Tolerancing Floating Fasteners[1]

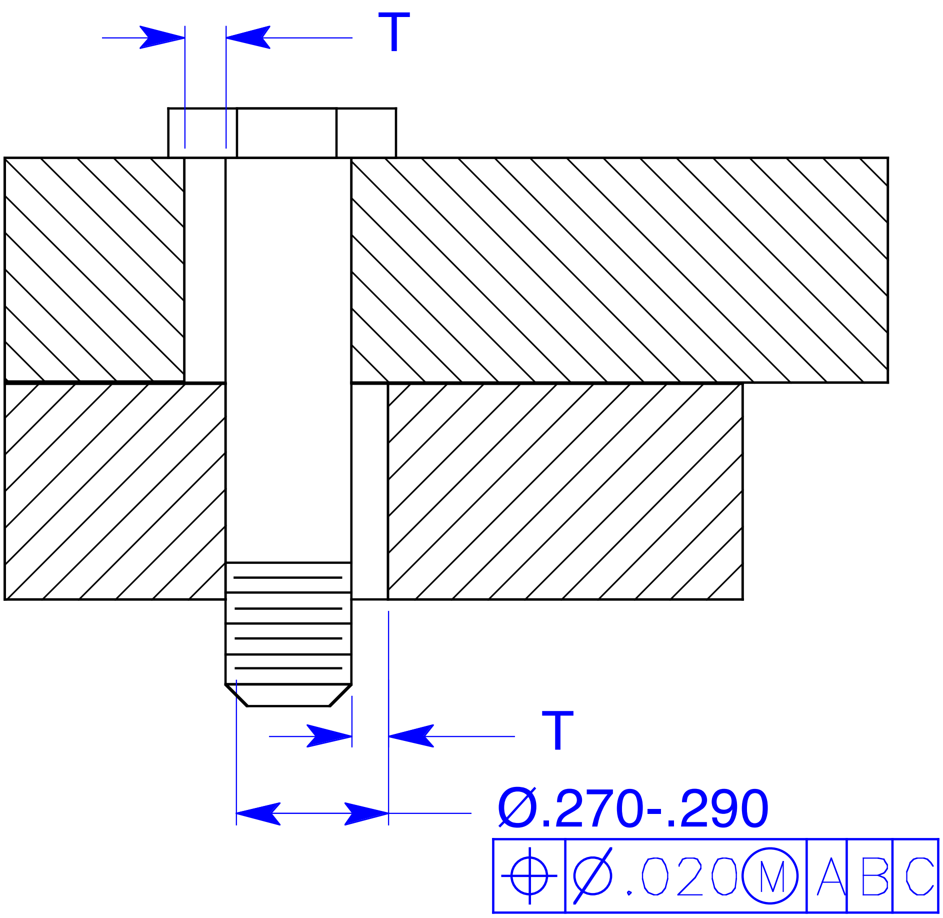

Figure 8-1 Floating fastener

The floating fastener in Fig. 8-1 got its name from the fact that the fastener is not restrained by any of the members being fastened. In other words, all parts being fastened together have clearance holes in which the fastener can float before the fastener is tightened.

The floating fastener formula is

$$T = H - F \quad \text{or} \quad H = F + T$$

T is the clearance hole location tolerance at MMC

H is the clearance hole MMC diameter

F is the fastener's MMC diameter, the nominal size.

The floating fastener tolerance applies to each hole in each part.

$$H = F + T$$

$$H = .250 + .020 = .270$$

Once the fastener is determined, three pieces of information are needed to complete the clearance hole dimension and tolerances. They are illustrated in Fig. 8-2 and listed below.

