TTS

Tormach Tooling System

Operation Manual

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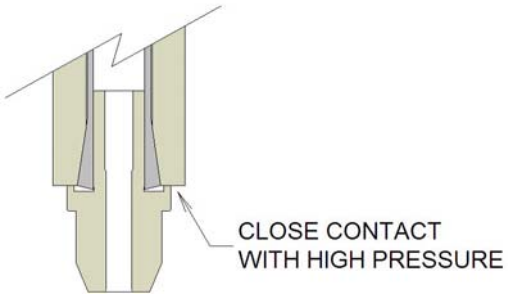
Description
TTS tool holders are designed to hold milling cutters, drills, and similar tooling in milling machine spindles. The tool holders consist of a 3/4" straight shank body with a precision ground shoulder designed to contact the spindle face. The tool holders are available in a variety of styles.

Intended Use
TTS is intended for general purpose light machining operations.

Safety Issues
This brief manual reviews the unique properties of the Tormach Tooling System (TTS) and provides some suggestions for operation. It does not cover general machine shop practices. Operators should be versed in safe milling machine operations before attempting to use any milling machine. Tool holders by themselves are not dangerous, but the combination of a sharp cutting tool, a powerful machine, and an untrained or inattentive operator can be extremely dangerous. Users and operators are ultimately responsible for safe setup and operation. Wear safety glasses and observe safe shop practices at all times.

Principles of Operation
Each TTS holder has a shoulder that is undercut so it contacts the spindle itself, not the end of the collet. As the drawbar is tightened the collet will simultaneously squeeze the shank and be pulled upward into the spindle taper. This simultaneous action, grasping while moving up, pulls the toolholder tightly against the spindle face. The high-pressure contact between the shoulder of the toolholder and the spindle is the equivalent of a zero tolerance fit; the vertical location (Z-height) of the tool is exact. The initial placement, created by simply sliding the toolholder up until it stops, is normally within a few thousandths of an inch. The final location, after tightening the collet, is exact, highly repeatable, and not affected by the variable tension of the drawbar or wear on the collet.



Preparing the Machine
It is important to check the spindle face before beginning to use TTS holders. Any collision with a vise or spindle crash with a workpiece in the prior history of the machine may have left marks on the surface of the spindle face which will affect the accuracy of TTS. Because most tooling references the spindle taper only, not the face of the machine spindle, it is unlikely that any such damage will have been noticed. If a TTS holder is mounted in a spindle with a face that is not flat and perpendicular to the axis of rotation, the TTS holder will cock slightly as it is drawn tightly against the spindle face. This will cause significant eccentricity in the motion of the cutting tool.

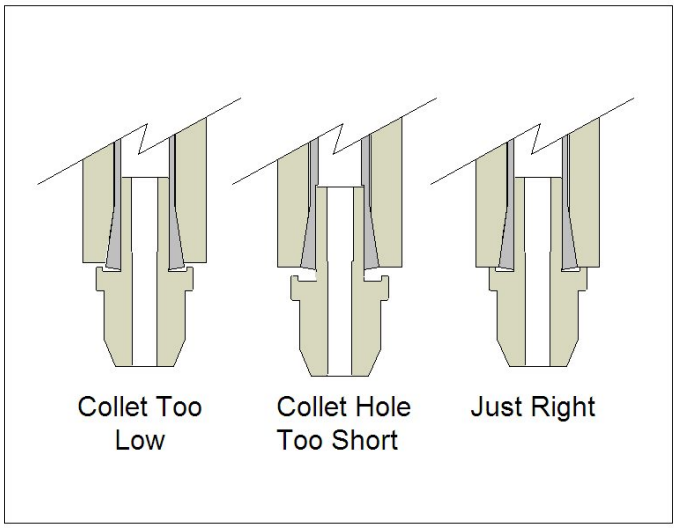
Checking the face is a simple matter of running a 0.0005" or 0.0001" indicator across the face, near the spindle taper, while the machine spindle is turned slowly. The spindle face should show no more than 0.0001" deviation.

