A METHOD OF MEASURING PULMONARY EXCRETION

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In studying pulmonary excretory function and its regulation at the suggestion of N. P. Sinitsyn, we encountered many experimental difficulties. Existing methods of measurement of pulmonary respiration do not enable the amount of volatile substances excreted through the lungs to be measured. The commonest methods use the closed circuit system with constant circulation of air (Benedict [1], Knipping [2] and others). Compensation for air movements due to respiration is afforded in these systems by a spirometer which may contain many materials which absorb the volatile substances excreted by the lungs. This must certainly cause errors, particularly when it is realized that large quantities of air circulate through the absorbers.

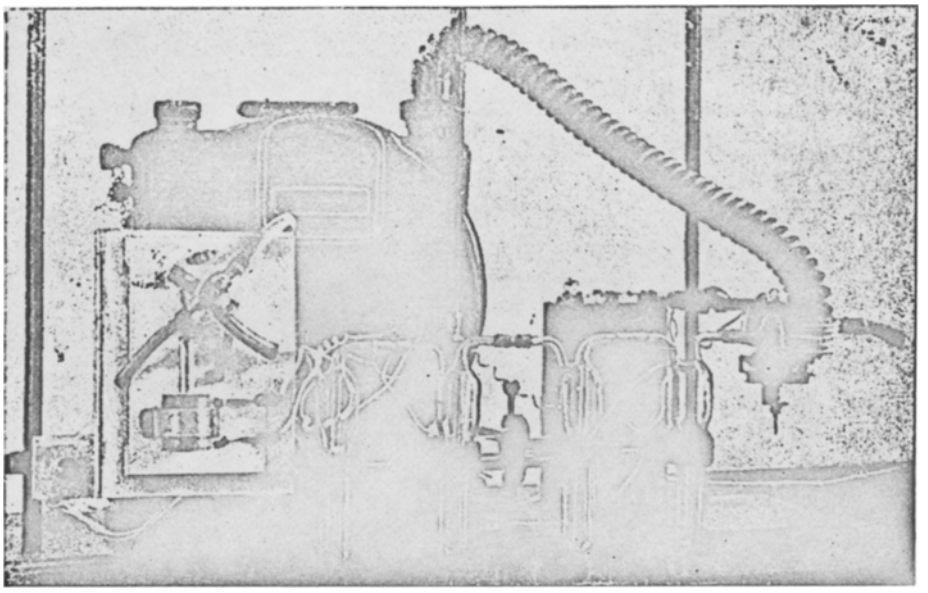

Fig. 1. General view of the apparatus for studying pulmonary excretion.

We have worked out a method of breathing directly through the absorbers [3], but in many cases it cannot be usefully applied for the investigation of pulmonary excretion of substances which are not readily absorbed. For complete absorption of these substances the amount of absorbent substance required becomes so great as to cause a considerable resistance to the movement of the expired air, so that the conditions become nonphysiological. We have therefore devised a new method for the investigation of pulmonary excretion, which is in large measure free from these shortcomings. The basis of the method is that of supplying auxiliary suction through the absorbers timed to coincide with expiration.

The whole setup, as shown in Fig. 1, consists of a gas flow meter to measure pulmonary ventilation, a box containing valves, a capsule which makes and breaks a contact, a three way solenoid operated tap, and a suction pump (not drawn).

