Workholding Styles & Considerations

Machinists have a number of variables to consider when setting up workholding devices for a machining operation. When it comes to workholding, there are some major differences between holding a loosely toleranced duplicate part with a 10-minute cycle time and holding a tightly toleranced specialized part with a 10-hour cycle time. Determining which method works best for your machining job is essential to maintaining an efficient operation.

Workholding Devices

Ideal workholding devices have easily repeatable setups. For this reason, some machines have standard workholding devices. Vises are generally used with milling machines while chucks or collets are used when running a lathe machine. Sometimes, a part may need a customized workholding setup in order to secure the piece properly during machining. Fixtures and jigs are examples of customized workholding devices.

Fixtures and Jigs

A jig is a work holding device that holds, supports and locates a workpiece and guides the cutting tool into a specific operation (usually through the use of one or more bushings). A fixture is essentially the same type of device, but the main difference is that it does not guide the cutting tool into a specified operation. Fixtures are typically used in milling operations while jigs are generally used in drilling, reaming, tapping and boring. Jigs and fixtures are more precise relative to standard workholding devices, which leads to tighter tolerances. They can also be indexable, allowing them to control the cutting tool movement as well as workpiece movement. Both jigs and fixtures are made up of the same basic components: fixture bodies, locators, supports, and clamps.

The 4 Fixture Bodies

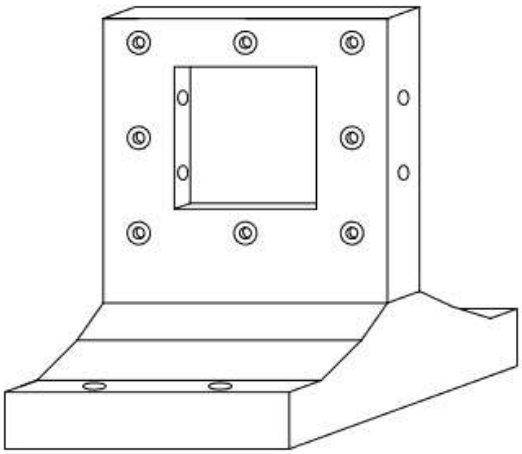
There are 4 basic types of fixture bodies: faceplates, baseplates, angle plates, and tombstones.

Faceplates: Typically used in lathe operations, where components are secured to the faceplate and then mounted onto the spindle.

Baseplates: Common in milling and drilling operations and are mounted to the worktable.

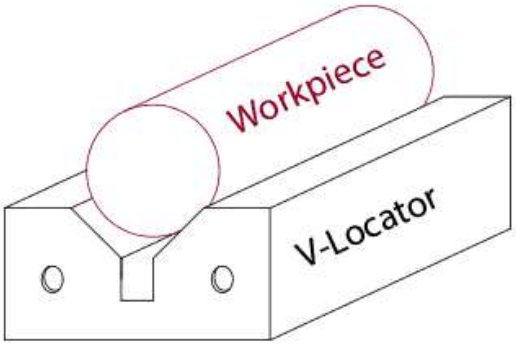
Angle plates: Two plates perpendicular to each other but some are adjustable or customized to change the angle of the workpiece.

Tombstones: Large vertically oriented rectangular fixtures that orients a workpiece perpendicular to the worktable. Tombstones also have two sides to accommodate multiple parts.



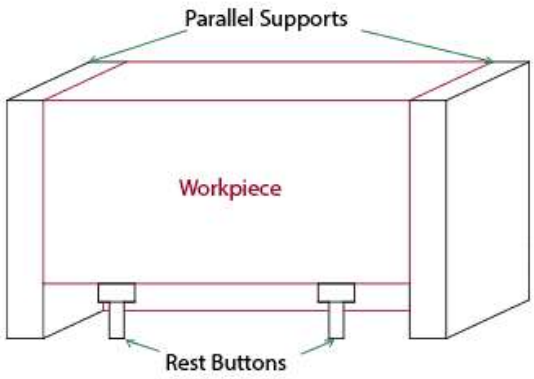
Locators

Locators are characterized by four criteria: assembled, integral, fixed, and adjustable. Assembled locators, can be attached and removed from the fixture, which is contrary to integral locators that are built into the fixture. Fixed locators allow for no moving components, while adjustable locators permit movement through the use of threads and/or springs, and can adjust to a workpiece's size. These can be combined to provide the appropriate rigidity-assembly convenience ratio. For example, a V-locator fixture is the combination of assembled and fixed locators. It can be secured to a fixture but has no moving components.



Supports

Supports do exactly what their name suggests, they support the workpiece during the machining process to avoid workpiece deformation. These components can double as locators and also come fixed, adjustable and integral, or assembled. Generally, supports are placed under the workpiece during manufacturing but this also depends on the geometry of the workpiece, the machine being operated and where the cutting tool will make contact. Supports can come in different shapes and sizes. For example, rest buttons are smaller support components used in series either from underneath the workpiece or from the sides. Concurrently, parallel supports are placed on either side of the part to provide general support.



Clamps

Clamps are devices used for strengthening or holding things together, and come in different shapes, sizes and strengths. Vises and chucks have movable jaws and are considered standard clamps. One atypical example is the toggle clamp, which has a pivot pin that acts as a fulcrum for a lever system. One of the more convenient types is a power clamping system. There are two type of power clamping methods: hydraulic and pneumatic.

Example of a standard fixture setup.

Hydraulic Systems

Hydraulic Systems create a gripping force by attaining power from compressing a liquid. This type of power clamp is generally used with larger workpieces as it usually takes up less space relative to pneumatic clamps.

Pneumatic clamps

Pneumatic clamps attain their gripping force from the power created by a compressed gas (usually air). These systems are generally bulkier and are used for smaller workpieces that require less room on the worktable. Power clamping offers a few advantages over conventional clamping. First, these systems can be activated and deactivated quickly to save on changeover time. Second, they place uniform pressure on the part, which help prevent errors and deformation. A significant disadvantage they pose is the cost of a system but this can be quickly offset by production time saved.

Key Guidelines to Follow

Lastly, there are a few guidelines to follow when choosing the appropriate fixture or jig setup.

Ensure Proper Tolerancing

The tolerances of the workholding device being used should be 20%-50% tighter than those of the workpiece.

Utilize Acceptable Locating & Supporting Pieces

Locating and supporting pieces should be made of a hardened material to prevent wear and allow for several uses without the workpieces they support falling out of tolerance. Supports and locators should also be standardized so that they can be easily replaced.

Place Clamps in Correct Locations

Clamps should be placed above the locations of supports to allow the force of the clamp to pass into the support without deforming the workpiece. Clamps, locators and supports should also be placed to distribute cutting forces as evenly as possible throughout the part. The setup should allow for easy clamping and not require much change over time

Maximize Machining Flexibility

The design of the fixture or jigs should maximize the amount of operations that can be performed in one orientation. During the machining operation, the setup should be rigid and stable.

Bottom Line

Workholding can be accomplished in a number of different ways and accomplish the same task of successfully gripping a part during a machining operation with the end result being in tolerance. The quality of this workholding may differ greatly as some setups will be more efficient than others. For example, there is no reason to create an elaborate jig for creating a small slot down the center of a rectangular brick of aluminum; a vise grip would work just fine. Maximizing the efficiency and effectiveness of an operators' workholding setup will boost productivity by saving on changeover, time as well as cost of scrapped, out of tolerance parts.