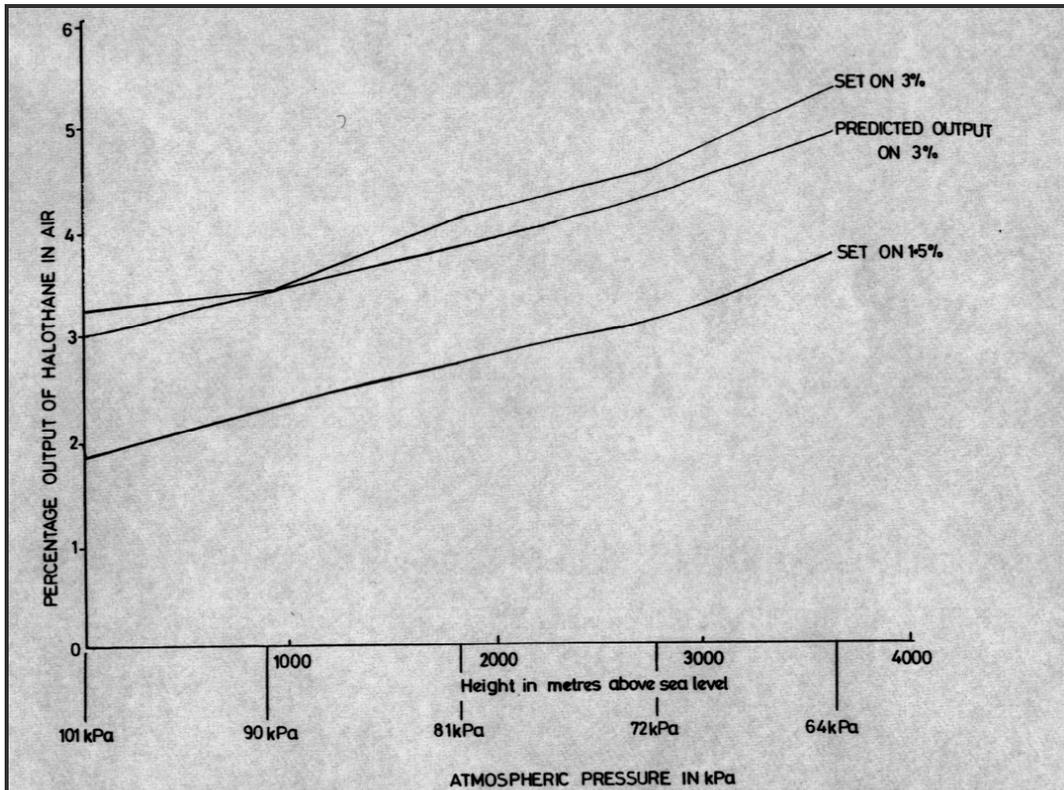


Fig. 12. The effect of atmospheric pressure on the halothane output of the Triservice vaporiser.

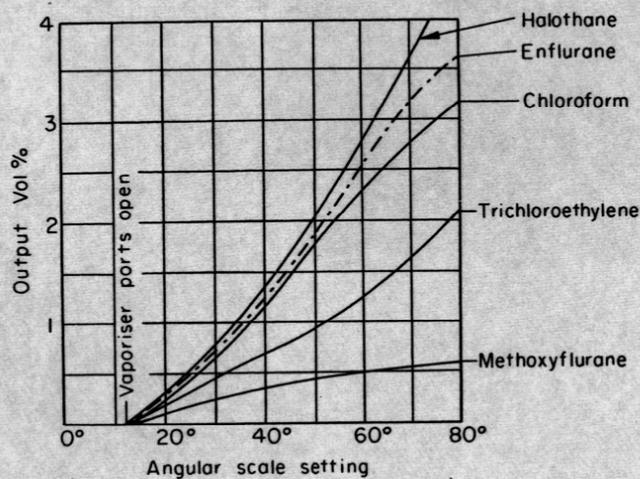


Fig. 13. The output from the Triservice vaporiser measured at 20° Celsius with various volatile agents.

The oxygen outputs of two Houtonox regulators were measured with a Rotameter at different cylinder pressures. The results are given in Fig. 15

Performance of the apparatus at low temperatures

The equipment was taken into a cold chamber and left for 30 minutes to allow it to cool to the ambient temperature before testing. The equipment was rested for 30-minute periods between subsequent tests.

