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The Form of the Electrocardiogram. II. The Character of the Excitation Wave in Auricular Muscle.

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Wilson, Wishart, and Herrmann[1] have pointed out that the distribution of the potential differences produced by the heart beat within the body and at its surface is determined by the laws which govern the flow of currents in a solid conductor within which a potential difference is maintained.

In the case of a conductor of infinite extent the potential of any point (V) is determined by the following expression:

$$V = c\left(\frac{1}{r_1} - \frac{1}{r_2}\right). \quad (1)$$

In this expression (c) is a constant, (r_1) is the distance of the point from the positive pole or source, and (r_2) is the distance from the negative pole or sink.

Let us assume that the positive pole is located at a point of which the coordinates are (a), (0), (0), and the negative pole at a second point (—a), (0), (0), and let us investigate the line, $y = b$, $z = 0$. The expression

$$V = c\left(\frac{1}{\sqrt{(x+a)^2 + b^2}} - \frac{1}{\sqrt{(x-a)^2 + b^2}}\right) \quad (2)$$

will then give the potential of any point on this line.

Let us imagine that we can examine the potential of this line with the string galvanometer. To do so let us connect the left-hand electrode to a point so far distant from the origin that it may be considered as indifferent, and let us move the right-hand electrode with a uniform velocity along the line mentioned from a point where (x) has a very large positive value to a point where (x) has a very large negative value.

The form of the curve which would be written by our galvanometer under these conditions can be determined by equation (2), of which the essential constants are assumed to be known.

Let us now imagine that the exploring electrode is stationary and that the system of coordinates approaches it with the same uniform

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[1] Wilson, Wishart and Herrmann, PROC. SOC. EXP. BIOL. AND MED., 1926, xxiii, 276.

velocity as before. The recorded curve will then be identical with the previous one.

By placing the right-hand electrode upon the right auricle of the dog at a point distant from the sinus node and the left-hand electrode at a point distant from the heart, electrograms identical in all essential particulars with the curves plotted from equation (2) are obtained. Knowing the velocity of the excitation process in the auricle the effective distance (2a) over which the excitation wave extends may be determined. It is very short, apparently 10 mm. or less. We conclude from such experiments that auricular muscle produces electrical effects during the period of activation and deactivation only. When fully active it exerts no influence upon the electrocardiogram. The period of activation at any point probably lasts 0.01 sec. or less.

The process of deactivation produces a curve similar to that produced by activation except that the phases of the curve are reversed, the amplitude is less and the effective distance (2a in formula 2) over which the wave of deactivation extends is greater than in the case of activation.

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The Form of the Electrocardiogram. III. Opposed Potential Differences.

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At the onset of ventricular systole the excitation process is spreading within the ventricular muscle in many different directions simultaneously. Many of the electrical forces, or potential differences, produced are opposed by forces opposite in direction, and their effects are consequently neutralized. Other potential differences are not opposed; it is these potential differences and these alone which have an effect upon the electrocardiogram.

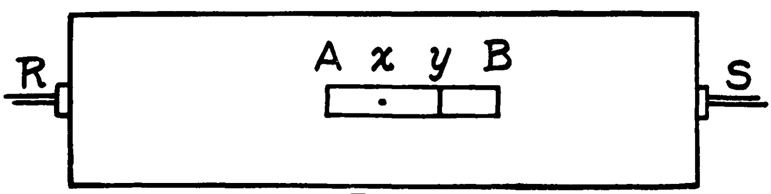

FIG. 1.