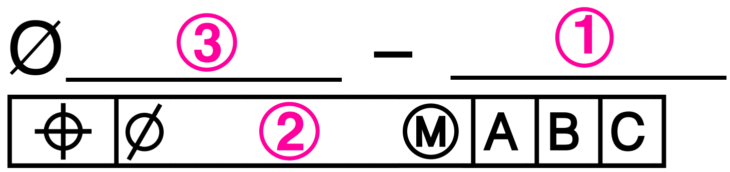

Figure 8-2 Floating fastener dimension and tolerances

1. Clearance hole LMC diameter
2. Clearance hole location tolerance *T*
3. Clearance hole MMC diameter *H*

1. Clearance Hole LMC Diameter

The first step in calculating the tolerance for fasteners is to determine the diameter of the clearance hole at LMC, the largest possible clearance hole diameter. The LMC hole diameter is essentially arbitrary. Of course, the clearance hole must be at least large enough to include the fastener plus the stated positional tolerance, and it cannot be so large that the head of the fastener pulls through the hole.

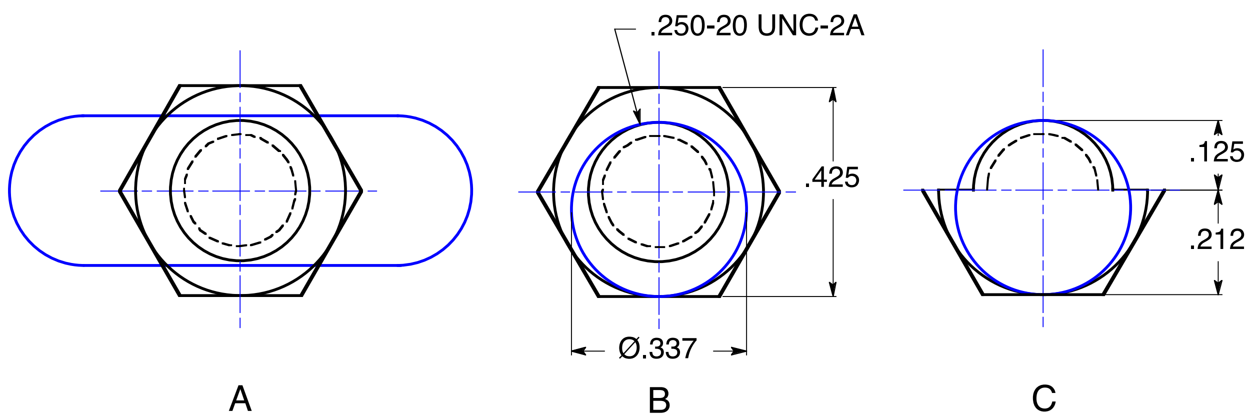

Figure 8-3 Clearance hole least material condition diameter

It has been suggested that the clearance hole should not be larger than the largest hole that will fit under the head of the fastener. If a slotted clearance hole (Fig. 8-3*A*) will fit and function, then surely the .337 diameter hole in Fig. 8-3*B* also will fit and function. How is the clearance hole diameter in Fig. 8-3*B* determined? The largest hole that will fit under the head of a fastener is the sum of half the diameter of the fastener plus half the diameter of the fastener head or half the distance across the flats of the head, as shown in Fig. 8-3*C*. The LMC clearance hole also can be calculated by adding the diameter of the fastener and the diameter of the fastener head and then dividing the sum by two.

$$\textbf{Clearance hole LMC diameter} = (F + F_{head}) / 2 = (.250 + .425) / 2 = .337$$

This method of selecting the LMC clearance hole size is a rule of thumb that will yield the largest hole that will fit under the head of the fastener. Engineers may select any size clearance hole that is required. The .337 clearance hole diameter might have been selected for our example, but instead, a more conservative hole size of .290 in diameter was assigned in Fig. 8-1. With the use of the preceding formula, engineers can make an informed decision and not have to blindly depend on an arbitrary clearance hole tolerance chart.

