kidneys from the 200 autopsies reviewed contained calcium oxalate crystals. Of these nine had undergone surgery, but none had been anesthetized with methoxyflurane. However, all twenty had clinical and anatomic evidence of renal disease, sixteen being uremic, a finding in agreement with the reports of other investigators.[4, 5, 6]

This study seems to exonerate methoxyflurane as a cause of renal pathology in healthy patients. A further investigation is in progress to determine if the same holds true in seriously ill patients with previously existing renal disease.

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Calibration of a New Vaporizer

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We have examined several commercially available temperature compensated vaporizers of a new design. The apparatus, intended to replace the glass vaporizer, is a portable unit for use on anesthesia machines not provided with an efficient built-in device for the vaporization of liquid anesthetics (fig. 1). Four models are available. The Halothane "Two" is scaled to indicate concentrations of 0 to 2 per cent and is intended for use in those locations and situations where concentrations in excess of this value are undesirable. The Halothane "Four," with a scale that is graduated from 0–4 per cent is intended for routine clinical use. When higher concentrations are necessary, the Halothane "Ten" may be employed, the scale being etched in gradations of 1 per cent extending from 0–10 per cent. A fourth model, designed to deliver ether vapor, is scaled in 1 per cent increments from 0–20 per cent.

These vaporizers differ from the well-known Fluotec apparatus in that the gas stream which is diverted through it is controlled by a simple lever mechanism rather than by a spindle rotating in a hollow cylinder (fig. 2). Mal-

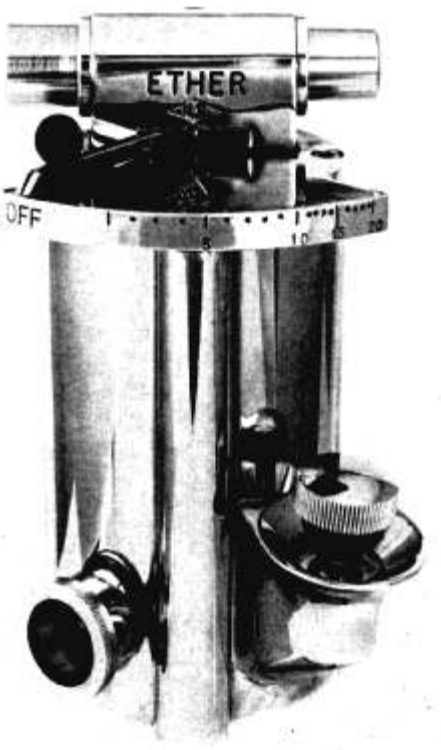

FIG. 1. External appearance of the vaporizer.

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function or "sticking," as a result of gum formation, with prolonged use was relatively common with the latter apparatus; it presumably does not occur in the former.

The vaporizers were calibrated by flowing oxygen, from a standard anesthesia machine through the vaporizer for a period of five minutes. Samples were then collected in gas tight, glass syringes and analyzed for anesthetic content by gas chromatography.[1] The entire range of dial settings were examined for each vaporizer as were flow rates of 1–10 liters per minute. Two or three samples were withdrawn in rapid succession at each flow rate and at each dial setting. The duplicate

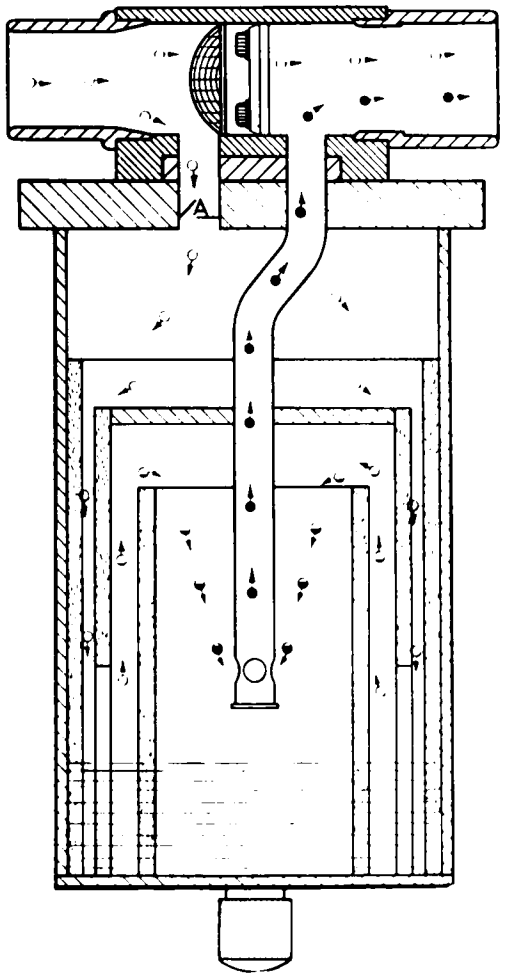

FIG. 2. Schematic of vaporizer showing path of gas and vapor. Thermocompensating device is located at A.

