

# Guide to Top Tooling

Top jaws should be designed to hold the workpiece as close to the chuck face as possible. Excessive jaw height reduces the effective gripping force available and is detrimental to accuracy. As a general rule the height of the grip point above the chuck front face should not exceed one-quarter of the chuck's diameter. Thus for a 12 inch chuck the height of the grip point should not exceed 3 inches.

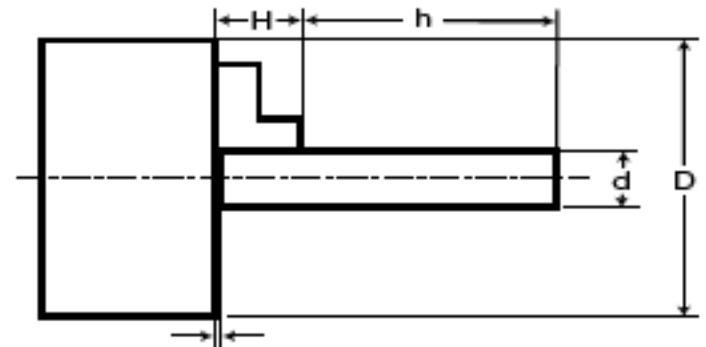
Large heavy top jaws should be avoided if possible since the loss in gripping force due to centrifugal effects at high spindle speeds is increased. If heavy jaws are unavoidable it may be necessary to restrict the spindle speed below the chuck's maximum recommended speed to ensure that sufficient gripping force is retained to hold the workpiece.

All top jaws in a set should be of equal weight to ensure no large out-of-balance forces occur. In the case of workpieces with a residual out-of-balance this may be corrected by designing the top jaws to counteract the imbalance component. Alternatively, it may be necessary to restrict the machine spindle to low speeds to avoid possible vibration problems.

Ideally, top jaws should not extend beyond the chuck periphery. If this is unavoidable, the amount of projection should be restricted within safe limits bearing in mind that the loss in gripping force due to centrifugal effect is a function of the product of top jaw mass and the distance to the jaws center of mass about the chuck's rotational axis. Precautions should also be taken to ensure that projecting top jaws will not collide with tooling during the machining cycle.

Care should be exercised in machining workpieces whose length protrudes excessively beyond the chuck jaws. As a general guide, for workpieces up to approximately one-third of the chuck diameter whose inner end face is located close to the chuck, machining should not be carried out at a distance greater than five times the workpiece diameter or three times the axial length gripped by the jaws measured from the outer end of the jaws. The lesser of these two values should be used and the maximum height of the top jaws should be restricted to one-quarter of the chuck diameter. The proportions for this condition are shown in figure 1.

Figure 1 For  $d$  less than  $D/3$



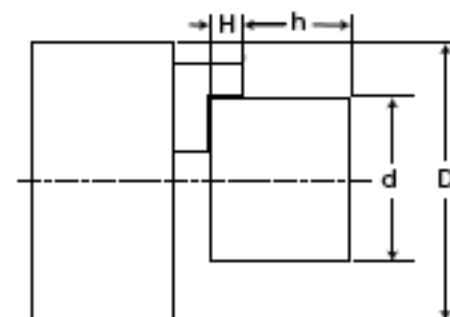
Workpiece close to chuck face

Max  $h = 3H$  or  $5d$  whichever is the smallest  
Max  $H = 1/4D$

If the protrusion of the workpiece exceeds this amount then support by the tailstock and/or use of a steady rest should be considered.

When the workpiece diameter is greater than approximately one-third of the chuck diameter and the workpiece is well-supported axially close to its outer periphery, the distance to the machining point from the outer end face of the jaws should not normally exceed three-quarters of the workpiece diameter. This is based on the assumption that the axial length of the workpiece gripped by the jaws is not less than one-tenth of the workpiece diameter. The proportions for this condition are shown in figure 2.

Figure 2 For  $d$  greater than  $D/3$



Max  $h = 3/4d$  Min  $H = 1/10d$

If these conditions cannot be satisfied, support by the machine's tailstock should be considered.

With slender or thin-walled tubular workpieces, care should be taken to ensure that the workpiece is sufficiently rigid to withstand the cutting force incurred.

