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Chuck Checkout

Lever-operated, counterbalanced power jaw chucks have an edge over wedge chucks.

By Hardinge Engineering Staff

All images: Hardinge

Hardinge's Sure-Grip power chucks are lever-operated, counter-centrifugal and dynamically balanced to maintain jaw force.

The horsepower and accuracy potential of a lathe can be significantly impacted by the design of the jaw chuck used during machining. Not all 3-jaw chucks for CNC lathes have similar performance characteristics, and choosing the right chuck can optimize lathe utilization.

There are four principal ways to evaluate jaw chucks:

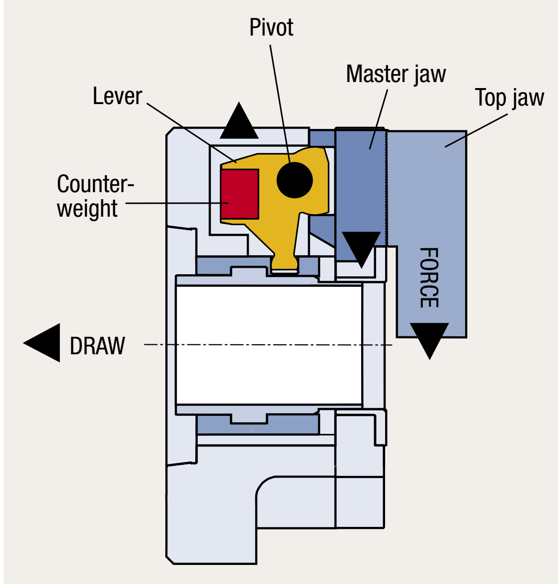
- jaw actuation, or closure, method,
- jaw force loss at high rpm,
- hysteresis (jaw force increase from

inertia shift), and
- accuracy and repeatability.

Method of Actuation

There are two basic jaw actuation systems: the wedge, or sleeve, system and the lever system. The wedge system is most commonly found on lower-cost, noncounterbalanced chucks supplied as standard equipment with some CNC lathes. The jaws on such chucks are actuated by the inclined plane principle, where the drawtube is connected to an angled sleeve that slides inside the chuck body against a matching wedge. The matching wedge is permanently connected to the master chuck jaws, forcing the top jaws open or closed.

There are two basic drawbacks to this actuation style. In many cases, mechanical efficiency is sacrificed to gain acceptable jaw travel. Second, the wedge design requires a large amount of bearing surface to actuate the chuck, which can cause components to rapidly wear the actuating surfaces. Wear accelerates if the chuck is not kept lubricated, which also rapidly degrades gripping power.



Hardinge's jaw chuck design uses a pivoting lever with a counterweight at each master jaw to maintain optimum gripping force at high rpm.

A preferred method of jaw actuation is the lever system. In this system, the drawtube is connected to the jaws through a rocking lever mounted on pins inside the chuck body. A lever-operated chuck also needs lubrication, but it is less sensitive to suboptimal lubrication than a wedge design.

The lever system typically operates with reduced friction and increased mechanical advantage compared with wedge systems for a given drawbar pressure. A lever system will always have greater actual gripping power at the jaws than a wedge system for any given drawbar pressure. The lever system also has less internal bearing surface area than the wedge-type closure, making it less sensitive to lack of lubrication. Higher system efficiency produces less wear on the operating cylinder, increasing component life. For this reason, a lever-actuated chuck system (chuck and operating cylinder) will usually have a

Power chucks for close-tolerance turning

HARDINGE MANUFACTURES several counterbalanced, lever-type power chucks. Its Sure-Grip power chucks have accuracy TIR and accuracy repeatability of 0.0005", according to the company. This makes them appropriate for close-tolerance turning requirements. The drawtube that actuates the chuck is configured identically with the corresponding collet for each machine tool.

Because all Hardinge machines have collet spindles that do not require a collet chuck or adapter, the collet can be quickly removed and the 3-jaw Sure-Grip power chuck mounted when needed, according to the company. The chuck's drawtube threads directly into the machine's collet closer, just like a collet. This changeover can be accomplished in 10 minutes or less.

The Hardinge spindle tooling system also includes step chuck, dead-length collets and internal expanding collet systems. The Sure-Grip power chuck is available for non-Hardinge lathes that do not have collet-style spindles.

—CTE Staff

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longer life than that of a wedge-operated system.

Jaw Force Loss

All jaw chucks lose gripping force as spindle speed increases due to centrifugal force acting on the top jaws. Because inexpensive chucks can lose some of their static (zero rpm) gripping power when run at higher rpm, full horsepower cuts on a workpiece may not be possible. This can compromise the lathe's ability to remove material, increasing cycle times and production costs. In addition, the machine can be damaged if centrifugal force causes the workpiece to leave the chuck.

Some suppliers state that the loss of gripping power of noncounterbalanced chucks can be offset by increasing the drawbar force, but this puts additional strain on the actuating cylinder and the chuck mechanism. This can shorten system life.

The counterbalanced chuck is an improvement on this situation. In this design, weights are included in the chuck's actuating levers at the opposite

keyword

CHUCK: Workholding device that affixes to a mill, lathe or drill-press spindle. It holds a tool or workpiece by one end, allowing it to be rotated in many cases. May also be fitted to the machine table to hold a workpiece. Two or more adjustable jaws actually hold the tool or part. May be actuated manually, pneumatically, hydraulically or electrically.

end of the fulcrum, or pivot point, of the jaws. Centrifugal force acts on this weight just as it does on the top jaws. However, because the weight is at the opposite side of the lever from the top jaws, the upward thrust generated counteracts some of the jaw force loss. Thus, the counterbalanced lever system has more gripping force at high rpms than that of a noncounterbalanced system.

Hysteresis

Another critical factor in chuck design is hysteresis. This condition occurs when a chuck is being decelerated to a stop or the spindle direction is rapidly reversed, a common practice in CNC turning. In these situations, jaw forces actually increase due to the inertia shift that occurs when direction is changed (similar to a person flying over the handlebars of a bicycle when it is brought to a sudden stop).

There are many factors that influence the amount of hysteresis generated, such as the chuck's rotational mass and the top jaws' weight. On low-cost chucks supplied with some CNC lathes, hysteresis can be higher than the static gripping power. This can distort parts out of tolerance or crush thin-wall parts. When selecting a chuck, hysteresis is a key consideration because it influences machine performance and part quality.

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Repeatability is the final factor in chuck performance. A chuck's repeatability is a measure of its ability to duplicate its performance, either from job-to-job or from part-to-part. An accepted standard for jaw chuck repeatability is approximately 0.001". The majority of chucks are built to this standard. Some specialty chuck builders can supply chucks with 0.00005" repeatability. However, these chucks are primarily light-duty chucks for secondary operations, not general-purpose, main-spindle CNC chucks.

In terms of component life and efficient use of the lathe's horsepower, counterbalanced, lever-type chucks are preferred over noncounterbalanced, wedge-operated chucks. CTE

Hardinge Inc., Elmira, N.Y., supplies turning, milling, grinding and workholding products. For more information on lever-operated, counterbalanced power chucks, call (800) 843-8801, or visit www.hardinge.com.