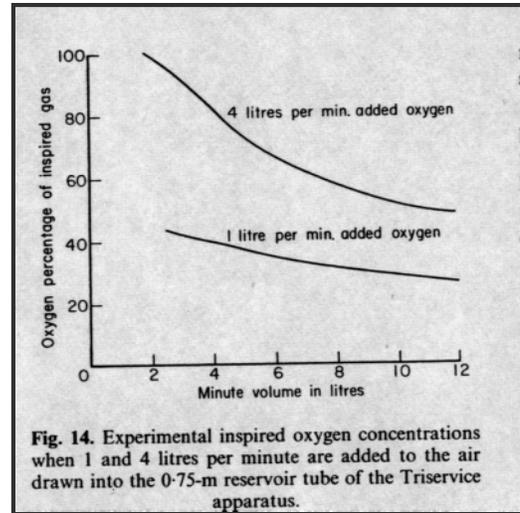


Fig. 14. Experimental inspired oxygen concentrations when 1 and 4 litres per minute are added to the air drawn into the 0.75-m reservoir tube of the Triservice apparatus.

The Resusci folding bag was operated at temperatures down to minus 40° Celsius. It was found that the polyvinyl chloride became harder and less resilient as the temperature decreased, so that, at minus 40° Celsius, a rate of only 15 full compressions per minute could be achieved.

The silicone rubber valve sometimes stuck if the condensation from the expired breath was allowed to collect and freeze in the valve and on the valve cusps but sticking did not occur before the first use or during continuous operation even at minus 40° Celsius.

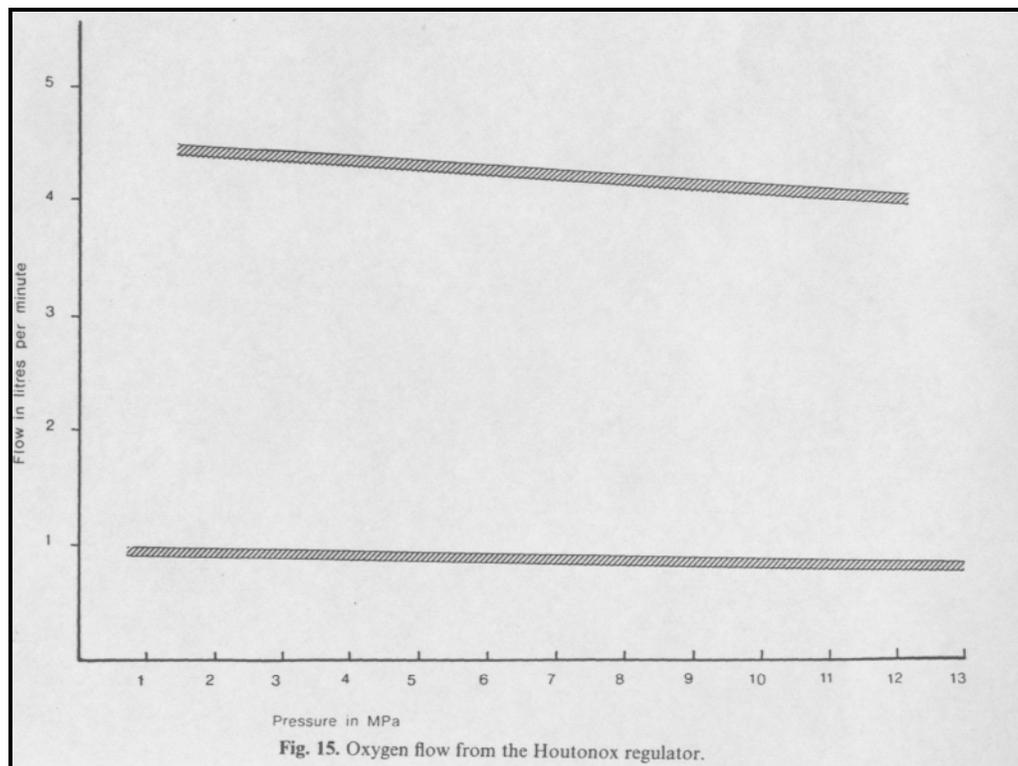


Fig. 15. Oxygen flow from the Houtonox regulator.

The Houtonox regulator functioned at minus 40°C Celsius.

The Triservice vaporisers were stored at minus 40° Celsius; they were found to be undamaged and fully functional after being rewarmed to room temperature

Field Trials

The author has used the Triservice equipment in a field surgical environment for over a year with very satisfactory results without needing to resort to other apparatus.

A more detailed account of the field trials of the apparatus is the subject of another communication.³⁶

Discussion

The modular concept of this apparatus enables an increasing number of functions to be used by combining the components in differing configurations.

