

METHODS

ATTACHMENT TO ELECTROCARDIOGRAPH ALLOWING SIMULTANEOUS RECORDING OF E. C. G. AND RESPIRATORY MOVEMENTS*

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(Received July 26, 1957. Presented by Active Member of the Acad. Med. Sci. USSR V. V. Parin)

Given the appropriate apparatus, simultaneous recording of the electrocardiogram and respiration presents no serious difficulty. For this, however, either a string or a cathode ray oscillograph is necessary, and then both electrocardiogram and pneumogram can be recorded one above the other by various methods which have been described by Kh. B. Gurevich [1], D. N. Menitskii [2], L. I. Shvang and A. D. Fedorov [3] and others.

As far as we know, no device for simultaneous registration of both curves on the widely used EKP-4M electrocardiograph has been described.

Together with F. T. Shevchenko of the radio section of the Tuberculosis Institute we have developed a simple addition to the electrocardiograph which allows the respiration curve to be recorded together with the electrocardiogram on the same strip of paper. The device which is shown in Fig. 1 consists of three parts: 1) a Marey's capsule fitted with a taut fine rubber membrane and bolted to a stand which is integral to the case of the electrocardiograph; 2) a lever bearing a mirror so arranged that the axis of the lever is free to rotate between the pointed ends of two bolts; 3) the illumination system.

A short length of rubber tubing is joined to the tube leading from the capsule and is led out from the apparatus through a hole drilled in the front folding side of the electrocardiograph. This tube is connected via a three-way tap to the respiration pressure transmitter. The latter consists of a 20 cm length of corrugated rubber tubing 3.5 cm in diameter.

The whole air system may be either completely enclosed, or it may be connected to the atmosphere by a small glass tap. The latter must be open when the pressure transmitter is placed in position.

A light metal disk 5-6 mm in diameter is fixed to the membrane of the capsule and is joined to a length of fine wire. The latter connects the membrane with the arm of lever "b". A mirror "c" in a metal mount is fixed to the other arm of the lever. Close up against the mirror there is the lamp housing "d" in which is drilled a 0.1 mm diameter hole through which passes a narrow beam of light from the lamp, mounted in a focussing tube (the tube support can be seen in Fig. 2).

The lamp and mirror are disposed so that the reflected bundle of rays passes through a lens (Fig. 1, f) onto the light-sensitive strip. The spot focussed by the lens falls on a line dividing the upper and middle thirds of the strip, so that when the light spot from the galvanometer has been slightly decentered, and when tension is applied to the strip, the pneumogram and electrocardiogram are recorded one below the other.

The position of the light spot can be controlled together with the galvanometer spot, since part of the beam reflected from the inclined mirror (Fig. 1, c) of the electrocardiograph falls on the inspection window (Fig. 1, e).

* Read on the June 20, 1957 at a joint meeting of the staff of the laboratory of respiration and circulation of the Physiological Institute of the AN Ukrainian SSSR and the pathophysiological Laboratory of the Ukrainian Tuberculosis Institute.

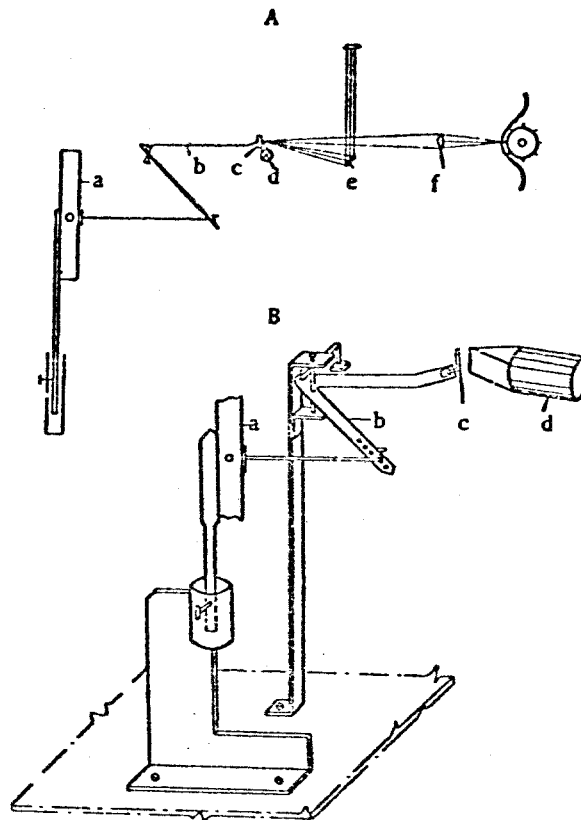


Fig. 1. (A) diagrammatic (B) perspective drawings of the attachment of the EKP-4M electrocardiograph. Description in text.

