eliminate the above sources of error, the recording plethysmograph shown schematically in Fig. 1 was built.

![Diagram](https://via.placeholder.com/150)

**Fig. 1**

The recumbent dog lies within a box (P) closed except for valves and tambour outlets, with head protruding through a seal. The seal consists of a spongy rubber mat with a hole just large enough to permit the head of the dog to go through. A circular hole is cut in a piece of dental rubber dam and this is placed around the dog’s neck to fit tightly. Adhesive tape seals the rubber dam to the dog’s neck and the rubber mat, which is then clamped by a brass frame tightly to the edge of a large hole in the plethysmograph. When carefully placed a dog experiences no discomfort and a trained animal will lie quietly for six hours in the apparatus. The lid of the apparatus is clamped on tightly, soft rubber tubing acting as a washer.

Each of the two box valves consists of a half ping-pong ball seated on mercury. The inlet valve admits room air to the plethysmograph during expiration. During inspiration this air is forced through the outlet valve into a large 150 liter sealed tank (T). From the tank (T) an outlet tube leads to a sensitive spirometer and a dry gas meter. The cylinder of the spirometer is of aluminum, displaces 20 ml per cm and is carefully counterweighted. The meter has electrical contacts which record every one fifth of a revolution representing about 750 ml between contacts. A manually operated valve (V) controls the measured amount of air drawn from (T).

In operation the dog draws air into (P) by expiration and forces the air into (T) during inspiration. Pressure builds up in (T) causing the cylinder of the spirometer to rise. Suction then withdraws air from (T) until the spirometer has returned to its original position. During rapid respirations of 300 per minute, to which the small spirometer can not respond, the large air volume in (T) has added to it by rapid pulsations relatively small quantities of air which build up the pressure. The large air volume acts as a pneumatic cushion to the air pulsations. It is important to have the tank (T) at a slight positive pressure, otherwise air would be drawn through the entire system without breathing. A kymograph record contains a 5 seconds time line, a tambour tracing of rate and a record of the volume of air passing through the plethysmograph, as indicated by the meter contacts.

The apparatus was tested by using a cylinder and piston arrangement (C). The free open end of this cylinder was placed through a hole in the mat (M). Closed containers approximately equal in volume to the dogs were placed in (P). The piston was then moved back and forth between stops (S) at rates simulating respiration. The volume of air drawn into and expelled from (P) could be computed from the stroke and area of the piston.

With this testing procedure the following methods of recording the ventilation rate were tested: (a) a large tambour over a large hole in (P); (b) the small spirometer directly connected to (P); (c) the inlet valve connected to the spirometer and the outlet valve discharging to the room air; (d) the inlet valve opening to the room and the outlet valve discharging air through a wet or dry gas meter; (e) the differential method as described above. As a result of these tests it was found that for respiratory rates exceeding 100 per minute method (e) was the only one giving satisfactory checks. The other methods (a)–(d) depended on some mechanical recorder stopping and starting with each respiration. For rapid respirations the starting inertia was too great to be overcome by the low driving pressures of the plethysmograph.

**BOOKS RECEIVED**

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**MORTON, AVERY A. Laboratory Technique in Organic Chemistry.** Pp. x+261. 122 figures. McGraw-Hill. $2.50.
