A PNEUMOELECTRIC CONVERTER FOR PHYSIOLOGICAL RESEARCH

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We propose a simple, inexpensive pneumoelectric converter, within the means of any laboratory, which provides for recording with magnetoelectric and electromagnetic loops, or for projection onto the screen of a cathode oscillograph a number of physiological functions (respiration, the pulsation of peripheral vessels, the plethysmogram and so on) in the form of curves of the usual shape. In order to obtain photographic records of

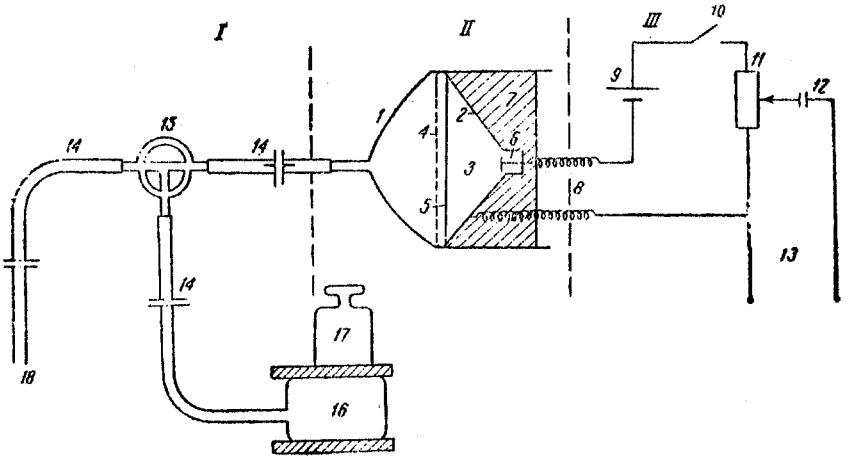

Fig. 1. General scheme of a simple pneumoelectric converter. I) Pneumatic transmission system with supplementary reservoir; II) pneumoelectric converter; III) scheme of feeding the converter and connecting the recording apparatus. 1) glass funnel; 2) body of microphone; 3) microphone chamber, filled withpowdered carbon; 4) perforated metal lid, protecting the diaphragm; 5) metal operating sensitive diaphragm; 6) fixed electrode of microphone with screw; 7) airtight packing; 8) lead from source of current; 9) source of current for microphone; 10) switch; 11) potentiometer (1.5 kohm); 12) condenser (3 μf); 13) lead to recording apparatus (amplifier and loop oscillograph or cathode oscillograph, or electrocardiograph, etc.); 14) rubber connecting tube; 15) 3-way cock; 16) supplementary reservoir beneath a weight; 17) weight, ensuring constant excess pressure in transmission system; 18) point of connection of pneumatic or hydraulic pick-up, sensitive to mechanical changes.

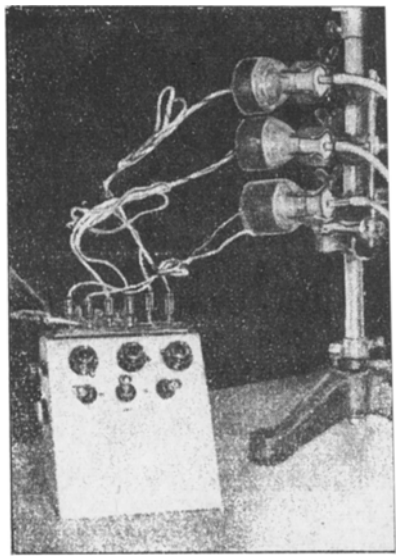

Fig. 2. Assembly containing three simple pneumoelectric converters. On the right – universal stand to which three converters are securely fixed. On the left – box in which is mounted a control panel and source of current for the three converters; on the top of the box are terminals for connection to the converters and the recording apparatus; the front of the box houses the knobs for the three potentiometers and three switches.

these phenomena with loop oscillographs, it is necessary to have a very simple amplifier, providing an amplification of not less than 500 of the signal received from the converter. In order to project the curves onto the screen of the tube of a cathode oscillograph, or to record them on an electrocardiograph, no additional amplification of the signal supplied by the converter is required.

The main operating part of the converter is a commercial model MK-10 carbon button microphone. The microphone is placed in a glass funnel with the diaphragm facing the narrow neck of the funnel (Fig. 1).