The simplest portable anaesthetic apparatus for use in a major disaster or forward on the battlefield can be constructed from one vaporiser and the resuscitator bag; this enables either halothane or trichloroethylene with either spontaneous or controlled ventilation to be used. If the oxygen supplementation system is attached, either to the resuscitator bag for resuscitation or to the vaporiser for anaesthesia, the safety and effectiveness of the equipment is increased; when two vaporisers are available, the benefits of combining trichloroethylene with halothane for anaesthesia with a spontaneously respiring patient can be exploited.^{37,38}

The reduction of the actual inspired oxygen concentration compared with the theoretical value (Figs 3 & 14) at minute volumes of more than 4 litres per minute is eliminated by the use of a larger reservoir tube; this shows there is an overspill when the standard 075-rn tube is used and there may also be an increased loss from diffusion of the supplementary oxygen. This effect is not important in clinical practice.

Two vaporisers may be connected in series in a less mobile location such as in a field hospital, or as a reserve machine for use when compressed gases are scarce or unavailable. This will increase the resistance to airflow. The general effects of resistance to breathing have been reviewed by Nunn³⁹ and by Smith,^{40,41} The effects of the degree of increase in resistance of having two vaporisers in series are eliminated by controlled ventilation and are not important in practice with spontaneous respiration.³⁶

The Triservice vaporiser can be fitted on the back bar of a conventional Boyle's type machine as the second or third vaporiser using an off-line mounting block in a base, military, or civilian general hospital. An additional calibrated vaporiser is thus made available for routine use but, in the event of a major disaster situation or for domiciliary midwifery,⁴² it can be taken off for use with a resuscitator bag leaving behind a fully

functional anaesthetic machine. Regular use of the equipment in these ways will prevent the deterioration which tends to occur in storage, personnel will be familiar with it, and maximum use is made of the capital invested in the equipment.

There is a risk that the Triservice OMV could be filled with the wrong agent but a pin-indexed system for filling would be inappropriate as it would destroy the versatility of the vaporiser. The scales for trichloroethylene and halothane are on opposite sides of an easily removed label clipped to the top of the vaporiser; the appropriate scale is, therefore, always to hand and can easily and rapidly be changed or an alternative scale for another volatile agent such as enflurane substituted; this easily altered system provides the best chance that the agent will be labelled correctly in practice. Residual waxoline blue tends to colour halothane blue in a vaporiser previously used for trichloroethylene; in order to avoid any possible confusion, a plastic sphere, which will be visible in the sight-chamber of the vaporiser, has been developed which will float in halothane but sink in trichloroethylene.

The Triservice OMV is temperature-stabilised. Contrary to recent trends, a temperature compensator has not been incorporated, as these devices increase the complexity, decrease the reliability and add to the bulk and cost. The effect of high or low ambient temperatures is predictable by reference to the graphs in Figs 8 & 9.

The performance of the Laerdal Resusci resuscitator bag in the extreme cold is adequate for life saving, even if it is impaired. The freezing of valves is a hazard which would probably be common to all designs at very low temperatures. Prolonged resuscitation is clearly incompatible with survival at extreme sub-zero temperatures and anaesthesia is unlikely to be used except in a warmed location; therefore, although the Resusci folding bag Mark 2 is not the ideal resuscitator for elective use in very cold conditions, its use in the Triservice apparatus is acceptable.

The complete assembly of modules, comprising vaporisers, oxygen supplementation and inflation systems, can be used as the anaesthetic component of an anaesthetic ventilator, provided that the ventilator draws in the gases through a suitable port. Two ventilators have been used in trials—the Oxford (Penlon)²⁷ and the East Radcliffe (East);⁴³ both are easily portable and have dual power sources; one of the latter (gas cylinders in the case of the Oxford and electric batteries for the East Radcliffe) being transportable.

Servicing and replacement of the components of the Triservice on anaesthetic apparatus is simplified by the modular concept. If a module is broken or lost, it can be readily replaced by any similar alternative type of equipment; for example an Ambu bag can be substituted for the Resusci bag, a Rotameter oxygen regulator for the Houtonox control or a Blease Universal vaporiser for the Triservice OMV.