The position of the top jaw securing screws is important with tee-slotted and serrated type jaws, particularly when split tee nuts are used. The centers of the screws should always be within the length of the base jaw. In addition, the center distance between pairs of screws on chucks

with split tee nuts should always be as large as possible to restrain any lifting effect. It is particularly important that the inner screws should be as far forward as possible to counteract the couple arising from application of the gripping force at some distance above the chuck face.

If distortion occurs with thin-walled workpieces, the amount may be reduced by lowering the chuck's operating pressure thus reducing the gripping force. In general the amount of distortion reduces in direct proportion to gripping force. Thus, halving the gripping force will reduce distortion to one-half of the original amount. Extreme care should be exercised in lowering the chuck's operating pressure since the resulting lower gripping force may be inadequate to hold the workpiece at high speed due to the effect of centrifugal force. In many cases it is better to overcome distortion problems by using wraparound top jaws. These should preferably contact the workpiece circumferentially at six-equally spaced points with the gripping force distributed equally between all six points. If this ideal arrangement is achieved the resulting distortion will be reduced to approximately 1/20th of that experienced with an equivalent total gripping force distributed over only three grip points. When the diameter to be gripped is not perfectly round the provision of a rocking top jaw arrangement may be necessary to ensure that the total gripping force is equally distributed between all six grip points.

Where it is desired to ensure that the turned end face of a workpiece is perfectly parallel with a previously machined rear face, the use of end location stops should be considered. These are fitted directly to the chuck body so that the machined face of the workpiece rests against them rather than on the top jaw step faces. Tapped holes are provided in most chucks on their front face for this purpose. Three locators of equal length should be used, positioned at as large a diameter as possible. For extreme accuracy the end faces of the locators may be machined in position on the chuck with the top jaws temporarily removed.

Top jaws can be used for holding workpieces either externally or internally and should be positioned on the chuck's base jaws accordingly. When fitting top jaws they should be located to grip the mean workpiece diameter at the master jaw at mid-stroke position, which is indicated when master jaws are flush with the chuck O.D.

The effect of variations in workpiece grip diameters should be considered to ensure in the workpiece maximum metal condition that sufficient clearance exists with the jaws fully

opened to permit insertion of the workpiece. It is even more important to ensure that in the workpiece minimum metal condition the jaws do not close an excessive amount to guarantee that the workpiece is securely gripped. The latter is important from a safety aspect since it is possible with an undersize workpiece for the jaws to close to their end-of-stroke position while only loosely holding the part. As a safety check to ensure that the workpiece is gripped, rotating hydraulic cylinders can be fitted with electrical proximity probes to detect the end-of-stroke condition.

The length of the workpiece and its axial location when loaded are important to prevent an excessive depth of cut occurring during end facing operations. This in the extreme case may dislodge the workpiece from the chuck jaws. Similarly, variations in unmachined diameters of forged and cast workpieces should be considered to ensure that an excessive depth of cut does not inadvertently occur. In certain cases an additional preliminary pass of the tool may be necessary in the interest of safety.

Always check that all the top jaw securing screws are correctly tightened. Avoid over-tightening as this can spread the width of tee-slotted master jaws, distorting them and tightening their fit in the chuck body. Use top jaws conforming to flatness and fit tolerance standards since poor quality top jaws can also promote distortion of the chuck's master jaws. Cheap soft blank top jaws not conforming to the tolerance standards can be dangerous and should not be used.

Pratt Burnerd's Constant Grip, Quick Change Jaw Chuck will accept collet pads. Collet pads are ideal for bar stock work and are fitted to the inner end of the base jaws. Always ensure that the pads are correctly secured but do not over-tighten the pad expander plug as this can distort the chuck's base jaws.

Do not leave loose keys or tee nuts in the chuck as these will be thrown out if spindle rotation is started and may cause damage or injury. Always check that the workpiece is correctly loaded and securely gripped and ensure that the covers and guards are in place before commencing spindle rotation.

Please understand that the foregoing recommendations can only act as a general guide and may require modification depending on other factors such as the severity of the machining operation being carried out particularly where interrupted cutting conditions appertain.