# Technical Report

# A high-pressure alarm for the detection of obstruction of the fresh gas line in the T-piece circuit

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*An electronic high-pressure alarm for detecting obstruction of the fresh gas flow line in T-piece type anaesthetic circuits is described. The system is small, battery operated, and unobtrusive on the anaesthetic machine. The alarm is designed to sound whenever an obstruction reduces fresh gas flow to the patient, resulting in undesired rebreathing of expired gases.*

The T-piece system was developed by Ayre in response to the need for an anaesthetic circuit with low resistance and minimal dead space.[1] Numerous modifications of Ayre's original circuit have been described. The Bain circuit,[2] for example, is often used in adult anaesthesia, and the Jackson-Rees modification[3] is commonly used in paediatric anaesthesia. Other modifications of Ayre's T-piece are described by Dorsch and Dorsch.[4] All involve a flexible fresh gas line, usually one-half inch rubber tubing.

**Description of hazard**

One hazard of the T-piece circuit is that the fresh gas line may kink (Figure 1). Should this occur, little or no fresh gas will reach the patient, who will therefore rebreathe expired gases. In such an event, the usual monitors of patient ventilation such as breath sounds and airway pressure will not change immediately. Clinical evidence of this rebreathing may only become apparent when hypoxia develops. An obstruction to fresh gas flow may be detected earlier by recognizing a gradual decrease in airway pressure and a decrease in the excursion of the ventilator bellows during controlled ventilation. These signs may be absent if ventilation is spontaneous. Faced with this potentially lethal hazard, it is not uncommon for anaesthetists who use the T-piece to check for obstruction of the fresh gas flow by deliberately kinking the line, causing the Norry valve (a 40 mmHg high-pressure relief valve commonly used in the fresh-gas line[5]) to vent gas. This produces a faint "chattering" sound as the valve oscillates which confirms the integrity of the circuit. However, when low fresh gas flows are used[6] the sound of a chattering valve may be difficult to detect.

**Key words**

EQUIPMENT: high pressure alarm; EQUIPMENT, CIRCUITS: T-piece.

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**Safety monitor**

This paper describes a simple electronic alarm which monitors the pressure in the fresh gas flow line to detect any obstruction. The system uses a pressure switch connected to the line which reacts when line pressures exceed an adjustable threshold (usually set at 35–40 mmHg to match the pressure relief setting on the Norry valve). The switch, in turn, is connected to an electronic buzzer which indicates excessive pressures with a distinctive audible alarm. When used with a pressure threshold of 35–40 mmHg the alarm will sound whenever the

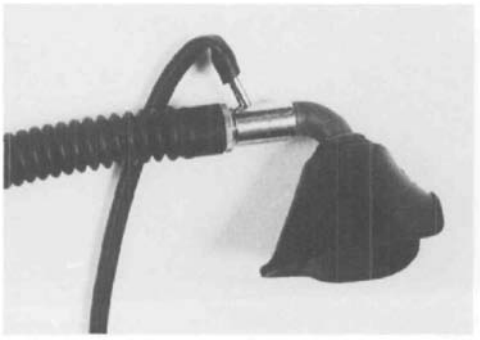

FIGURE 1 Illustration of a kink in the fresh gas flow line of a T-piece circuit.

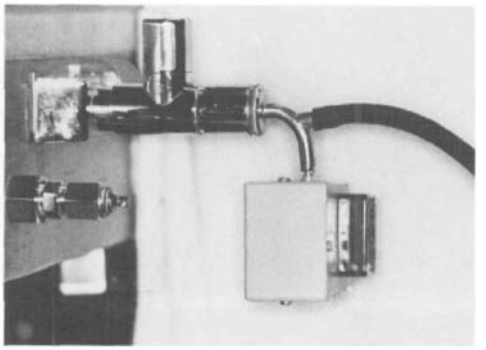

FIGURE 3 Photograph of the alarm system and its connection to the anaesthetic machine.

