A MULTICHANNEL WATER-MERCURY MANOMETER*

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Despite the wide use of electromanometers, mercury and water manometers nevertheless continue to find applications in the laboratory. However, it is difficult to make them sufficiently convenient in use, and it is not easy to design reliable devices for the simultaneous recording of several processes.

These difficulties have been overcome in an instrument which we have used for several years.

The manometric multichannel system is mounted on a vertical rod. On it are fixed three transverse members; two of them carry openings for the glass tubes of the water and mercury manometers (Figs. 1 and 2).

The diameter of the hole for the mercury manometers is 8 mm, and for the water manometers 12-14 mm. The uppermost transverse member bears apertures 1 mm in diameter to position the glass rods of the manometers, which are a close fit in the transverse members where they are held in place by soft metal screws, and no kind of packing is required.

A better method of securing the glass tubes in the apertures is to use clamps. Then, when they are tightened, the tubes are not displaced, as they may be when a screw at one side is used. Each limb of the mercury manometer is mounted separately, and then connected with a stiff rubber or polyethylene tube.

Usually single-channel water manometers are used, but to record gaseous pressure, or when air transmission is used, they also may be made in two-channel form (V-shaped).

Floats for the mercury manometers are made from plastic, and those for the water manometers from foamed plastic.

For the vertical limbs of the manometers we used thin-walled capillary tubing of about 1 mm diameter. Such a tube slips readily through the holes in the metal. The movement of the capillary is controlled at three points: its attachment to the float, the aperture in the metal cap at the output of the manometer, and the opening in the uppermost cross member.

When the whole of the kymograph paper width is used for recording, for each channel the length of the capillary tube must be greater than twice the paper width, and the distance between the upper and middle transverse members must be equal to the paper width. When the float is in the lowermost position, the capillary tubes must not move out of the openings in the uppermost transverse member.

To the capillary tubes are attached pointers made of movie film (see Fig. 2). The position of the pointers which write on the kymograph, and the pressure they exert on the paper, is controlled by a series of parallel threads which are held in tension by removable bars which are attached to the middle and upper cross pieces. Tension is applied to the threads by a portion of rubber connected between the end of each thread and its attachment. The pressure of the pointers on the paper is easily regulated by moving the threads along the bars.

The pointers are arranged so that their tips come to lie in a vertical line, while each pointer lies in a different horizontal direction (see Figs. 1 and 2). In this way, there is no interference between the vertical movements of the different pointer. In order for the pointers not to catch in each other when they are strictly aligned vertically so as to produce accurate synchronization of the record, it is important that all the ends of the pointers should be

* The metallic parts of the manometer were made in the workshop by V. M. Vlasyuk.

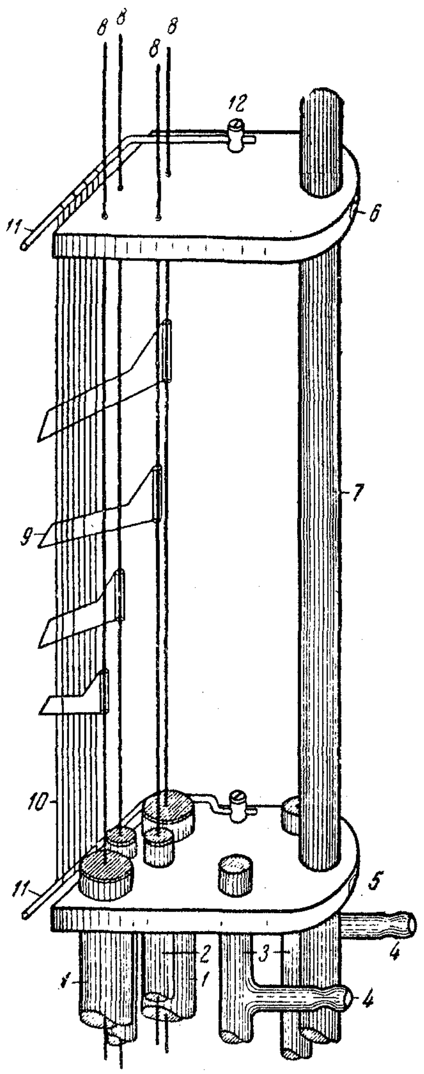

Fig. 1. Diagram of the recording portion of a four-channel water-mercury manometer. 1) Water channels of the manometer; 2) mercury channels; 3) second limb of mercury manometer; 4) connection to cannula or catheter; 5) middle transverse member; 6) uppermost transverse members; 7) vertical bar; 8) capillary tubing; 9) recording arms; 10) threads controlling position of recording arms; 11) rod to maintain tension in threads; 12) support for removable bar.

cut in one direction at an angle not less than 45°.

The pointers should be made as short as possible, and the manometer must therefore be brought as close as possible to the drum.

Some kymographs are of inconvenient shape, and it is then impossible to bring the manometer directly up against the drum. In such cases the drum diameter must be increased.

When the multichannel manometer is correctly mounted and adjusted, many advantages are obtained from its convenience in operation. The whole manometer may be removed or replaced in position by a clamp holding the vertical rod. It is convenient to be able to replace it in its previous position relative to the kymograph, and there will then be no necessity for further alignment of the points of the different channels. The pointers, being held in position between parallel threads, will then not need to be adjusted.

