A PUMP-FLOWMETER FOR RECORDING THE VOLUME VELOCITY OF THE CIRCULATION

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The pump-flowmeter constructed in the manner suggested below enables the volume velocity of the venous return blood flow to be measured, and at the same time, it pumps the outflowing venous blood back into the animal's blood stream. This pump has no aspirating action and merely removes the blood which enters it.

The scheme of the apparatus described is shown in Fig. 1. It consists of the following parts: two working heads A and B, working in turn; three external electromagnetic valves C, D, and E; a measuring cylinder F; a water bath G, and a feed for the pump H, consisting of a Mariotte's jar.

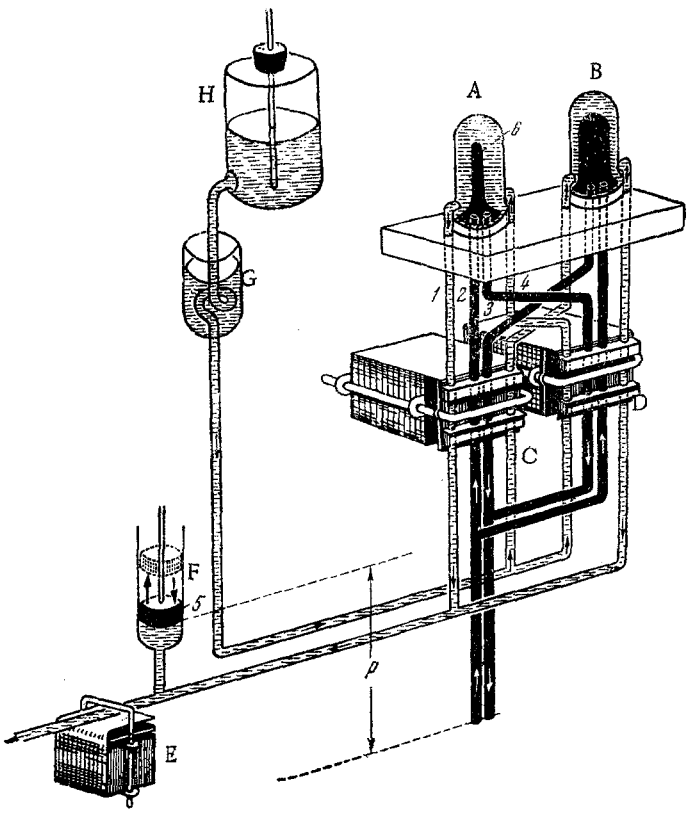

Fig. 1. The pump-flowmeter. Explanation in text.

We begin the description of the full cycle of operation of the pump at the head A. When the valve C is open, valve D is closed; under these circumstances blood from the peripheral segment of the vein passes along the tube 2 into a thin-walled rubber bag 6, situated inside the working head A. The inside of the chamber of the working head is filled with water. Blood entering the rubber bag 6 displaces an equivalent volume of water from the working head A into the measuring cylinder F through the tube 1. Immediately after closure of the valve C, the valve D opens, and water from the vessel H passes under pressure along the tube 4 into the interior of the working head A, displacing the blood contained in the rubber bag 6 through the tube 3 into the central segment of the vein. After closure of the valve D, valve C again opens, and the cycle is repeated. Impulses to the electromagnetic valve pass from a distributor mounted on a Warren motor (2 rpm).

The working head B acts in sequence with the head A. When the valve D is open and valve C closed, blood passes into the head B, and when valve C is open and valve D closed, blood is expelled from the head B. Thus ,when blood enters one head, it leaves the other, and vice versa. By this means it is possible to obtain a continuous, pulsating flow of blood through the apparatus. Water passes into the measuring cylinder in a volume precisely equal to the volume of blood passing through the pump in unit time. Water displaced from the working heads when the valve E is closed fills the measuring cylinder and lifts the float 5, the movement of which is recorded by means of a light lever on the drum of a kymograph. The valve E is closed periodically for a definite period of time. Under these conditions the height of elevation of the float is determined by the volume of blood passing in unit time through the

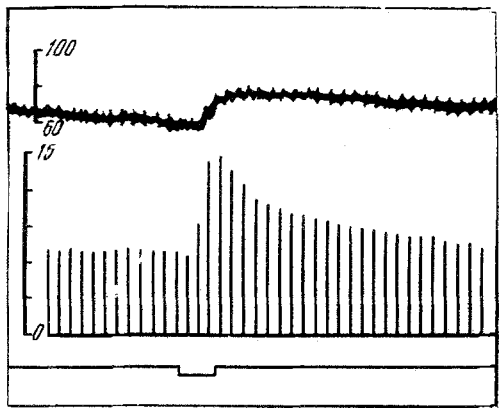

Fig. 2. The effect of sodium salicylate (50 mg/kg) on the volume velocity of the blood flow from the coronary sinus. Significance of the curves (from above down): arterial pressure in mm Hg; outflow of blood from the coronary sinus in ml/min; marker of administration of the drug. Measurement of the velocity of the blood flow was made every 30 seconds.

pump. When the valve E opens, the cylinder is emptied. When the valve E is closed, the cycle is repeated. The working of the valve E is not connected with the action of the valves C and D.

It should be mentioned that the pressure on the inlet of the tube 2 is determined by the difference between its level and the level of the measuring cylinder, indicated in the figure by P. In order to make the conditions of flow of the blood into the flowmeter close to physiological, this distance P must be equivalent to the value of the venous pressure in the vessel which is being investigated.

Using the apparatus described, we measured the volume velocity of the blood flow from the coronary sinus of the cat's heart. For this purpose the tube 2 (see Fig. 1) was linked to a polyethylene catheter inserted into the coronary sinus, and the tube 3, to the central end of the jugular vein. A recording of the volume velocity of the blood outflow is shown in Fig. 2. The blood flow was measured every 30 seconds. Movement of the kymograph drum was effected only in the intervals between the measurements of the velocity of the blood flow, so that the results of each measurement appear in the form of a vertical line. The higher the velocity of the blood flow, the higher the line on the recording.

SUMMARY

A new design for a pump-flowmeter is suggested, with which it is possible to measure the volume velocity of the venous blood outflow and to simultaneously pump the outflowing venous blood into the animal's blood stream. The pump has no suction action and only removes the blood entering it.