We rechecked the breathing machine, and there was no apparent leak in the breathing circuit. The wall oxygen source was adequate, and its connection to the anesthesia machine was proper. The oxygen cylinder mounted on the anesthesia machine was full, but when turned on, no more than 200 ml/min of oxygen could be delivered. The oxygen supply failure alarm was not activated. The machine was removed from service until it was repaired. The oxygen flow control valve of the anesthesia machine was later disassembled and examined. The needle of the oxygen flow control valve stem was found to be broken (fig. 1) and was jammed inside the silver seat, obstructing the flow of oxygen to the oxygen flowmeter. Normally, when the oxygen flow control valve is turned on, the needle valve stem moves out of the silver seat allowing oxygen to flow to the flowmeter.

The Ohmeda Modulus I anesthesia machine incorporates Proportion Limiting Control System that links the flow control valves for oxygen and nitrous oxide together, so that in any oxygen–nitrous oxide mixture there will be at least a nominal 25% oxygen concentration.† To achieve this, the sprocket on the nitrous oxide flow control valve stem is connected to the sprocket of the oxygen flow control valve stem by a chain. Thus, when the nitrous oxide valve is turned on, the chain simultaneously rotates the oxygen flow control valve stem and turns the oxygen on. In our case, when we turned the nitrous oxide flow control valve on, the chain, as expected, rotated the oxygen valve stem for oxygen delivery. But, as the passage of the oxygen to the oxygen flowmeter was blocked, no more than 200 ml/min of oxygen was delivered. We were able to deliver 200 ml/min of oxygen because the oxygen flow control valve stem has, at its end, "a minimal stop" which keeps a small passage patent to deliver 200 ml/min of oxygen once the anesthesia machine is turned on, even when the oxygen flow control valve is in the off position. The needle flow control valve stem, whether it is intact or broken, cannot block that small passage, and thus allows the flow of 200 ml/min of oxygen.

It is important to note that routine machine check of reserve gas supply and integrity of breathing circuit failed to detect the oxygen flow control valve failure, since the oxygen surge bottom used to check the anesthesia circuit worked normally. As part of checking the anesthesia, the oxygen flow to the oxygen flowmeter should be checked each time before administering an anesthetic, as we used the same anesthesia machine the day before without problems in oxygen delivery.


REFERENCE
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In Reply:—The subject valve was analyzed by our research and development and quality control departments. Although Ohmeda was unable to determine the exact cause of the needle valve break, it was observed that excessive forces had, at some point in time, been exerted onto the needle stem.

The breakage apparently had occurred with the needle tip placed in its minimum flow configuration, thus allowing only the minimum flow of 200 ml/min, regardless of knob position. Under expected use condition, this needle valve is designed to operate throughout its range such that the needle’s stem is never exposed to excessive force.

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