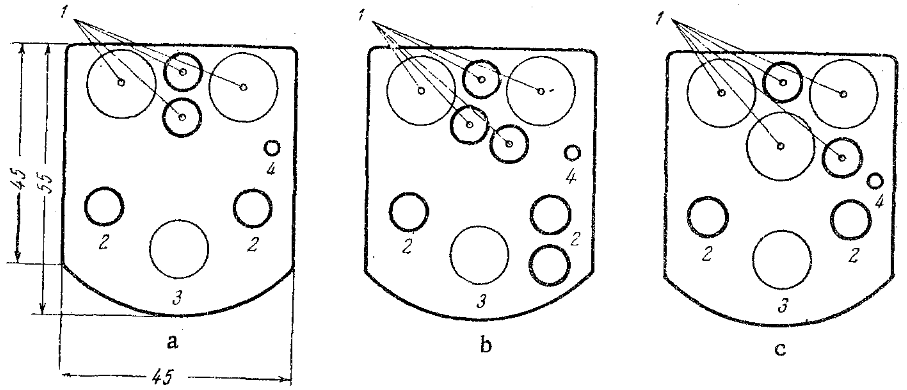

Fig. 2. Diagram of cross members: a) with two water and two mercury channels; b) with two water and three mercury channels; and c) with three water and two mercury channels. 1) Arrangement of the recording arms; 2) opening for the second limb of the mercury channel; 3) opening for the vertical bar; 4) hole into which removable bar fits.

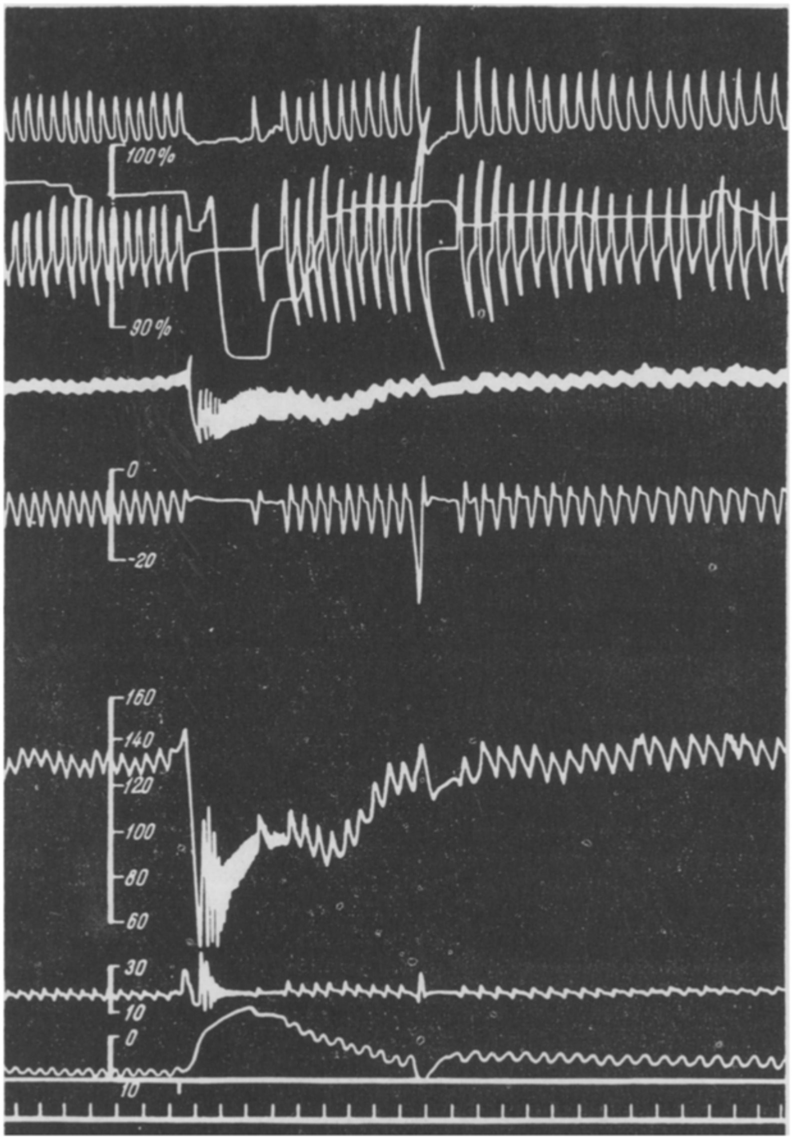

Fig. 3. Kymogram of an experiment on a dog (morphine and oxygen anesthesia). Curves, from top down: respiratory movement of the thorax; blood oxygen saturation in carotid artery; tracheal pressure; pressure in the femoral artery (membrane manometer); intrapleural pressure (in mm water); pressure in the femoral artery (in mm mercury); pressure in the pulmonary artery (in mm mercury, catheter in right external jugular vein); mean central venous pressure (in mm water, catheter in femoral vein); stimulus marker; time marker (5 sec).

The manometer makes it possible to record synchronously and reliably many pressure variations in the circulation, and no account need be taken of calibrating the apparatus at different times, nor of eliminating electrical artifacts.

Many other recording systems may be used simultaneously with the manometer, such as membrane manometers, electromanometers, capsules for recording respiration, or the removable indicator of an oxyhemograph, etc.

An example of a recording is given in Fig. 3.

High frequency electromanometers give a more detailed trace only in the case of the pulse pressure. Naturally, under conditions where a knowledge of the details of the pulse pressure curve is required, an instrument of low inertia and good linearity is required.

SUMMARY

A description is given of a four- and five-channel water-mercury manometer for use in physiology. Glass tubes, styrofoam floats, glass capillaries and other parts are mounted on three metal brackets supported from a vertical rod. Pointers attached to the capillary tubes are guided between stretched parallel threads. The construction ensures accurate alignment to record synchronously the pressures in different parts of the vascular system. The whole width of the kymograph band may be used for each pressure curve. It is usually not necessary to regulate the synchronization of the different channels after changing the kymograph band.