Correcting the face is just as easy. Clamp a lathe tool in the milling machine vise. A new carbide tool is recommended. With the spindle turning at a few hundred RPM, take a very light surface cut. There is no need to remove much more than a few thousandths of an inch.

If there is a large ding in the spindle face, there will be a recessed area where it was hit, and a raised area to one side where the displaced material is proud of the surface. It is not necessary to cut away the recessed area, only to remove the raised area.

Checking the Collet

The recessed area between the shank of the holder and the shoulder will allow the tool holder to make contact with the spindle face even though the collet extends beyond the face of the spindle. Most machines can use TTS without modification, but sometimes the geometry of the machine or a collet creates some additional issues. The diagram shows two possible problems. On the left (collet too low) the taper geometry is not very deep in the spindle. This results in the collet extending too far beyond the spindle. If the collet extends beyond the spindle farther than the recessed area on the TTS holder can accommodate, then the shoulder of the holder will not contact the face of the spindle.



The center diagram shows a collet where the 3/4" section inside the collet is less than the length of the TTS shank. This will also prevent the shoulder from contacting the face of the spindle. If the shoulder cannot make contact with the spindle face, then the unique benefits of TTS (rigidity and exact Z height) will not be seen.

If you find these geometry issues on a machine that has an R8 spindle taper, the best solution is to use the Tormach TTS-R8 collet. This is a special variation of a precision R8 collet with the end of the collet ground flat and the overall length slightly less than the standard length. The TTS-R8 collet is included with each TTS kit, or it can be purchased separately.

If your machine exhibits the geometry problems mentioned above and does not use R8, or if you wish to use your existing R8 collet, the solution is to modify the collet. Using a disk sander or bench grinder, a hardened collet can easily be shortened about 1/8". Be sure to avoid overheating the collet by grinding lightly. Pause the grinding process occasionally and dunk the collet it in water to keep the temperature low. Grinding open the internal diameter is more time consuming, but not really more difficult. A small die grinder (Dremel tool or similar) with a long shank grinding wheel can be used, but be careful not to grind the precision section of the collet that will grasp the shank of the TTS holder.

General Limitations & Operating Recommendations

Metal cutting operations with tooling of cutting diameters greater than 1/2" should be limited to light finish operations only. Plastic and wood cutting operations should be limited to cutters no greater than 1.5" in diameter. Never use unbalanced cutters.

Tool holders and collets should be dry when mounted. Remove any oil with alcohol and a clean cloth.

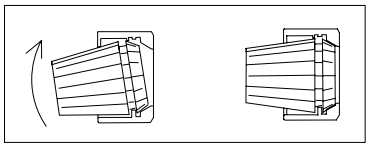
Check drawbar tension frequently. Collet tension is created by a slight stretch of the drawbar. Only a few thousandths of an inch of stretch is needed to generate hundreds of pounds of force by a steel drawbar. As the machine is operated, the spindle bearings will generate heat, resulting in an increasing temperature of the spindle and drawbar. This increases the natural length of the drawbar and reduces the force that the drawbar exerts on the collet. Checking tension is particularly important when beginning a long cutting process with a cold machine. Pause the process as the machine begins to come up to temperature and re-tension the drawbar.

Set Screw Adaptors

The 3/8" and 1/2" set screw adaptors are intended to be used with end mills that have a Weldon flat on them. They can also be used with certain Silver & Deming style drill bits. Make certain that the set screw is on the flat of the tool and never attempt to hold tooling without a flat.

Any tool mounted in a set screw holder will be held about 0.0003" off center due to the set screw and the required clearance. This is not significant in 1/2" and 3/8" tooling, but begins to become important on smaller cutters. The ER20 collet holders will mount tooling on center, without the offset inherent to a set screw holder. The ER20 collet holders are recommended if you are using 1/4" or smaller cutters that are based on a larger shank diameter, even if the shank offers a Weldon flat for mounting. The set screw holders will work for this application, but the tool will last longer and the machined finish will be better when using an ER20 holder.

