Br. J. Pharmac. Chemother. (1968), **32**, 164–167.

A PNEUMOGRAPH WHICH REGISTERS BOTH VOLUME AND RATE

BY

E. C. SAVINI

From the Department of Pharmacology, Ecole Nationale de Médecine et de Pharmacie, 14-Caen, France

(*Received September* 8, 1967)

Most of the methods used nowadays to record expired air are based on spirometry. They register the cumulative volume of air corresponding to several respiratory cycles, and the recorder is either reset intermittently (Lembeck & Winne, 1965) or continuously

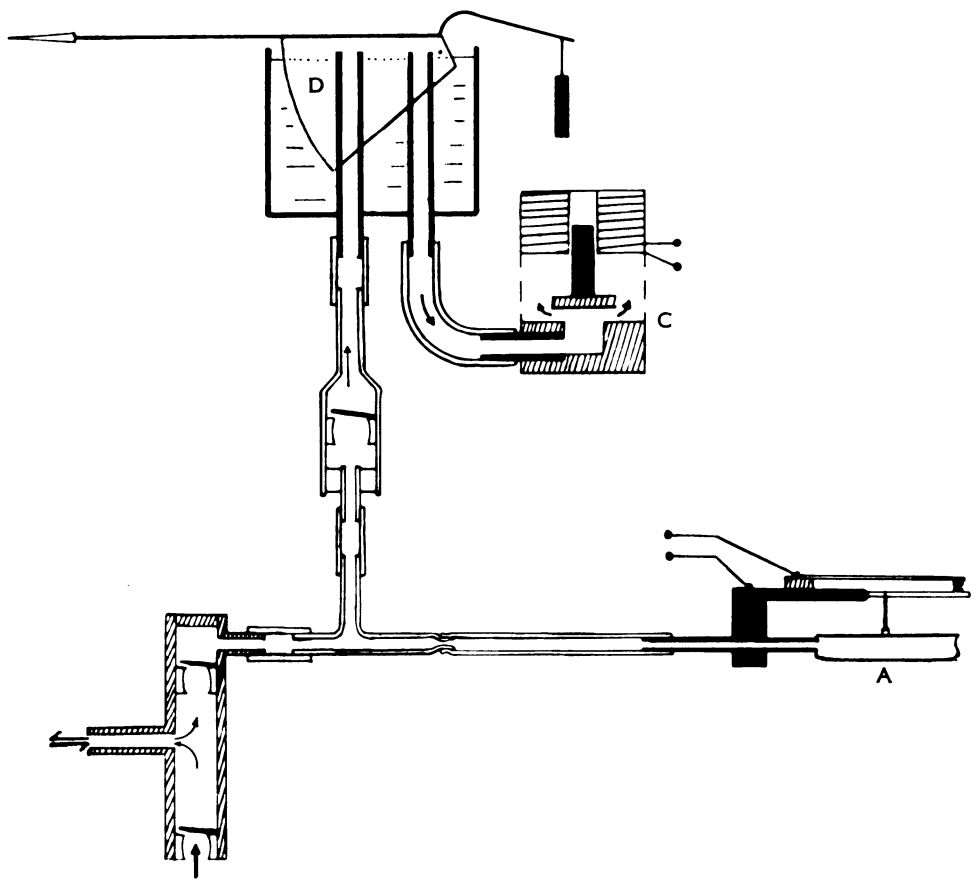

Fig. 1. The recording system. A, tambour ; B, electrical contacts ; C, electric air valve ; D, volume recorder.