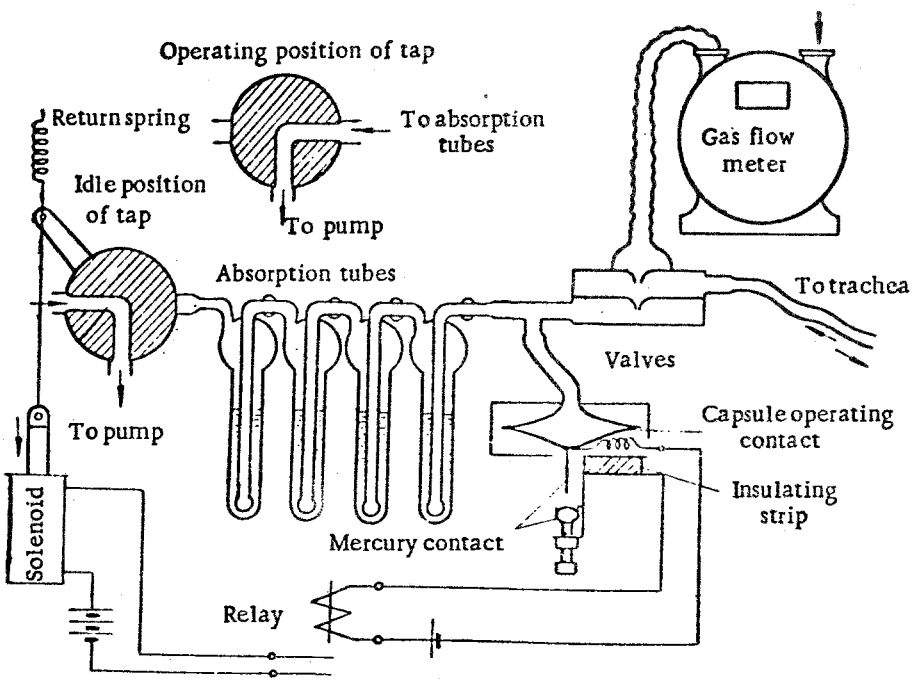

Fig. 2. Diagram illustrating method of investigating pulmonary excretion (description in text).

The operation of the system is as follows (Fig. 2). At expiration the pressure in the absorbing system rises; this causes the capsule to expand, to close the mercury contact so that the relay included in this circuit operates and energizes the solenoid. The armature of the solenoid is pulled into the coil and so operates the three way tap connected to the suction pump, placing it in the working position. The pump which is always working now begins to suck air out of the absorbers. As soon as the pressure in the system falls to atmospheric level, or as soon as inspiration starts, the contact on the capsule rises so breaking the mercury switch. As a result the relay and solenoid circuits are opened, and the return spring puts the three way tap back into the off position. The additional suction through the absorbers stops, and the pump sucks in air from outside.

An important detail which to a large extent determines the precision of the apparatus is the capsule, which must react to very small pressure changes within the system. It is best made out of two springy rubber disks of diameter about 5 cm stuck together round the edge. The hole is made in one of these disks for connection to the absorbing system, while a silver electrode for the mercury contact is secured to the other disk. The capsule together with the adjustable mercury contact are mounted in a metal case.

A telephone relay, whose windings are of thicker wire so that it can work from a potential of 3-4 volts is used to switch in the solenoid which takes a heavy current. The construction of the tap and the dimensions of the solenoid will be determined by what is available; it is important that the movement from the idle to the working position and back should be as rapid as possible. The type of suction pump will depend on the species and size of the experimental animal. For rabbits and small dogs a filter pump works well.

The results of the investigation of pulmonary excretory function are shown in Fig. 3.

It should be possible to use this method for studying pulmonary excretion in human objects.

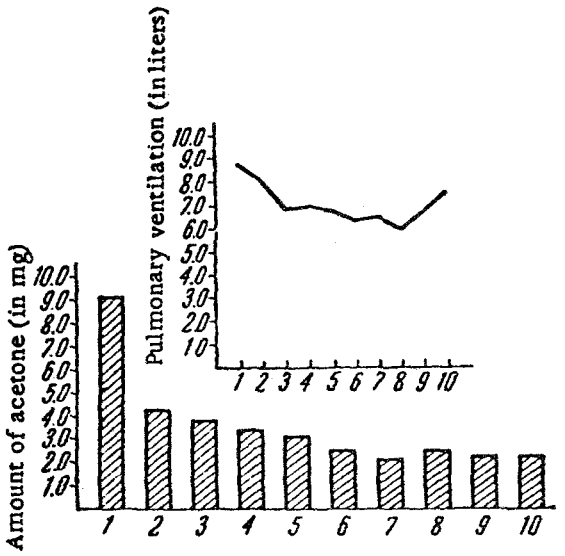

Fig. 3. Excretion of acetone through lungs in rabbit after intravenous injection of 0.5 ml per kg weight.

SUMMARY

A method of study of the excretory function of the lungs was elaborated, which allows registration of the amount of substances excreted by the lungs.

The principle of this method consists in certain of auxiliary draught air movement through an absorber which combines the volatile substances only at the moments of expiration.

A description of this installation is presented.

LITERATURE CITED

[1] Francis G. Benedict and W. E. Collins, The Boston Med. a Surg. J. 1920, Vol. 183, pp. 449-458.

[2] Knipping – cited in Sterling's Principles of Human Physiology, Philadelphia, 1936.

[3] E. G. Iziumov, Farmakol. i Toksikol 5, 23-27, (1955).