ER20 Collet Holder



The ER20 collet is a self-extracting style. This means that the collet must be mounted into the nut first, then the nut and collet assembly are put into the collet holder. If these steps are not taken the collet and/or nut may be damaged and there will be very little holding capacity of the collet. A close inspection of the collet nut will reveal that it is not symmetrical. An area of the retaining ring is cut away. With the collet held at an angle, it is tipped into the cut-out area and will snap into place. With the collet correctly mounted in the nut, the collet will be pulled forward and out of the collet holder taper when the nut is slightly loosened, resulting in self-extraction.

Jacobs Taper Adaptors

Jacobs taper adaptors are used to mount Jacobs taper drill chucks. Occasionally novice operators will try using a drill chuck to hold an end mill or other side cutting tool. Such operations are dangerous, always educational, often expensive, and rarely repeated. Since a Jacobs taper is not designed to support lateral (side) loads, the vibration, in combination with side loads from a milling operation, will generally shake the drill chuck off the mount. The heavy mass of the free spinning chuck is certain to destroy the milling cutter, damage the work piece, and possibly damage the chuck itself. More importantly, it will shred any human flesh that happens to be in the way as it bounces violently around the workshop and dissipates its kinetic energy. Jacobs taper adaptors are for drill chucks and drill chucks are for tooling with axial forces only.

If you want to reuse a chuck that is mounted on a different taper adaptor, all you need is a long punch and a vise. Set the chuck on top of a vise with the taper adaptor pointing down. When the chuck jaws are fully open, the small circular part you will see in the center, down inside the chuck, is actually the end of the taper adaptor. Using a punch placed directly in the center, drive the punch with a good sharp hammer blow and the taper adaptor should drop free. Be prepared with a rag or something below the chuck in order to catch the taper adaptor. The ground surfaces of an adaptor are likely to be damaged if it is dropped onto a concrete floor.

Mounting a chuck on a taper adaptor is a simple matter of pushing the adaptor onto the chuck. It is important to remove any oil or grease on both the taper adaptor and the socket in the chuck before putting them together. A cotton swab and a little rubbing alcohol is all that is needed to degrease each end. Heating the chuck and/or cooling the taper adaptor before putting them together can provide a more secure connection. Don't go crazy with a blowtorch; a halogen desk lamp held over the chuck until it is

quite warm is plenty of heat. The heating technique is not necessary, but it does help the connection resist vibration

Tool Measurement

Tool measurement is a simple matter of setting the tool into the measuring fixture and recording the height. It is best to use a surface plate to ensure an accurate measurement. If you don't have a measurement fixture, simply place the tool holder between two standard 1-2-3 blocks, resting the ground surface of the shoulder on the surface of the blocks. Never measure with the tool holder standing directly on the surface plate. The end of the tool holder is not ground and will not be a precision reference. Always measure referencing against the shoulder of the tool holder.

Always measure all tools using the same technique. If you have a measurement fixture, use it for all tools. If you use 1-2-3 blocks, use the same height for all tools. This will normally be the 2" side of a 1-2-3 block. If you mix techniques then some tools will be off by the difference in height between the measurement fixture and the 1-2-3 block.

When referencing your CNC machine to a work piece you need to do the following sequence:

1. Enter your tool offsets in the tool table of your CNC controller.
2. Mount a measured tool in the machine
3. Turn on the offset for that particular tool. In most systems a tool offset is selected by using the command sequence ***G43 Hn***, where ***n*** would be the integer tool number. The controller will look up the tool number in the tool table and use the length as a current offset. Be aware that this is a different command than the tool load command of ***M6 Tn***. This command will load the tool #***n***, but it does not apply the offset. If your codes are generated by a CAM software package, you will likely find that these commands are combined. For example, using tool #14 would be ***M6 T14 G43 H14***.
4. Touch off the tool to the work piece and set the Z axis to zero.

Once the above sequence has been followed, the machine will be referenced to the entire set of tools. Each subsequent tool change will require the ***G43 Hn*** command to select the correct tool offset. The exact height of the measurement fixture is not important because a CNC machine has no absolute Z height reference.