Norry valve vents gas. Figure 2 shows a diagram of the system, while the Appendix provides information on commercial sources for the key components. This electronic alarm has been evaluated during many surgical procedures and found to be quite satisfactory. It is small (about 10 cm × 10 cm × 5 cm) and unobtrusive on the anaesthetic machine (Figure 3). Integration of the unit into an existing airway pressure alarm system offers further space advantage. The unit is battery-operated and consumes power only when the alarm is sounding. The alarm circuit is designed in such a manner that when the gas-line pressures return to normal the buzzer turns itself off automatically. This eliminates the need to manually reset the alarm.

There are two additional uses for the system: (a) to pressure-test the anaesthetic circuit by blocking the fresh gas flow line and checking for activation of the alarm, and (b) to check for small leaks in the anaesthetic machine. In the latter case the fresh gas outlet is again blocked, and the minimum fresh-gas flow that will cause the alarm to trigger is determined. This flow is approximately equal to the level of leak in the anaesthetic machine.

## Conclusion

A simple electronic high-pressure alarm for detecting obstruction of the fresh gas line in T-piece type anaesthetic circuits has been described.

## Acknowledgement

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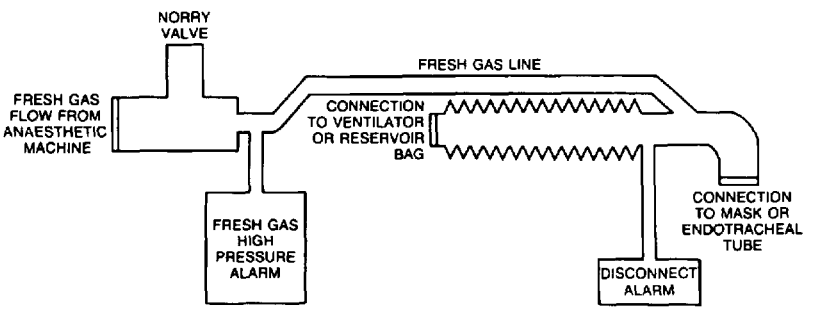


FIGURE 2 Diagram of the fresh-gas pressure line monitoring arrangement.

## References

1 *Ayre P.* The T-piece technique. Br J Anaesth 1956; 28: 520–6.
2 *Bain JA, Spoerel WE.* A streamlined anaesthetic system. Can Anaesth Soc J 1972; 19: 426–35.
3 *Jackson-Rees G.* Anaesthesia in the newborn. Br Med J 1950; 2: 1419–22.
4 *Dorsch JA, Dorsch SE.* Understanding anesthesia equipment: construction, care and complications. 2nd Edition. Baltimore: Williams and Wilkins, 1984.
5 *Norry HT.* A pressure limiting valve for anaesthetic and respirator circuits. Can Anaesth Soc J 1972; 19: 583–8.
6 *Rose DK, Froese AB.* The regulation of $PaCO_2$ during controlled ventilation of children with a T-piece. Can Anaesth Soc J 1979; 26: 104–13.

Résumé

*Une alarme électronique à haute pression pour détecter l'obstruction dans les lignes d'arrivée des gaz frais dans une pièce en T du circuit anesthésique est décrite. Le système est petit, opéré par batterie, non encombrant sur la machine d'anesthésie. L'alarme est conçue de telle façon qu'elle détecte toute réduction du flot des gaz frais pour le patient pouvant occasionner une réinspiration des gaz expirés.*

## Appendix

### Commercial sources for key components

The two key components for the alarm system are the pneumatic pressure switch and the audio transducer. Commercial sources for these items are given below.

*Pressure switch*

Part number MPL501-50CMH20 (operating overpressure 100 cm H20)
Micro Pneumatic Logic Inc.
2890 North West 62nd Street
Fort Lauderdale, Florida
USA 33309
(305) 973-6166

*Audio Transducer*

Part Number QMB12D
Star Micronics,
Components Division,
70-D Ethel Road West
Piscataway N.J.
USA 08854
(201) 572-9512