to specify the size range of parts.

FIT

The types of fits have been given names. They range from an interference fit, where the parts are purposely made to be forced together. This fit can be further described as heavy through to light interference. Whereas a clearance fit is for parts made to have a space between them. This fit can be further described as tight through to loose. Between these two fits is the transition fit where interference may or may not occur. The amount of interference or clearance is achieved by specifying the tolerance range for the parts possible sizes.

TOLERANCE

Because of gradual cutting tool wear and minute changes in the machine tool internals due to temperature changes and wear/movement of internal parts, machined items can not all be made perfectly to the same dimension. It is permitted to make the part to within a range of sizes. That range is called the tolerance on the dimension.

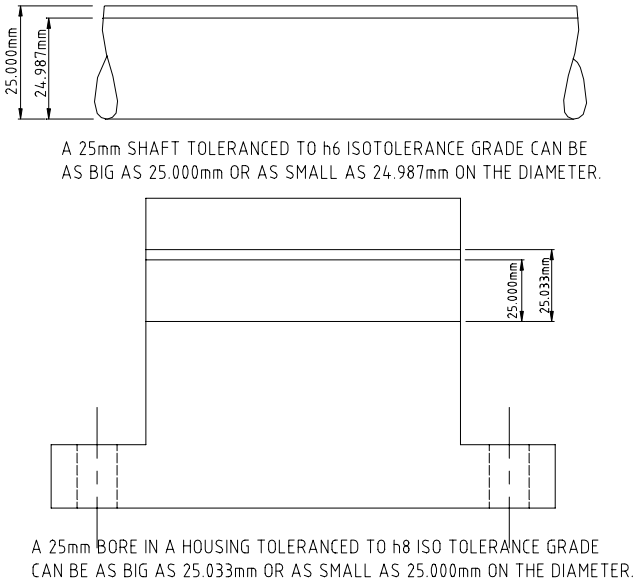

Figure 1. A dimensioned and toleranced shaft and hole.

Figure 1 shows a dimensioned shaft and a dimensioned hole in a block with tolerances to provide a transition fit when assembled. At the largest sized shaft and the smallest sized hole they would contact. This tolerance is too tight

Selection of tolerances for a part is made after considering -

- the speed at which the part moves
- the applied loads and forces it must withstand
- the amount of vibration permitted
- whether grease or oil lubrication is used
- ease of assembly
- changes in size due to thermal expansion.

Engineering drawings follow a recognised standard for displaying the dimensions and tolerances required for a machined part. The Figure 2 shows two acceptable ways to dimension and tolerance a part.

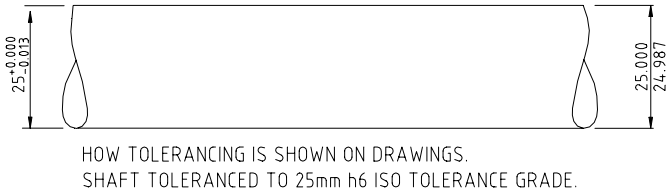

Figure 2. Methods for tolerancing parts

It is critical to know the fit, tolerance and clearance required for replacement parts. Often damaged parts are measured-up in order to manufacture a replacement. If the old part is worn and no allowance is made for wear, the clearances will be in error and the machine may not operate properly or for long.

FITTING TOLERANCED PARTS

When tolerances are too loose parts rattle about causing vibration and wear. An oversized bore on a shaft coupling allows it to flop about on the shaft. At high speed the coupling is thrown about causing noise, vibration and shaft distortion. Bearing failure occurs well before time. Always machine parts to the proper size and tolerance for the application. Drive couplings must be bored centrally and axially to prevent out-of-balance. Bored couplings directly mounted on the shaft should have a light interference fit and be heated on assembly to slide onto the shaft and key.

Machine parts heat-up when operated and they expand and change size. If there is insufficient clearance when the parts have expanded they may contact, or loose contact or prevent sufficient lubrication thickness to develop. When parts make contact heat is generated and material is scraped

is available from machinery handbooks. The growth in size is added to the 'cold' dimensions and the clearances again determined.

An example of a thermal expansion problem because of insufficient clearance for shaft axial elongation was a bearing failure on a high speed rotating 80-mm (3") shaft. The shaft ran on two bearings mounted in separate housings. The drive end bearing was the floating bearing and the other the fixed bearing. This configuration, of one fixed and one floating bearing, is the correct way to allow for shaft expansion. The fixed bearing's outer race was clamped in place inside the housing by the end covers and spacers. However the axial clearance between the floating bearing's outer race and the housing's rear cover had not been checked and was insufficient. As the shaft grew in length with the heat of operation, the floating bearing was forced against the end cover causing tremendous heat and noise.

During machine assembly the available gap between holes and shafts can be readily checked with micrometers. It is more difficult to check axial spacing. A simple method to check axial clearance is to insert plasticine between the shoulder and the abutting face and mount the parts fully. The plasticine is squeezed into the available space and the parts are again stripped down and the thickness of the plasticine checked with a micrometer. Only use enough plasticine so the parts still pull-up properly together as if finally assembled.

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