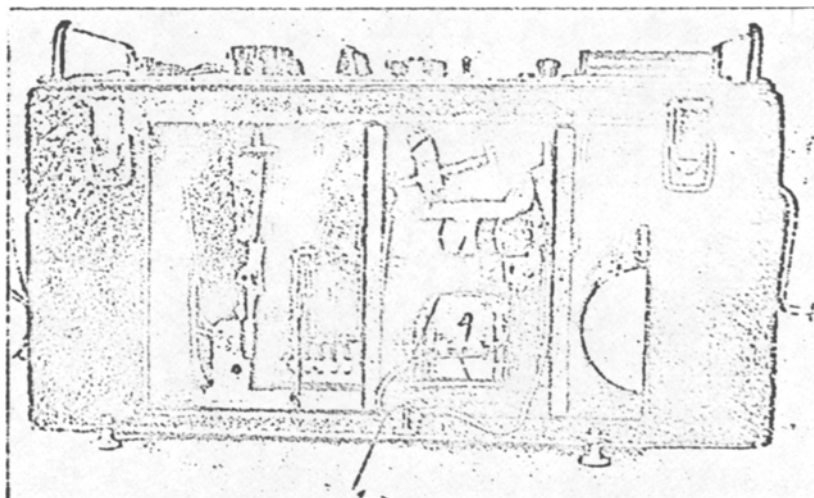


Fig. 2. General view of the electrocardiograph with attachment.