A custom-built carrying case would not be necessary for most purposes but for some military requirements a transport container for the equipment and drugs is desirable and a neat civilian case is now available from Penlon Ltd. The military container (Figs 16 &

17) is an aluminium alloy box with fitted trays (Zarges) measuring 06 x 041 x 025 m. It can be packed with sufficient equipment and drugs for 10 anaesthetic procedures. The complete unit, less oxygen cylinder and foot-operated suction machine, weighs 25 kg. Careful consideration has been

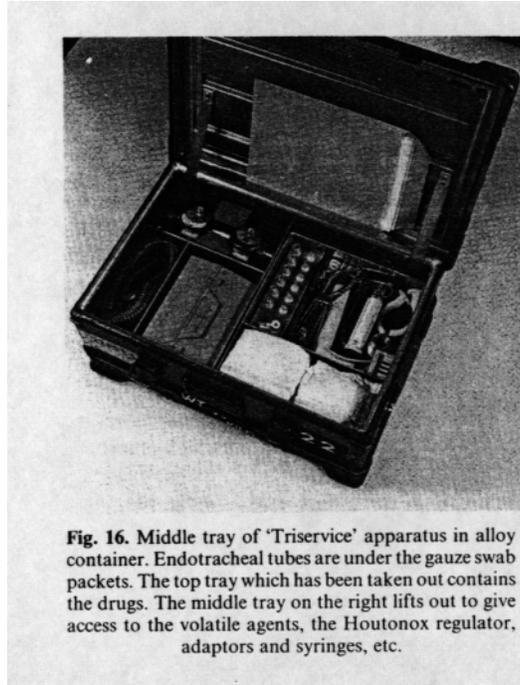


Fig 16



Fig 17

given to shelf-life, heat stability, and interchangeability with existing equipment scales in selecting the items included in the outfit, a list of which forms an appendix to this paper.

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Appendix

Components of the Triservice anaesthesia apparatus

MEDICAL GAS

Oxygen, O•3 cu m cylinder 1 contains 340 litres

EQUIPMENT

Airways, Guedel, sizes 1, 2, 3, 4	1 of each size
Connectors, endotracheal, 15 mm	1 set
Regulator, oxygen (Houtonox, Penlon)	1
Resuscitator, Laerdal, RF II (Vickers Medical) complete with adult mask, child mask, extension tube (0~75 m) (cagemount taper connexions), extension tube (0~ 15 m) (cagemount taper connections) and oxygen adaptor	

Spanner, gas cylinder (Penlon)	1
1-piece connector (Sanders) with side gas inlet (cagemount taper connexions) (Penlon)	1
Tubing, 30 mm lumen	3m
Vaporiser, Triservice (Penlon)	2
Instruction and servicing handbooks (Penlon)	1 of each
Yoke adaptor, bullnose to oxygen pin index	1
Yoke adaptor, US to oxygen pin index	1
Yoke adaptor, DIN 477 to oxygen pin index	1

Additional items packed in "Lacon" alloy container sufficient for ten cases

DRUGS

Adrenalin injection 01%	1ml ampoules	10
Alcuronium chloride injection	10mg ampoules	10
Atropine sulphate injection	600mcg ampoules	30
Calcium gluconate injection 10%	10mls ampoules	10
Diazepam injection	10mg ampoules	10
Halothane	250mls bottle	1
Hydrocortisone sodium succinate	100mg vials	2
Ketamine 50 mg per ml	10mls vials	2
Lubricating jelly	82 gms	1
Naloxone hydrochloride injection	0.4mgs ampoules	10
Neostigmine injection	2.5mgs ampoules	20
Papaveretum injection	20mg ampoules	20
Perphenazine injection	5mg ampoules	5
Pethidine injection	100mg amoules	20
Suxamethonium bromide (powder)	67mg ampoules	20
Thiopentone sodium injection	2.5g multidose	2
Trichloroethylene	500 ml bottle	
Tubocurarine injection	15 mg ampoules	25
Water for injection	100 ml bottles	3

DRESSINGS

Adhesive plaster, zinc oxide	25 cm x 5 m roll	2
Gauze pads, spirit impregnated	100	
Gauze pads, green, 12 ply	10cm x 10 cm	100

EQUIPMENT

Brush, endotracheal	1
Bulb, laryngoscope	2
Connectors, endotracheal (15 mm)	1 set
Forceps, Magill	1

Forceps, Dunhill (130 mm)	2
Gag (Ferguson)	1
Introducer (malleable)	1
Laryngoscope (Macintosh)	2
Needles, hypodermic (23 and 21 SWG)	40
Scissors, blunt points 130 mm	1
Sphygmomanometer, anaeroid	1
Stethoscope	1
Syringes, hypodermic (2 ml, 5 ml, 20 ml)	30
Tubes, endotracheal (cuffed, 7, 8, 9, 95 mm, and non-cuffed, 3, 4, 5, 6, 8 mm)	1 of each 1 of each
Spanner gas cylinder (Penlon)	1
Bodok seal	2
o ring (for bull-nose cylinder adaptor)	1
Battery, dry, No. 9. U 11	4

Note. It has been assumed that transfusion fluids and equipment and foot operated suction apparatus would be carried as well