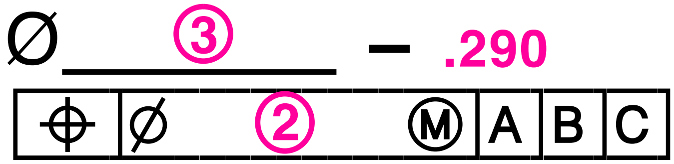

Figure 8-2A Dimension and tolerances for the floating fastener in Figure 8-1, the LMC hole size is assigned

2. Clearance Hole Location Tolerance *T*

The positional tolerance at MMC for the clearance hole is also arbitrary because bonus tolerance is available. Zero positional tolerance at MMC is as good as any, but a positional tolerance of .020 was selected in the example in Fig. 8-1 to illustrate the relationship between the clearance hole MMC diameter and the location tolerance.

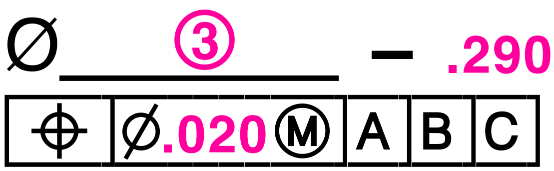

Figure 8-2B Dimension and tolerances for the floating fastener in Figure 8-1, the LMC hole size and the hole location tolerance are assigned

What is the actual clearance hole location tolerance in Fig. 8-4? The location tolerance for a given hole diameter at MMC is the same no matter what tolerance is specified in the feature control frame. If the clearance hole is actually produced at a diameter of .285, the total location tolerance is .035 whether the tolerance is specified as .020 or .000 or any other tolerance between .000 and .035. The location tolerance is equal to the difference between the diameter of the clearance hole and the diameter of the fastener.

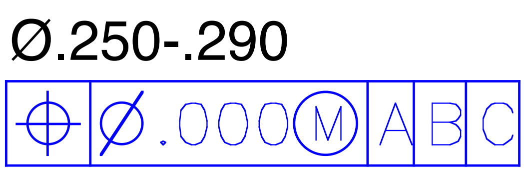

Figure 8-4 A clearance hole with a zero positional tolerance at MMC.

Total location tolerance = position tolerance + bonus

$$= .020 + (.285 - .270) = .035$$

or

$$= .000 + (.285 - .250) = .035$$

If the machinist happens to produce the hole at a diameter .265 and zero positional tolerance is specified, the hole size is acceptable, but the hole must be located within a positional tolerance zone .015 in diameter.

3. Clearance Hole MMC Diameter *H*

All too often designers simply use a reference chart for dimensioning clearance holes and have little understanding of how these numbers are derived. Once the fastener diameter and the position tolerance have been selected, it is a simple matter to calculate the clearance hole MMC diameter. In reality, the calculations couldn't be easier. The clearance hole MMC diameter is equal to the diameter of the fastener plus the positional tolerance of the clearance hole.

$$H = F + T$$

$$H = .250 + .020 = .270$$

The floating fastener formula is a simple formula to remember. The hole has to be larger than the fastener. The clearance hole location tolerance is equal to the difference between the actual size of the clearance hole and the size of the fastener, as shown graphically in Fig. 8-1. No matter what tolerance is selected, it is important to use the formula to determine the correct MMC clearance hole diameter. If the clearance hole diameter is incorrect, either a possible no fit condition exists or tolerance is wasted.

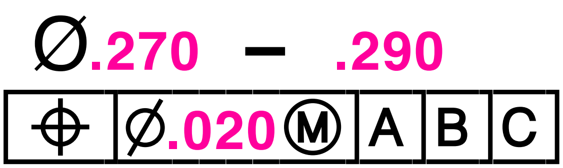

Figure 8-2C Dimension and tolerances for the floating fastener in Figure 8-1, the LMC hole size, the hole location tolerance, and the MMC hole size are assigned

[1]Cogorno, Gene R., ***Geometric Dimensioning and Tolerancing for Mechanical Design, Second Edition***, McGraw-Hill, New York, 2011, p. 131.