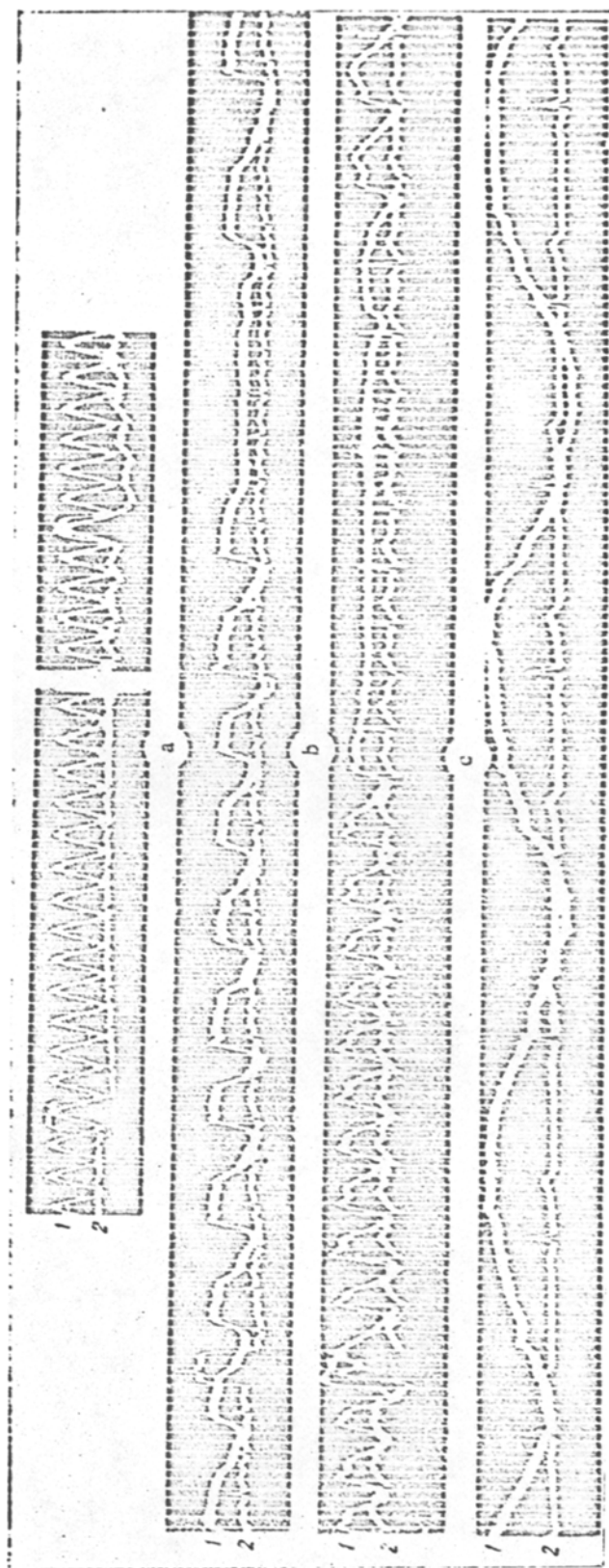


Fig. 3. Examples of simultaneous recordings of pneumogram and electrocardiogram.
a) Pneumogram and electrocardiogram of a rabbit (leads I and II); b and c) the effect of intravenous injection of cititone (0.5 ml diluted 1:5) on the respiration and heart rate of rabbits (thoracic ECG lead); millivolt mark — time of injecting solution into peripheral ear vein; d) electrocardiogram (ECG lead II) and human pneumogram; 1) pneumogram (movement of curve downwards represents inspiration); 2) electrocardiogram.

Vacant space in the electrocardiograph is used for mounting the parts of the apparatus just described. The capsule and the lever bearing the mirror are placed in the galvanometer section; the illumination system is placed by that belonging to the E. C. G. (Fig. 2). The lamp for recording the pneumogram is fed from the E. C. G. batteries. Provision is made for switching the lamp on or off. The switch is brought to the outside and fixed on the front wall.

The pneumogram is recorded as follows. After the pressure transmitter has been attached to the chest or abdominal wall of the animal, the tap connecting the system with the atmosphere is closed. After this, pressure changes caused by respiratory movements are transmitted to the rubber membrane of the capsule, and from there through the lever to the mirror. When the light is switched on, oscillations of the mirror cause a corresponding displacement of the light spot on the recording strip. The amplitude of the mirror oscillations, and consequently the amplitude of the film trace of the respiratory movements can be controlled by choosing an appropriate thickness of the capsule membrane, and by placing the screw (Fig. 1, B) in the appropriate hole in the arm of the lever "b". Also it must be noted that various pneumatic pressure transmitters can be used depending on the particular requirements.

To record changes in response to stimuli which may cause considerable changes in the amplitude of the respiratory movements, an additional air-filled reservoir communicating with the transmitter and capsule should be fitted. The connection between these vessels allows control over the effective volume of air.

Figure 3 shows examples of simultaneous recordings of pneumogram and electrocardiogram.

If the speed of the recording strip is made sufficiently high, the 0.05 second interval marker in the apparatus allows accurate measurements of respiration frequency as well as the duration of the separate phases to be made even when the respiration rate is several hundred per minute (Fig. 3,a).

The millivolt knob on the electrocardiogram may be used to indicate the time at which the stimulus is applied so that changes in heart rate and respiration in response to various agents can be investigated. Curves b and c show the electrocardiogram and pneumogram before and after injecting 1:5 cititone* into the veins of the ear. The greatest change occurs in the respiration, and after a few seconds an apnea of varied duration takes place. Changes in heart rate are less marked, though the curves show a slowed rhythm.

We have used this device to investigate circulation time in rabbits (by measuring the time of onset of respiratory changes following injections of cititone).

The pneumogram and electrocardiogram can be recorded together not only in animal experiments, but in investigations of human subjects (Fig. 3,d).

Simultaneous recording of the two curves may find application in clinical practice in examining patients with cardiovascular and respiratory disturbances. Recording the respiration either by itself or together with the electrocardiogram extends the scope of the diagnosis, while the method is simple and demands no more time than does the normal electrocardiograph.

There is also the possibility that this method may be used to investigate other phenomena where the pneumatic recording technique is applicable.

SUMMARY

A simple device attached to the electrocardiograph EKP-4M which allows registration of the curve of respiratory movements simultaneously with electrocardiography is described.

LITERATURE CITED

- [1] Kh. B. Gurevich, *Fiziol. Zhur. SSSR*, 34, 3, 339-348 (1948).
- [2] D. N. Menitskii, *Fiziol. Zhur. SSSR*, 40, 1, 94-96 (1954).
- [3] L. I. Shvang and A. D. Fedorov, *Fiziol. Zhur. SSR* 40, 1, 90-94 (1954).

* As in original.