DISCUSSION

C. S. Yen[1] (*written discussion*)—From the years 1951 to 1961 I was fortunate enough to participate continuously in the development of the hole expansion and coining methods with A. Phillips, J. L. Waisman, C. Hedges, and others at Douglas Aircraft Co. These methods were used in aircraft DC-6, -7, and -8. A portion of the methods and results were presented (and subsequently published) in a paper entitled "Improvements of Fatigue Life of Aircraft Components by Coining," by A. Phillips, in the ASME National Aviation Division Conference, March 1960.

I should like to congratulate Mr. Speakman and Douglas Aircraft Co. on the new stress coining methods developed more recently. I wonder what relations and differences there are between the new methods and the previously developed hole expansion and ring coining methods? How do they compare in fatigue life improvements? Can one use both new and old methods at one hole for greater improvement?

E. R. Speakman (*author's closure*)—The recent design of airbus-type aircraft has created the necessity for new coining methods adaptable to thick materials. The ring coining method developed at the Douglas Aircraft Co. from 1951 to 1961 increases the fatigue life of single members 0.125 to 0.400 in. thick; ring coining thicknesses above 0.400 in. are restricted, as they lead to reduction of fatigue life. As the thickness increases, the effect of ring-coined grooves around the hole at the surface of the material diminishes toward the center of the material. Squeeze pressures of 20,000 to 35,000 lb are required to form the ring grooves in single members on a hydraulic press. Multiple members in aircraft joints cannot be ring coined on final assembly, whereas diassembly of aircraft structure after setup and then drilling to be ring coined proves to be impractical.

Stress coining was developed at the Douglas Aircraft Co. from 1960 to 1970 for use on final assembly, utilizing standard lightweight portable tools such as rivet guns and drill motors. Hole diameters from 0.188 to 1.500 in. have been expansion stress coined in thickness combinations up to 5 in. using portable tools.

[1] Research projects engineer, Hughes Tool Co., Aircraft Division, Culver City, Calif. 90230.

The effect of ring coining and stress coining for fatigue improvement could be considered equal in thicknesses from 0.125 to 0.400 in. Application of the coining method has to be the main consideration to obtain increased fatigue strength at reduced cost.

In some cases it would be possible to combine the methods of ring and stress coining, but the improvement gained would not justify the costs. Either coining method would improve fatigue life relative to the noncoined surrounding structure. For this reason coining is used only in areas of high tension-stress concentrations in an effort to obtain a uniform, balanced fatigue life structure.