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An Electric Perfusion Pump, with Especial Reference to its Use in Blood-flow.

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In a previous communication I described an instrument for measuring the renal blood-flow of a fowl[1]. This instrument had certain disadvantages, amongst others, that of offering some resistance to the outflow of blood; being difficult to clean, and not differentiating between changes in the renal blood flow itself, and slowing of the blood stream due to back pressure. As a consequence I have designed an instrument which overcomes these difficulties.

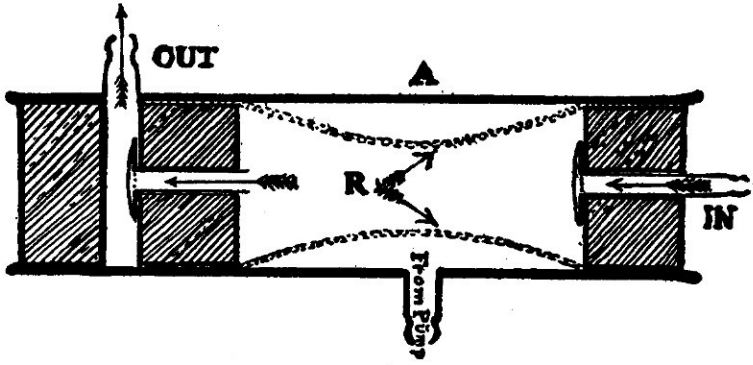
In brief this is an electric pump, so arranged that the fluid flowing in has no resistance to overcome, and when the pump is filled with a certain amount (usually 1 cc.) a switch is closed throwing into action an electric magnet which empties the pump. The pump mechanism simply consists of a piston fitting into a tube, both being covered in a special way by a thin rubber tube. This ensures a perfect joint without undue friction. The piston-rod carries at its other end an armature, on which acts the magnet that pulls forward the piston and thus empties the pump. The piston rod also bears the switch which controls the stroke. Suction stroke is accomplished

[1]Gibbs, Trans. Nova Scotian Inst. of Sci. 1927, XVII, p. 27.

by allowing the instrument to rest at a slightly lower level than the outflow source, and is so arranged that the downflow pressure just overcomes the piston friction.

The valve mechanism is separate from the piston chamber, and is arranged as is shown in the sketch. "A" is a glass part. In this is fitted a thin rubber tube "R", which has a valve at either end.

The pump is connected to the side arm, and acts by compressing the rubber tube "R". In this way the blood, or other fluid being circulated, only comes in contact with a relatively small amount of foreign material. Cleaning is also very simple, and merely consists in most cases of putting the valve chamber under the tap. It is very important that the pump, connecting



tubes, and space surrounding "R" be entirely filled with fluid, as air bubbles, being compressible, render the pump inaccurate.

The pump naturally has many uses, but is especially valuable as a constant rate injection apparatus, in which case the rate of the pump is controlled by an electric time clock.

Experiments with this and the previous form of instrument on the renal blood flow of the bird, show that this may be up to 4 litres an hour for one kidney, which is approximately 10 cc. per gram minute. This is a somewhat higher figure than that usually given for the rabbit or dog. The flow varies very considerably, depending on a number of factors. The chief of these is the cardiac output, and the peripheral resistance. The

highest flow yet obtained was with the low pressure of 25 mm. Hg blood pressure, indicating that the height of the pressure, in itself, is not the factor of great importance. This observation is borne out by further experiments with adrenalin, in which the rise of pressure thereby induced may be accompanied by no change, an increase, or a decrease in flow, depending on other factors present at the time.

Decreasing the cardiac output by vagal stimulation, or Co_2 inhalation, promptly decreases the flow.

Peripheral dilation by means of histamine, pituitrin, acetyl choline, choline, amyl nitrate, lead, during the pressure fall, to a slowing of the flow. Sometimes however this slowing is momentarily increased. This pressure may fall and is often followed by a rise, especially with choline, and during the rise the flow is often largely increased.

Increasing the bulk of the circulating fluid, and thereby frequently the pressure, leads to an increased flow. The amount of increase is not proportional to the amount of fluid injected, since an equivalent amount of 10% Na_2SO_4 solution always gives a greater flow than Ringer. Uric Acid in hexamine gives results more comparable with the sulphate than Ringer.

The details of the various reactions will be published elsewhere when they are completed.

Conclusions:—(1) The rate of the blood flow through the bird's kidney depends on the cardiac output and the peripheral resistance. (2) Blood pressure measurements are not necessarily correlated with the blood flow rate.