A SIMPLE MODEL TENSOMETRIC ELECTROMANOMETER FOR RECORDING INTRAVASCULAR PRESSURE

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The use of wire strain gauges for recording blood pressure was first proposed 15 years ago [10, 14, 15]. Since then a large number of modifications and improvements have been developed for recording of arterial pressure [6-9, 11, 13, 16, 17], intercranial pressure [1, 6] and pressure within the eye [11]; other models have been developed for recording the plethysmogram [1], heart rate [2, 4, 12], and the dynamocardiogram [3].

The relatively low sensitivity of wire strain gauges having very small displacements requires the use of either a highly sensitive recording device [9, 14, 16], or high-frequency d. c. amplifiers [8, 13, 17].

We have developed an electromanometer to be used in conjunction with Russian apparatus already available.

The principal component of the electromanometer is a pressure strain gauge (Figs. 1 and 2). It consists of a metallic cylinder (see Fig. 2) within which is a conical cavity. Above the cavity of the capsule is fixed a corrugated membrane of fine phosphorbronze (6) which is hermetically pressed onto the flange by screw (7). Two leads serve to connect the capsule by means of a hard polyethylene tube to the cavity of the vessel (3) and to the calibrating mercury manometer or to a vessel in which the catheter may be washed in heparinized physiological saline (4). Above the capsule is fixed a metal plug of non-cylindrical shape (13) to which are fixed constantan strain gauges (11) having a base of 20 mm and a resistance of 160-200 ohm. The strain gauges are fixed by adhesive BF-2 to the steel plate (17) having a thickness of 0.08-0.1 mm, a width of 10 mm, and a length of 40 mm (we used the blank for a razor blade).

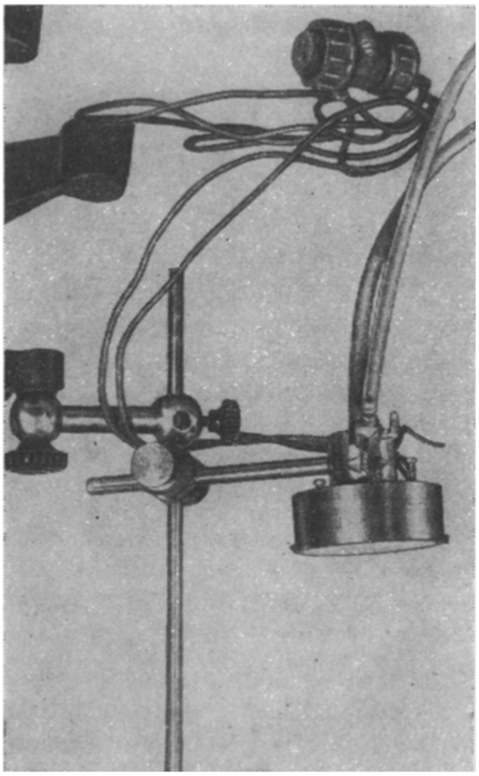

Fig. 1. General view of the pressure strain gauge.

On both sides of the plate are fixed two strain gauges connected by a bridge circuit. To the middle of the plate is soldered a plunger (8), whose free end is in contact with the center of the membrane of the capsule. The ends of the steel plate are fixed to a metal ring (9); two regulating screws (10) control the force exerted by the plunger on the membrane.

The ends of the power-supply and measuring leads from the bridge are brought out by screened cable through opening (16) in the plug. To the capsule of the cylinder is fixed a rod holder (15).

We have used a TU-4M or TU-6M* strain-gauge amplifier (amplification factor approximately 50,000); it contains a 5 kcs, 6 W generator. Before use the bridge is first balanced by means of balancing devices mounted in the amplifier (coarse and fine adjustments).

For the measurement of venous and arterial pressures membranes of thickness 0.05 mm and 0.1 mm respectively are used. The linear-

* The 4- and 6-channel amplifiers TU-4M and TU-6M, and also wire strain gauges used by us for the pressure strain gauge were made in the factory "Yunyi tekhnik" (Moscow, Khimki).

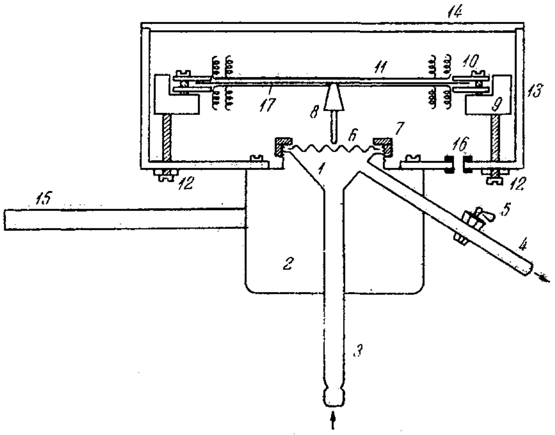

Fig. 2. Diagram of the pressure strain gauge.

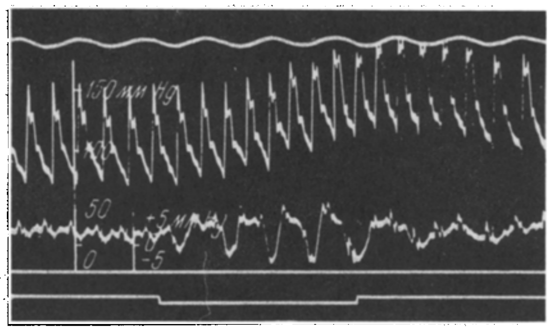

Fig. 3. Curve of intravascular pressure recorded by means of the strain gauge electromanometer. Electrical stimulation of the end of the tibial nerve (8 V, 50 cycles). Curves (top to bottom); time marker (1 sec), pressure in femoral artery, pressure in right auricle, zero line of electromanometer, electrical stimulus marker.

ity over the required range is regulated by a change in the tension in the steel plate by means of screws (see Fig. 2, 12).

Processes to be investigated are recorded on a string oscillograph. The sensitivity was set so that a deviation of 1 mm corresponded to a change of arterial pressure of 2.5 mm mercury or of a change of venous pressure of 6.4 mm of water.

An example of a trace is shown in Fig. 3. The calibration shows that the pressure curve is linear between 0 and 300 mm mercury, and between 4 and 10 mm water. A calibration repeated after $1\frac{1}{2}$-2 h shows that the drift did not exceed 1-2 mm mercury.

The resonance frequency of oscillation of the mobile portions of the strain gauge in air was higher than 75 cycles. The rigidity of the system when filled with fluid was entirely satisfactory, and the damping coefficient was greater than 1:7. The absence from our generator of hydraulic oscillations made it impossible to study the frequency-amplitude characteristic of the transducer.

The construction we have described for an electromanometer was tested in the laboratory for 2 h and gave excellent results.

SUMMARY

A strain gauge which we designed was adapted to record arterial and venous pressure.

A natural vibration frequency of the moving parts of the transmitter in air was greater than 75 per sec. The damping factor of the liquid-filled system exceeded 1:7.

The following facts indicate the sensitivity of the instrument: when a type MOB-5 loop was employed the deflection of the light spot on the loop oscillograph tape was 2.5 mm per mm Hg (arterial pressure gauge) and 6.4 mm of water (venous pressure gauge).

In addition provision was made for altering the sensitivity by changing the diaphragm in the gauge capsule.

A readily procurable Soviet strain gauge amplifier type TU-4M or TU-6M, which incorporated a carrier frequency generator, was employed to amplify the signal received from the output of the strain-gauge bridge.

The zero drift did not exceed 1-2 mm mercury during a period of 1 h.

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