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Sample

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OUTLINE OF PRECISION FORGING

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Industrial Summary
The precision forging methods and the related items are outlined. The present state of cold, warm and hot forging processes and their combinations are explained. Since the operation of precision forging is carried out under an extremely high pressure to the too surface and the material is deformed to a large strain, a good combination of press, tool material and structure, lubrication and the material to be deformed are critically important for successful operation. It is also important to combine the processes for economical production. The analytical and simulation methods for forging processes are effectively used in the stage of process design to minimize the number of trial and error. Correct data of flow stress and friction are essentially necessary for analysis and the methods for determining them are introduced.

1. Methods of Precision Forging

1.1 Classification of Forging by Temperature

The metallurgical definition of cold forging is forming of bulk metal below its recrystallization temperature. Since a steel recrystallizes at temperatures higher than 600-700℃, which is too high to be 'cold', forging at room temperature is customarily called 'cold forging', and forging at elevated temperatures without recrystallization is given the name of 'warm forging'. Forging above the recrystallization temperature is 'hot forging'. In practice, however, forging of steels below about 850℃ is called warm forging irrespective of recrystallization.

The annual production of cold forged components (including warm forged components and excluding fasteners like bolds and nuts) is estimated to be about 0.7 million tons in Japan by taking the total weight of the cold forged components mounted on each car (about 43 kgs [1]) and the number of produced automobiles (10 million cars/year) into account with some considerations of the number of auto bicycles and bicycles. From the industrial statistics, the annual production of fasteners, which are mainly formed by cold forging, is known to be about 2 million tons. In addition, about 2 million tons of hot die forged products and 0.5 million tons of large scale free forged products like rotor shaft are produced annually.

1.2 Cold Forging

The purpose of cold forging is mostly to produce a finished part with a high dimensional accuracy. In the cases of soft metals such as tin, lead and aluminum, cold forging has been utilized since the 19th century for producing collapsible tubes, like tooth paste tubes, by impact extrusion. Cold forging of steels was not possible because sliding of the significantly extended workpiece surface on the tool under a very high interface pressure caused serious sticking of the work-piece to the tool. An excellent lubricating method of coating with phosphate impregnated with metal soap was developed in Germany and was

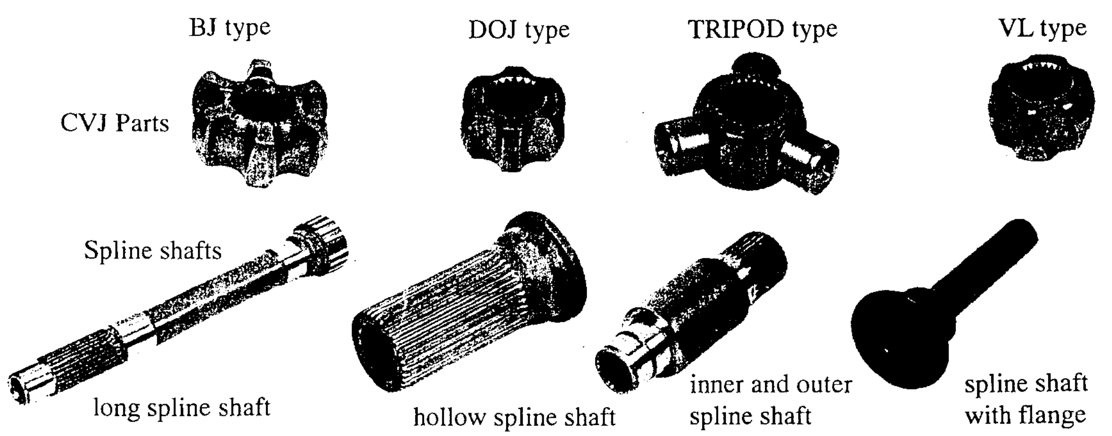

Fig1. Recent examples of cold forges products (Aikoku Alpha)

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Measurement of the surface enlargement under the punch and along the inner can wall in the model material experiments was made possible by painting concentric semi-circles on the end surface of the billet and measuring the distance between neighbouring circles after deformation. Similarly in the metal experiments concentric circles were machined on the end surface of the billet before surface treatment. Assuming a constant lubricant film thickness applied to the billets before extrusion the distribution of the film after deformation can be calculated adopting the measured distribution of the surface enlargement. In this way the film weight for cold extrusion of phosphate coated and soap lubricated steel 17Cr3 cans has been estimated by physical modelling as well as steel extrusions, [14].

A comparison of the estimated film weight distribution with direct determination is seen in Fig. 20. The direct determination of the weight distribution was done by dividing the can wall into rings, weighing each ring on a high precision scale, degreasing the rings to remove the phosphate coating and the lubricant and weighing again. Rather good accordance is noticed, indicating that in future film weight distributions could be indirectly estimated by a simple measurement of the surface enlargement distribution in either model material or steel experiments. The surface enlargement might also be theoretically calculated by FEM analysis.

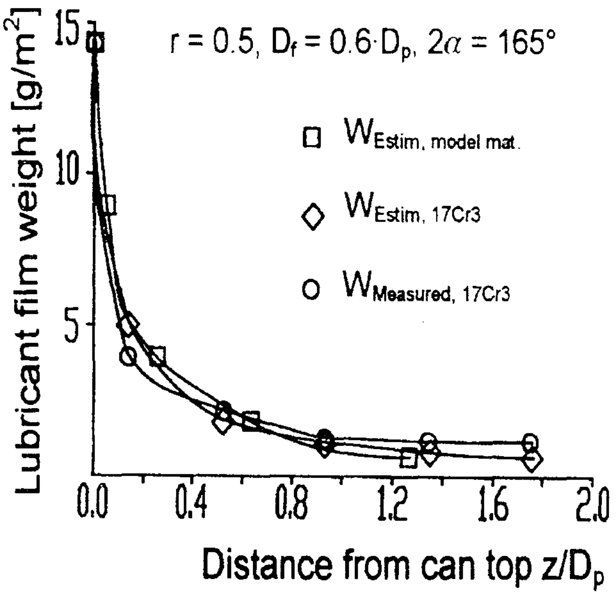

Fig. 20 - Comparison between measured and estimated lubricant film weight distributions, r = 50%.

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