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Technical note

A new ventilation failure alarm

Keywords—*Alarm, Pressure, Ventilation failure*

1 Introduction

ACCIDENTAL disconnection of the breathing circuit is a very common hazard in anaesthesia. In a recent study, COOPER *et al.* (1978) found it to be the most frequent single cause of anaesthetic incidents. The use of mechanical ventilators makes this hazard life threatening unless recognised promptly.

Ventilator alarms currently available commercially are very expensive and have not proved reliable in use.

Although alarms for specific purposes have been described (FODOR *et al.*, 1977) there is still a need for a cheap, general-purpose alarm that can be permanently attached to a ventilator and used in the operating theatre or the intensive-care unit.

In addition, the alarm must be simple to use and incorporate a long-life battery and a battery-check facility.

2 Design features

One of the weakest points of most ventilator alarms is the pressure sensitive switch; most switches being unreliable and requiring regular adjustment to maintain a given pressure threshold.

In the design described in this paper, the problem has been solved by the use of a high-reliability switch* designed for industrial use. The switch has a screw adjustment that enables the pressure threshold to be set over the range 4–18 mmHg and, although bulky, has proved very reliable in clinical use.

The instrument (Fig. 1) activates a 'Sonalert' audible alarm when more than 20 s have elapsed since the input pressure has crossed the 10 mmHg threshold. It has only one external control, a three-way toggle-switch having 'on' 'off' and 'test' positions. Preset controls for threshold pressure and time delay are located inside the case.

For intensive care use, the time delay is increased to 30 s to avoid actuating the alarm during tracheal suction.

The ventilator alarm is housed in a 108 × 108 × 108 mm vinyl covered aluminium box and is coupled to the ventilator circuit via a 6- mm diameter pressure inlet. A flap at the back enables the battery to be replaced. When a humidifier is used in the circuit, a water trap must be included in the line connecting the circuit and the alarm.

*Dwyer Model 1823-10, Dwyer Instruments, USA

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3 Circuit design

The Circuit (Fig. 2) is powered by a 9 V mercury battery and utilises 'CMOS' technology to achieve an extremely low battery current drain. Battery life is approximately one year in normal use.

The operation of the circuit is extremely simple. The timing capacitor at the input of gate 3 charges via the timing resistor, causing the gate to change state after 20 s, energising the Sonalert alarm via gate 4, and transistor Q_1.

If an increasing pressure applied to the pressure switch S_2 passes the preset threshold level, a negative-going pulse is generated at the output of gate 2, discharging the timing capacitor and hence resetting the timing circuit. Thus, a ventilation cycle that crosses the 10 mmHg pressure threshold and has a period less than 20 s prevents the alarm from sounding. These time and pres-

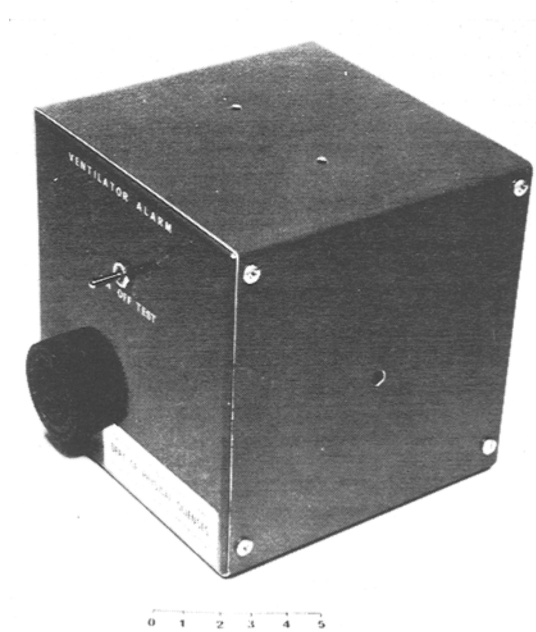

Fig. 1 *Ventilation failure alarm*
The connection to the ventilator circuit is made at the rear

sure limits may be varied by adjustment of the timing resistor and pressure-switch threshold.

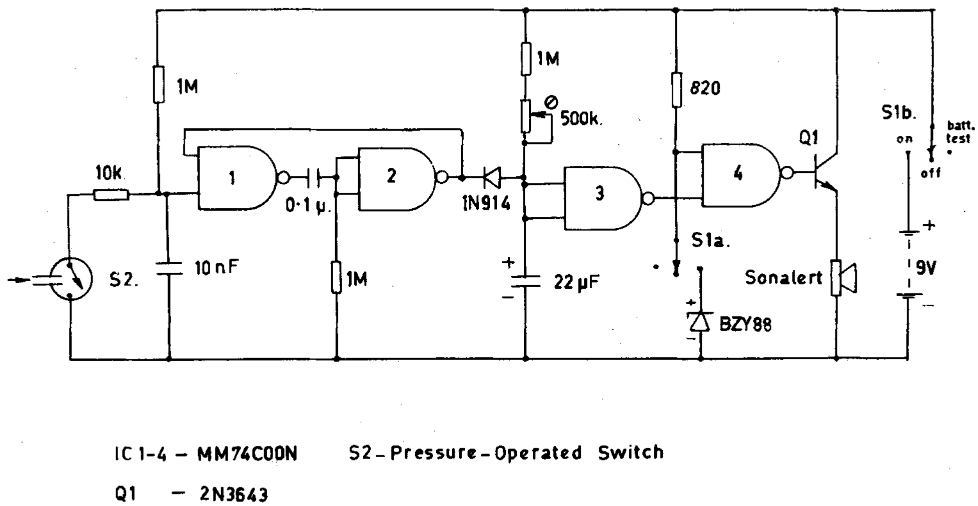

Fig. 2 *Circuit diagram*

The performance of the CMOS timing is relatively unaffected by changes in battery voltage, resulting in a time delay that varies only 4% over normal battery life.

A battery-powered alarm must include a facility for checking the battery voltage. Most ventilator alarms provide an audible alarm when the battery reaches the end of its life, but this was considered to be inappropriate for operating theatre use.

Because of the long battery life, a routine test when switching on the alarm provides ample warning of battery failure, provided that the 'end of life' indication level is conservatively chosen. When the main switch S_1 is pushed into the 'test' position, S_{1a} is turned on and the battery voltage is compared with the voltage from a Zener diode reference. The Sonalert sounds if the battery voltage is above 7 V. Since the alarm will operate for more than 10 h beyond this point, there is ample time for battery replacement.

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References

Cooper, J. B., Newbower, R. S., Long, C. D. and McPeek, B. (1978) Preventable anesthesia mishaps. *Anaesthesiology*, **49**, 399–406.

Fodor, I., Bloomfield, D., Fisher, A. and Kerr, J. H. (1977) A control-free ventilator alarm. *Anaesthesia*, **32**, 1026–1029.