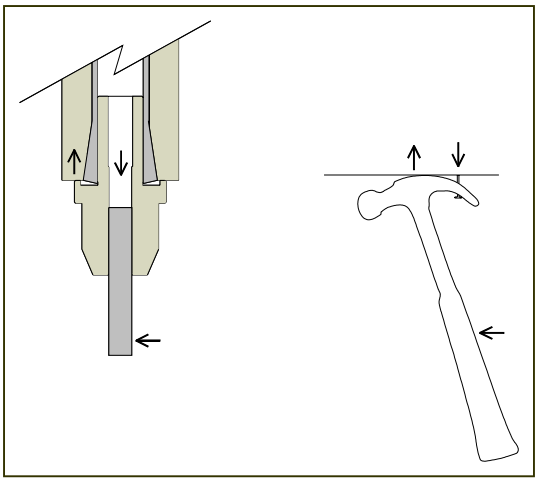
The Tormach CNC tooling kit includes a standard 8" dial height gauge. Occasionally a very long drill bit will exceed the reach of the height gauge. The easiest solution is to stand the height gauge on the 2" side of a set of 1-2-3 blocks, but don't forget to add the block offset to your measurement.

Heavy Cut Adaptor

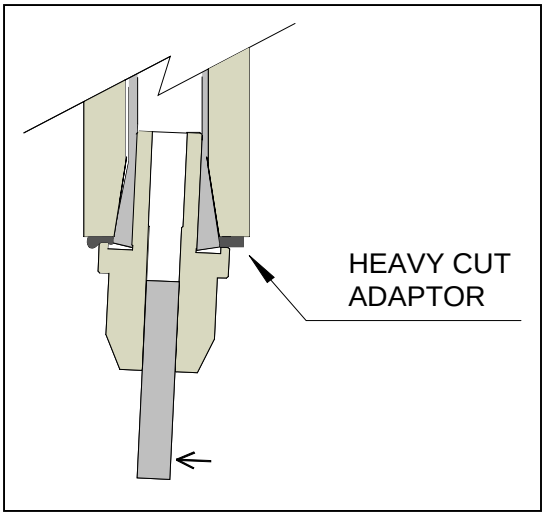
Heavy cutting operations can create conditions where the increased rigidity of the TTS design works against us. When a lateral force is applied on a milling cutter, the force is resisted by a combination of an increased pressure on the shoulder in combination with a downward force where it is held in the collet. This is identical to the forces applied when a hammer is used to extract a nail (diagram below). As the lateral force is increased, so is the force that works to extract the collet. The shoulder acts as the fulcrum point in a hammer. What will happen is that the TTS holder will be extracted about 0.010" and the cut will end up deeper than it started. If the collet is tightened properly, this will only occur on heavy cutting with ½" or larger cutters, particularly when making deep cuts in steel, titanium, or stainless steel. It is unlikely to occur during finish cuts or operations with smaller cutters.

The preferred solution is to reduce the lateral forces by reducing the depth of cut. The use of shorter cutting tools is also helpful. An alternative solution is the heavy cut adaptor. This is a heavy rubber washer that slides onto the shank of a TTS holder. The washer goes between the shoulder of the adaptor and the face of the spindle. Since the rubber washer will deform under pressure, it reduces the rigidity of the holder.

Users should be aware that the washer essentially defeats some of the function of the shoulder on the TTS tool holder. The diagram to the right is greatly exaggerated, but it does give the idea. The wide shoulder of the TTS holder no longer assists and the stiffness of the tool is wholly dependent on the collet. The slight flexibility that is normal to an R8 collet will apply and the quality of the cut will be the same as any normal collet-mounted R8 tool, a quality less than that normally seen with TTS.



The heavy cut adaptor should be on the tool holder when measuring tool height off-line. The actual mounted position on the machine spindle may be a few thousandths of an inch higher due to compression of the rubber adaptor. In addition, the precision of the Z height for tool compensation is also reduced. The repeatability with the heavy cut adaptor is generally within 0.002". While acceptable for most roughing operations, this is about 20x worse than the normal TTS operation of 0.0001".



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