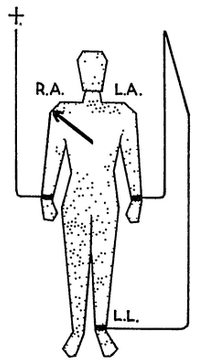

FIGURE 13. Electrical connections of standard lead aV_R.

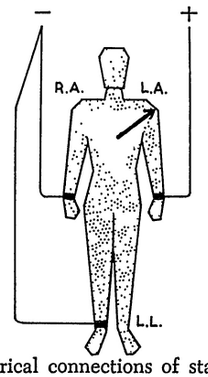

FIGURE 14. Electrical connections of standard lead aV_L.

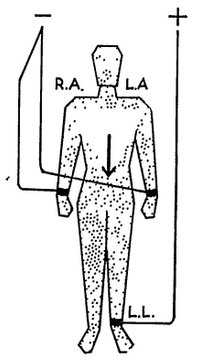

FIGURE 15. Electrical connections of standard lead aV_F.

Unipolar Extremity Leads (aV_R, aV_L, aV_F). Wilson devised a method for recording additional information from the frontal plane leads. By connecting the wires attached to the right arm, left arm and left leg through resistors, a new terminal, the Wilson Central Terminal, was formed. This terminal was connected to the negative pole of the electrocardiograph. At this terminal the voltage fluctuation throughout the entire cardiac cycle was theoretically zero and actually negligible. The positive electrode of the electrocardiograph is placed on any of the three extremities. The negative is connected to the Wilson Central Terminal. By this means a new electrocardiographic lead, the unipolar limb lead, is obtained. Since the Wilson Central Terminal is theoretically always at zero potential, the exploring or positive electrode will record only the potential changes from the extremity to which it is attached. The leads derived by placing the exploring electrode on the right arm, left arm and left leg, are called, respectively, "V_R," "V_L" and "V_F." If the electrical connection between the central terminal and the limb being explored is removed, the recorded voltage is increased, yielding a larger, more easily read complex. Leads recorded in this manner are called "Goldberger leads" or "augmented unipolar limb leads"—aV_R, aV_L and aV_F (Figs. 13-15).

In spite of the fact that the removal of one connection to the central terminal invalidates the concept of the zero potential central terminal, the resultant complexes are practically identical with those derived from the "true" unipolar leads and are generally accepted in practice today.

Angular Relationships between the Frontal Plane Leads. The relationship between the limb leads and the unipolar leads is a precise mathematical one. However, we shall avoid the mathematics and present rather their visual or pictorial relationship.

Triaxial System. The triaxial reference system of Bayley is a convenient method for presentation of the internal electromotive forces in the frontal plane as recorded by the standard limb leads 1, 2 and 3.

The horizontal top line of the Einthoven triangle, representing lead 1, connecting the right arm to the left arm, may without loss of accuracy be displaced downward until it passes through the center of the electrical field of the heart (Fig. 16).

Lead 2, the left diagonal of the Einthoven triangle, may be displaced to the right without change in its angular relation to lead 1.

In similar fashion, lead 3, the right leg of the triangle, may be moved to the left.

All three lines cross at one point, the electrical center of the heart.

Hexaxial System. The unipolar limb leads can conveniently be added to the triaxial reference system to form a hexaxial reference system. These three leads—aV_R (the augmented unipolar right arm lead), aV_L (the augmented unipolar left arm lead), and aV_F (the augmented unipolar left leg lead)—may be thought of as direct lines from the center of the heart (zero potential point) to the right arm, the left arm and the legs, respectively (Fig. 17).

Projection of the Hexaxial System on a Circle. This hexaxial system may be enclosed in a circle whose center is the electrical heart center. The points of intersection of the six lines with the circle are marked to indicate the lead projections on the circle. The radiating spokes may be removed. Angular relationship of the leads to each other remain the same (Fig. 18). Lead 1 is at zero degrees; aV_L, 30 degrees to the left of it, at minus 30; lead 2, at plus 60 degrees. The mirror image of aV_R, minus aV_R, lies midway between leads 1 and 2, at plus 30 degrees; aV_F at plus 90; and lead 3 at plus 120.