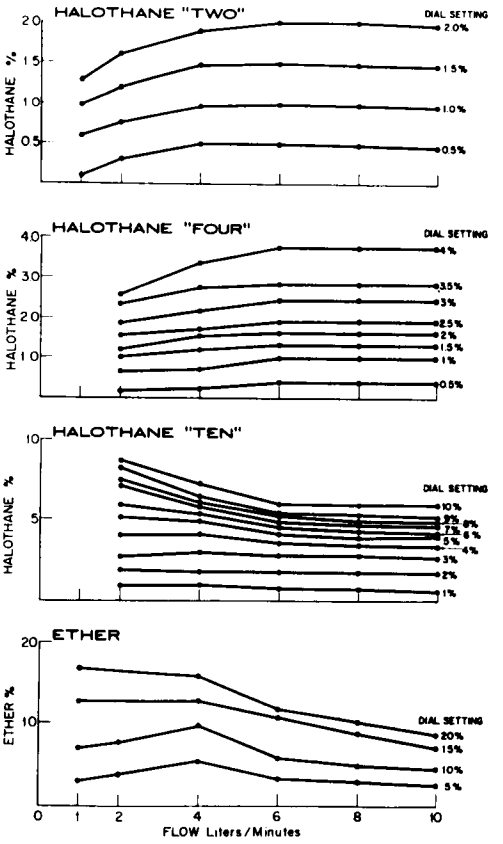

FIG. 3. Relationship of dial setting and flow rate to actual concentration.

samples checked within less than 0.05 per cent. Gas flow was discontinued for a 15 minute period whenever flow rate or dial setting was changed to allow for re-equilibration of the vaporizer.

The Halothane "Two" was found to be accurate at all settings from 0.5 to 2.0 per cent when the flow rate was 4–8 liters per minute. At flows in excess of this there was a detectable, but insignificant, fall in concentration (fig. 3). At flow rates below 4 liters/minute concentrations were much below the "dialed concentration." At a flow of 2 liters per minute actual concentration was about 50 per cent of that indicated on the scale. The Halothane "Four" was accurate at the 0.5 and 1.0 per cent dial settings when the flow through the vaporizer was 6–10 liters per minute. At lower flow rates lower concentrations were obtained. At higher dial settings the

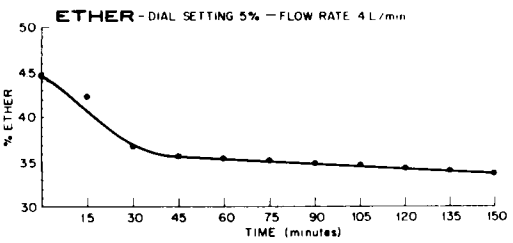

FIG. 4. Relative failure of the thermocompensating mechanism of an ether vaporizer during prolonged use.

actual concentration was always lower than the settings would indicate, regardless of the flow rate (fig. 3). The Halothane "Ten" was reasonably accurate when the dial was set at 1–7 per cent with flow rates of 2 liters per minute. Dial settings in excess of this resulted in low actual concentrations. The maximum obtainable concentration was 8.75 per cent when the dial was set at 10 per cent with a 2 liter flow rate. When flow rates were increased the actual concentration of halothane delivered decreased markedly. The concentration of ether was found to most closely approach the dial setting when the latter was set at 5 or 10 per cent and the flow of oxygen was 4 liters/minute. At lower flows the concentration was diminished, the same is true of flows in excess of 4 liters. The maximum obtainable concentration was 17 per cent when the dial was set at 20 per cent and one liter of gas flowed through the vaporizer (fig. 3). The relative failure of the thermocompensating device in the ether vaporizer is shown in figure 4. In the the halothane vaporizers, at flow rates of 2–6 liters and at low dial settings, the change in concentration of anesthetic flowing from the apparatus varies little with time over a three-hour period. At high flow rates and high dial settings, failure of the compensating device becomes evident in 30–60 minutes. The vaporizers are not valved; thus, concentration rises considerably, but momentarily, when positive pressure is applied to the system and is then released.

The one marked advantage of this group of vaporizers is that they tend to err on the low side. Thus, the concentration never exceeds that indicated on the scale.

(We have recently had several of these vaporizers calibrated for methoxyflurane. The range is from 0.25 to 1.5 per cent. These have been found to be extremely accurate at all flow rates and concentrations and are well thermal compensated.)

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Capacity of Suction Tubing

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Brief measurements using standard (No. 204 ¼-inch, inside diameter) amber suction tubing with a 14 F. catheter indicate that considerable amounts of blood are contained in the tubing before any blood appears in the suction bottle for measurement as loss. The amount varies, increasing as the height of the bottle from the floor or the length of tubing increases. Tubing of this size will hold 8 ml. per foot of length when filled completely. Under usual operating-room conditions it does not lay filled but rather irregularly contains blood which bubbles within its walls. Under these conditions it will contain about 1.1 ml. per foot if the highest point enroute to the bottle is four feet from the floor. Increasing the bottle elevation to six feet increases content to over 1.5 ml. per foot. The significance of this in blood replacement in premature or newborn infants is obvious. (A constant suction of 18 liters/minute was used in these measurements.)

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