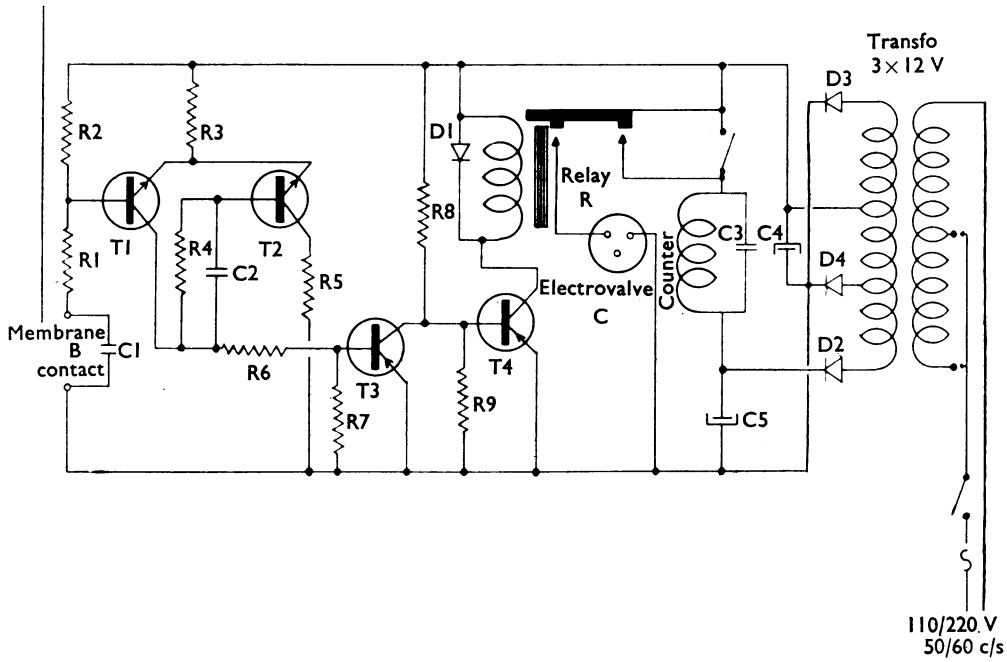

Fig. 2. The control circuit which operates the electric air valve. R1: 10 KΩ; R2: 100 KΩ; R3: 1.2 KΩ; R4: 100 KΩ; R5: 5.6 KΩ; R6: 3.3 KΩ; R7: 1 KΩ; R8: 150 Ω; R9: 100 Ω; C1: 10 nF; C2: 10 nF; C3: 0.22 μF; C4: 1,000 μF/30 V; C5: 1,000 μF/30 V; D1: 11 J2; D2: 11 J2; D3: BYX20 200; D4: BYX20 200; T1: SFT 714; T2: SFT 714; T3: AC 128; T4: 2N 555.

using a variable leak (Paton, 1949). With both types of recorder, there are two disadvantages: first, spirometers have a high inertia which prevents them from following the rapid respiratory movements seen in some laboratory animals; and second, rate is not measured and both respiratory volume and rhythm may be independently modified by drugs. The apparatus described here measures the frequency of respiration as well as the volume of each expiration.

METHODS

The animal breathes through a Perspex T-tube fitted with two respiratory valves (Gaddum, 1941). When the animal is anaesthetized, the trachea is cannulated but when it is unanaesthetized, a mask made airtight with Plasticine is fitted over the nose and mouth.

Each time the animal breathes out, the air enters the recording system (Fig. 1). The membrane of a sensitive tambour (A) (Boulitte, Paris) of 5 cm diameter is fitted with a pair of electrical contacts (B) arranged in such a way that a slight increase in pressure within the recording system closes the contacts. Thus, as soon as the expiratory phase of respiration starts, the contacts are closed and this, in turn, closes an electric air valve (C). All the expired air then passes into the volume recorder (D) (C. F. Palmer, Ltd.) and the volume expired is recorded on a kymograph. When the expiratory phase ends, the pressure in the system declines, the contacts open, the electric air-valve opens and the float of the volume recorder returns to baseline under its own weight. The cycle is repeated with each expiration. The electric air valve should be large enough to allow the air to escape rapidly and completely. The outlet is hollowed out in a Perspex cylinder and

