APPARATUS FOR STUDYING THE SURFACE PROPERTIES OF LUNG EXTRACTS

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An apparatus for studying the surface properties of lung extracts based on the Wilhelmy principle is described. It consists of a two-coordinate automatic recorder, compensatory amplifier, modified Wilhelmy's balance, rectifier, and stabilizer. By means of the apparatus the relationship between the surface tension of the extract and the area of its surface can be recorded automatically.

KEY WORDS: lungs; lung surfactant; Wilhelmy's balance.

Among the various physical methods available for studying the surface properties of the lung surfactant, the method of balancing with a thin vertical plate must evidently be regarded as the most promising.

Although this method has recently been closely studied [1, 4, 6-10], in the Soviet literature there are only a few papers containing a description of Wilhelmy' s balance, the design of which forms the basis of this method [2, 3, 5]. However, the constructions as described are not free from serious disadvantages. In particular, the hysteresis loop itself is either drawn by hand [2, 5] or photographed from the screen of an oscilloscope [3], makingthe analysis of the results much more difficult. Furthermore, in some descriptions some details important when the design is copied are omitted. It was accordingly decided to design an improved model for investigation of the lung surfactant (Fig. 1). The loops of adsorption hysteresis are recorded automatically, in this model by means of a two-coordinate automatic dc N359 recording milliammeter. The F359 compensatory amplifier makes it easy to obtain optimal parameters of the output current to the automatic recorder.

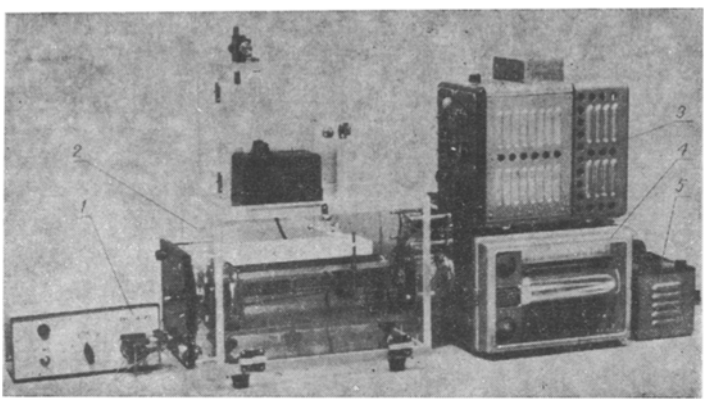

Fig. 1. General view of apparatus for studying surface properties of lung extracts by Wilhelmy's method: 1) VS 4-12 rectifier; 2) modified Wilhelmy's balance; 3) F359 amplifier; 4) N359 two-coordinate automatic recording milliammeter; 5) P359 voltage stabilizer.

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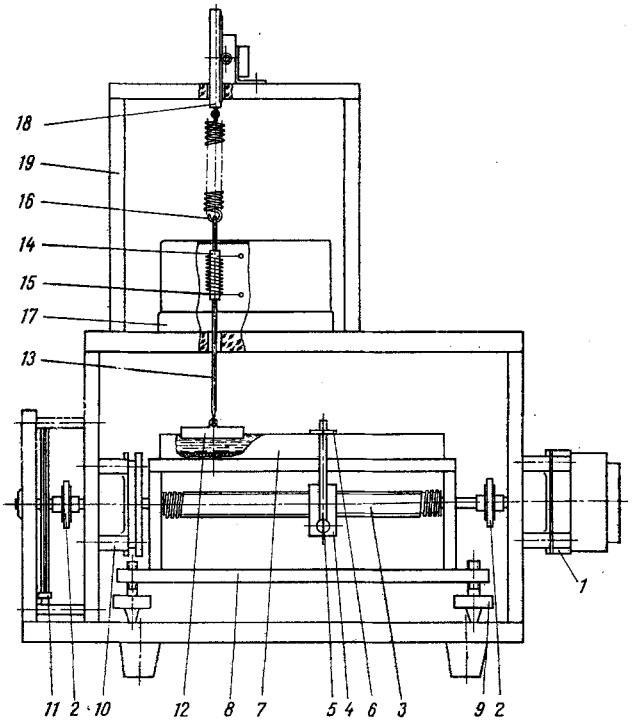

Fig. 2. Diagram of modified Wilhelmy's balance (explanation in text).

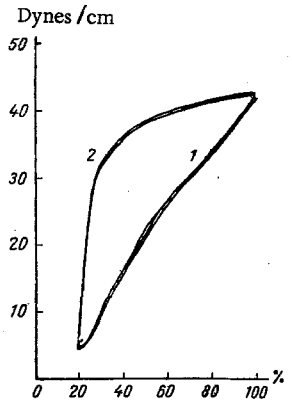

Fig. 3. Surface tension of lung extract during compression (1) and stretching (2) of its surface. Abscissa, area (in %); ordinate, surface tension (in dynes/cm).

The modified Wilhelmy's balance is shown diagramatically in Fig. 2. To protect the surface of the extract from dirt and to hold and protect the main parts of the instrument, a body (19) made from transparent plastic material 12 mm thick is provided and consists of two chambers. In the lower chamber a fluoroplast cell (7) with internal dimensions of 210 × 60 × 15 mm and with walls 10 mm thick, filled to the brim with the test fluid, is placed on a strong metal table (8) with three leveling screws (9).

To measure the surface tension a platinum disk (12) measuring 19 × 16 × 0.22 mm is suspended by a sensitive quartz coiled spring (16). A thin Pyrex glass rod (13) enclosed in a brass tube (14), together with an inductance pick-up (17), inside the solenoid of which the brass tube fits (15), are used to transform the force of stretching the disks by the liquid into an electrical signal that can be led through the F359 amplifier for display on the axis of the two-coordinate automatic writer. The pick-up consists of a generator with push–pull circuits based on P403 transistors and a measuring device including a solenoid (15). The platinum disks can be lowered smoothly to the surface of the extract by means of a vertical displacement mechanism (18).

A cyclic change in the area of the test surface is produced by moving the fluoroplast barrier (6). Push rods of the barrier (5) are connected to a nut (4) that moves along the thread (3) attached through the flexible coupling (2) to the shaft of a RD-09 reversing motor (1). The duration of one cycle is 6 min. On the other end of the threaded driving rod is secured a wire potentiometer (11) with ohmic resistance of 200 Ω, through a reducing gear (10) and coupling (2). Current is led to the potentiometer from the VS 4-12 rectifier. The change in voltage on the potentiometer during rotation of the threaded driving rod is proportional to change in area of surface of the extract recorded along the axis of the two-coordinate automatic recorder. Ultimately a curve of the change in surface tension during compression and stretching of the surface of the test fluid is drawn on its drum (Fig. 3).

The apparatus described above is simple in design, reliable in use, and can be widely employed for studying the activity of the lung surfactant.

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