The wide part of the funnel is hermetically sealed with paraffin wax, Mendeleev's putty or other insulating material. Two leads pass through the sealing material, one of which is connected to the body of the microphone and the other to the screw of the fixed electrode. The lead to the microphone supplies current from any form of constant current source. We use a low tension battery 1.58–SNMTs-2.5 with an EMF of 1.65v.

The principle of the converter is illustrated in Fig. 1. The potentiometer (1.5 kohm) regulates the variations in current taken from the contacts of the converter, and thus serves to control the sensitivity of the system. The condenser (3 μf) protects the recording device from direct current. The parameters of the components listed above – the potentiometer, the source of current and the condenser – may be varied. The choice of parameters is determined by the sensitivity of the loops in use, the coefficient of amplification of the amplifier, and the character of the phenomena investigated.

The scheme illustrated in Fig. 1 ensures the constant high quality of work of the converter. Because of the special constructional features of the button microphone, the converter possesses high sensitivity and permits the recording of mechanical signals of a strength equivalent to fractions of a microwatt, but at the same time it is suitable for the recording of signals of considerable strength. The frequency band transformed by the converter is very broad and extends from tenths of a cps to the upper limit of audible frequencies. The hermetic transmission system reliably protects the converter from incidental noise. In order to ensure constant conditions of recording and comparable curves from different experiments, it is essential to maintain a constant excess pressure in the sensitive pick-up device and in the pneumatic transmission system, and this is done by the introduction of a 3-way cock and a supplementary reservoir, on which is a weight, into the system (see Fig. 1). The position shown in Fig. 1 is that of equilibrium of pressure. At the time of recording, the supplementary reservoir is disconnected by turning the cock. The magnitude of the excess pressure is determined by the object to be investigated. When recording the carotid pulse and respiration in rabbits, we created an excess pressure in the system of between 50 and 100 mm of water. A very important condition for the stable working of the converter is the airtightness of the whole pick-up and transmission system. It is imperative that the funnel with the microphone should be securely fixed to some form of stand and protected from extraneous vibration, which can be done satisfactorily by resting the feet of the stand on a sheet of sponge rubber. When the converter is being assembled, the disk of the microphone must be in a vertical position, as shown in Fig. 2.

The converter is comparatively insensitive to electrical interference and may be used without screening, even in places where there is a high level of interference. Any pneumatic or pneumohydraulic pick-up of the Marey capsule, rubber cuff, plethysmograph, oncometer or other suitable type may be connected to the pneumatic transmission system. When a pneumatic pick-up is used with a transmission system 80 cm in length the inertia of the converter does not exceed 1 millisec, i.e., for practical purposes the converter can be regarded as having no inertia.

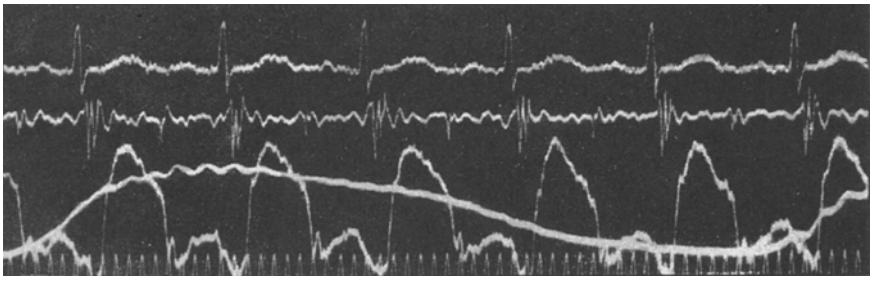

Fig. 3. Specimen of a simultaneous recording of the functions of different organs of a rabbit, using the MPO-2 loop oscillograph and the UIPP-2 amplifier.

Significance of the curves (from above down): electrocardiogram – fourth chest lead CR_4, phonocardiogram, pulsation of the right common carotid artery (recording from the vessel through a fold of skin by means of a simple pneumoelectric converter), respiration (recording by means of a pneumatic cuff and a simple converter), time marker (0.02 second).

In Fig. 3 is given a specimen tracing of the respiration and the pulse in the carotid artery of a rabbit, recorded by means of the pneumoelectric converter.

SUMMARY

The main part of the simple pneumo-electric converter is the carbon button microphone "MK-10", connected according to a special scheme. The converter enables signals received from pneumatic and hydraulic pick-ups, which are employed in physiological investigations, to be recorded on a loop oscillograph.