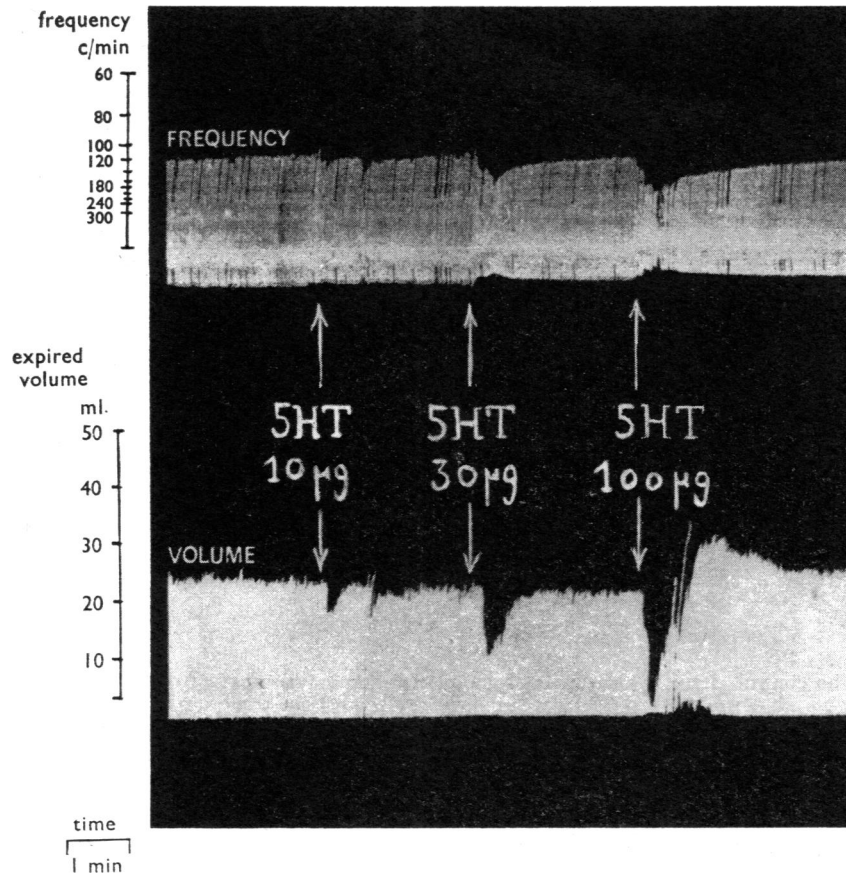

Fig. 3. Record obtained with the apparatus described coupled to a modification of Gaddum's drop timer.

widens into an opening 15 mm in diameter. This opening is kept closed by the weight of the solenoid case which is fitted with a Perspex flat cylinder 65 mm in diameter.

The control circuit which operates the electric air valve is shown in Fig. 2. It is composed of four transistors, two of them (T1 and T2) forming a Schmitt flip-flop and the other two (T3 and T4) acting as an amplifier to control a relay (R) on which there are a pair of contacts to control the electric air valve. A second pair of contacts on this relay can be used to activate an electromagnetic counter to give the total number of respiratory cycles, and to activate a convenient rate-meter, such as the Gaddum drop timer or the Thorpe impulse counter (C. F. Palmer, Ltd.).

A record obtained with this apparatus coupled to a modification of Gaddum's drop timer (Savini, 1963) is shown in Fig. 3. This was obtained from a conscious rabbit and shows the effects of 5-hydroxytryptamine 10, 30 and 100 μg/kg injected into the marginal ear vein.

SUMMARY

1. A pneumograph consisting of a float-recorder, an electric air valve and a transistor unit operated by the spontaneous respiration of the animal is described. A volumetric

registration of the expiratory air at each cycle is possible and in addition the respiratory frequency may be integrated by using an electronic or an electro-mechanical rate-meter.

REFERENCES

GADDUM, J. H. (1941). A method of recording the respiration. *J. Physiol., Lond.*, **99**, 257.
LEMBECK, F. & WINNE, D. (1965). *Pharmakologisches Praktikum*, p. 33. Stuttgart: Georg Thieme Verlag.
PATON, W. D. M. (1949). A respiration recorder. *J. Physiol., Lond.*, **108**, 1*P*.
SAVINI, E. C. (1963). A linear transistor rate-meter. Demonstration, Brit. Pharmac. Soc. Meet., Dublin.