"Fig. 249 shows a longitudinal frontal section through the left femur, which is the mate of the right femur on which the mathematical analysis was made. In this midsection the system of tensile trabeculæ, which rises from the lateral (outer) part of the shaft and crosses over the central area to end in the medial portion of the shaft, neck and head, is clearly shown. This figure also shows the compressive system of trabeculæ which rises on the medial portion of the shaft and crosses the central area to end in the head, neck and greater trochanter. By comparing the position of these two systems of trabeculæ shown in Fig. 249 with the lines of maximum and minimum stresses shown in Figs. 248 and 250 it is seen that the tensile system of trabeculæ corresponds exactly with the position of the lines of maximum and minimum tensile stresses which were determined by mathematical analysis. In a similar manner, the compressive system of trabeculæ in Fig. 249 corresponds exactly with the lines of maximum and minimum compressive stresses computed by mathematical analysis.

"The amount of vertical shear varies almost uniformly from a maximum of 90 pounds (90 per cent. of the load on the femur-head) midway between sections 4 and 6, to a minimum of —5.7 pounds at section 18" (Fig. 251). There is a gradual diminution of the spongy bone from section 6 to section 18 parallel with the diminished intensities of the vertical shear.

1. The trabeculæ of the upper femur, as shown in frontal sections, are arranged in two general systems, compressive and tensile, which correspond in position with the lines of maximum and minimum stresses in the femur determined by the mathematical analysis of the femur as a mechanical structure.

2. The thickness and spacing of the trabeculæ vary with the intensity of the maximum stresses at various points in the upper femur, being thickest and most closely spaced in the regions where the greatest stresses occur.

3. The amount of bony material in the spongy bone of the upper femur varies in proportion to the intensity of the shearing force at the various sections.

4. The arrangement of the trabeculæ in the positions of maximum stresses is such that the greatest strength is secured with a minimum of material.

Significance of the Inner Architecture of the Shaft.—1. Economy for resisting shear. The shearing stresses are at a minimum in the shaft. "It is clear that a minimum amount of material will be required to resist the shearing stresses." As horizontal and vertical shearing stresses are most efficiently resisted by material placed near the neutral plane, in this region a minimum amount of material will be needed near the neutral axis. In the shaft there is very little if any material in the central space, practically the only material near the neutral plane being in the compact bone, but lying at a distance from the neutral axis. This conforms to the requirement of mechanics for economy, as a minimum of material is provided for resisting shearing stresses where these stresses are a minimum.

2. Economy for resisting bending moment. "The bending moment increases from a minimum at section 4 to a maximum between sections 16 and 18, then gradually decreases almost uniformly to 0 near section 75." "To resist bending moment stresses most effectively the material should be as far from the neutral axis as possible." It is evident that the hollow shaft of the femur is an efficient structure for resisting bending moment stresses, all of the material in the shaft being relatively at a considerable distance from the neutral axis. It is evident that the hollow shaft provides efficiently for resisting bending moment not only due to the load on the femur-head, but from any other loads tending to produce bending in other planes.

3. Economy for resisting axial stress.

The inner architecture of the shaft is adapted to resist in the most efficient manner the combined action of the minimal shearing forces and the axial and maximum bending stresses.

The structure of the shaft is such as to secure great strength with a relatively small amount of material.

The Distal Portion of the Femur.—In frontal section (Fig. 249) in the distal 6 inches of the femur "there are to be seen two main systems of trabeculæ, a longitudinal and a transverse system. The trabeculæ of the former rise from the inner wall of the shaft and continue in perfectly straight lines parallel to the axis of the shaft and proceed to the epiphyseal line, whence they continue in more or less curved lines to meet the articular surface of the knee-joint at right angles at every point. Near the center there are a few thin, delicate, longitudinal trabeculæ which spring from the longitudinal trabeculæ just described, to which they are joined by fine transverse filaments that lie in planes parallel to the sagittal plane.

"The trabeculæ of the transverse system are somewhat lighter in structure than those of the longitudinal system, and consist of numerous trabeculæ at right angles to the latter.

"As the distal end of the femur is approached the shaft gradually becomes thinner until the articular surface is reached, where there remains only a thin shell of compact bone. With the gradual thinning of the compact bone of the shaft, there is a simultaneous increase in the amount of the spongy bone, and a gradual flaring of the femur which gives this portion of the bone a gradually increasing gross area of cross-section.

"There is a marked thickening of the shell of bone in the region of the intercondyloid fossa where the anterior and posterior crucial ligaments are attached. This thickened area is about