Differential Diagnosis of THE Electrocardiogram, by Sidney R. Arbeit, M.D., Ira L. Rubin, M.D., Harry Gross, M.d. 1st. Edition, 1960. F.A. Davis Company, Publisher, Philadelphia, PA

Chapter 1, pgs 3 thru 15, Tutorial – Electrophysiology of the Normal Heart

CHAPTER 1, ELECTROPHYSIOLOGY of the NORMAL HEART

In this section a brief description of the genesis of the electrical forces generated in the normal heart is presented. The alterations associated with disease states of the heart are then considered. Explanations of the electrophysiology of both the normal and the abnormal have been chosen for their simplicity and general acceptance. We feel it necessary to avoid controversial aspects of the subject. Detailed mathematical and laboratory background is beyond the scope of this book and may be readily found in other texts where the topic is treated in detail.

Only a few elementary basic electrical principles are presented in this chapter. A knowledge of these will aid materially in understanding the derivation of the electrocardiogram.

BASIC ELECTRIC THEORY

If a positive and negative pole (source and sink of current) are placed in a volume conductor in infinitely close proximity to each other, a dipole will be formed (Fig. 1). The pattern of current flow between these oppositely charged poles is dependent upon the conductivity of the medium. If the medium is highly conductive, current will flow from one pole to the other in a straight line as if through a copper wire and there will be no current flow or voltage disturbance in the surrounding medium. When the medium is resistive and homogeneous, the current cannot flow directly between the poles and must follow a longer and more complex pathway through the medium (Fig. 1). The voltage potential distribution associated with this current flow in the surrounding field and upon its surface is shown in Figure 2.

These voltage changes can be recorded at the boundary of the finite, homogeneous conducting medium by a voltmeter. The maximum voltage is recorded at the points where a line through the two poles of the dipole is projected to the boundary. A plane perpendicular to this line and between the two poles is at zero potential. On the positive side of the plane, progressively increasing positive voltages are recorded until the maximum is reached on the line of the dipole. On the negative side of this plane, progressively increasing negative voltage is recorded in a like manner.

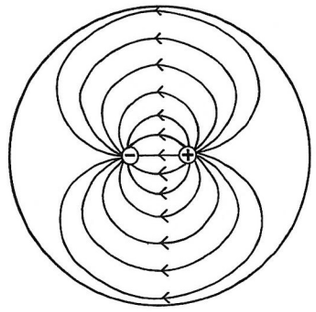

Figure 1. Current flow between the poles of a dipole in a homogeneous, finite conductive medium.

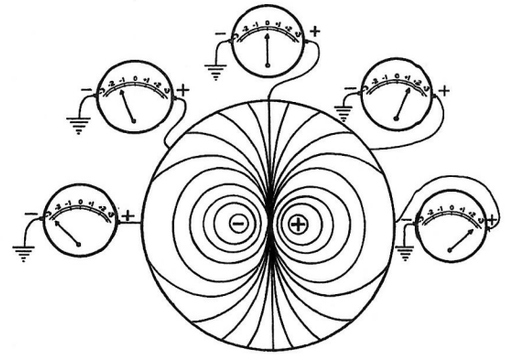

Figure 2. Voltage distribution at the boundaries of the medium associated with the current flow pattern of Figure 1.