



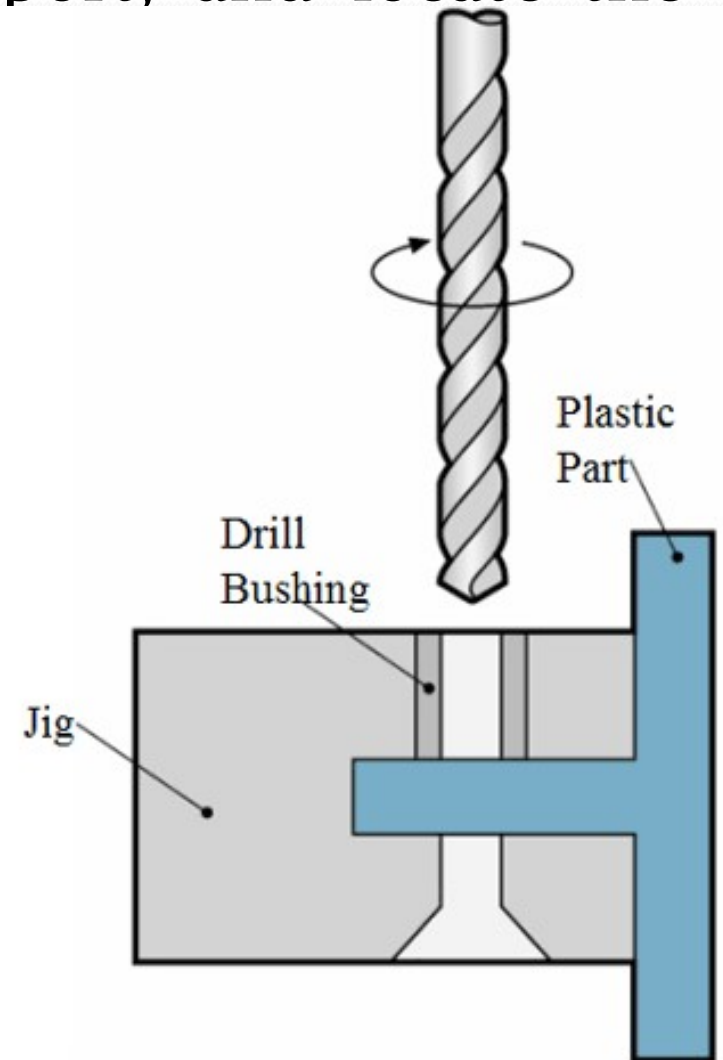
Jigs and Fixtures

Introduction

- Jigs and fixtures are devices that are used for production of repeated parts essentially for mass production.
- Functionality of Jigs or fixtures:
 - Locating
 - Clamping
 - Supporting
 - Resistance to cutting forces
 - Safety

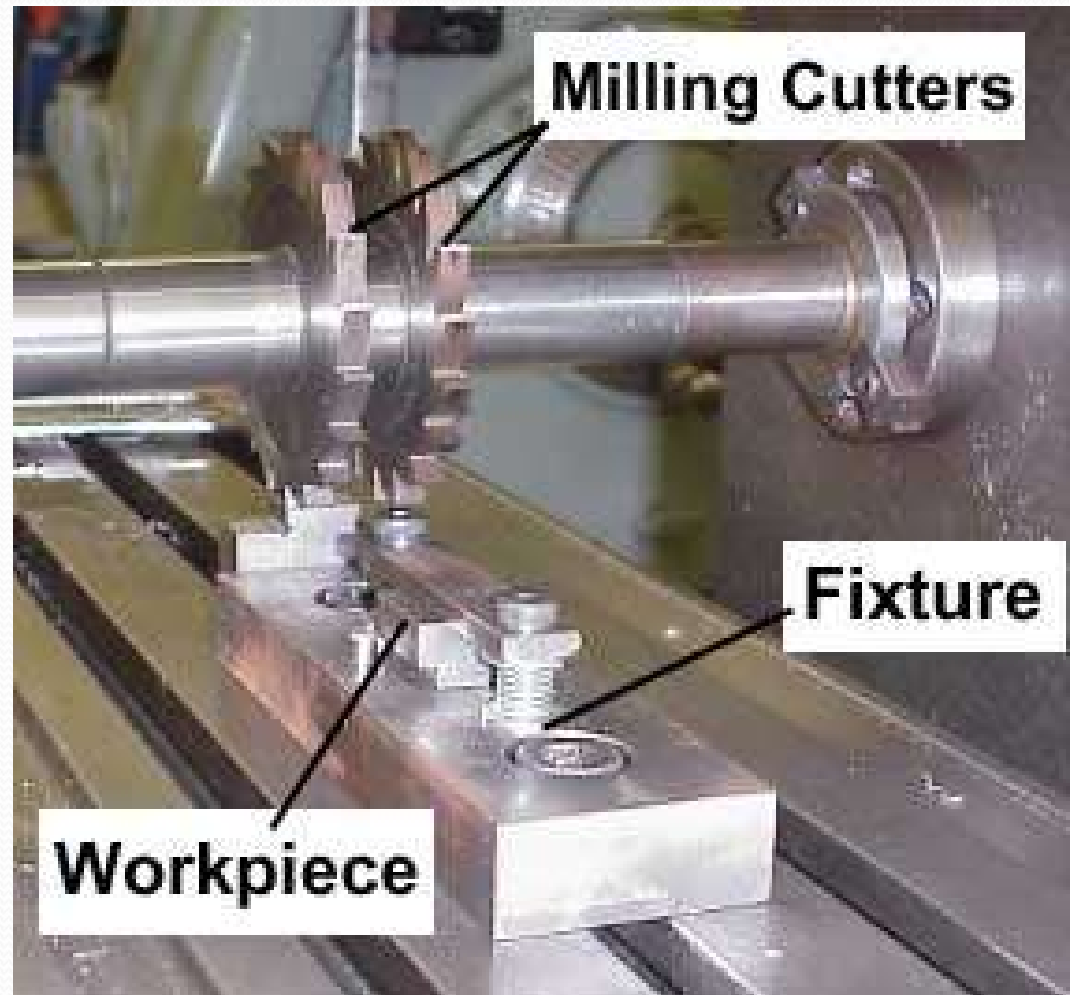
Jig

- Both jigs and fixtures hold, support, and locate the work piece.
- A jig also guides the cutting tool.



Fixtures

- Both jigs and fixtures hold, support, and locate the work piece.
- A fixture has a reference point for setting the cutting tool with reference to the work piece.



Purpose of using Fixtures and Jigs

- Eliminate marking, punching, positioning, alignments etc.
- Easy, quick and accurate locating, supporting and clamping the blank.
- Guide the cutting tool like drill, reamer etc.
- Increase productivity and maintain product quality.
- Reduce operator's labour and skill requirement
- Enhancing technological capacity of the machine tools
- Reduce overall machining cost and increase interchangeability.

Design considerations for Jigs and Fixtures

- Jigs and fixtures are manually or partially power operated devices. comprised of several elements :
 - Base and body or frame with clamping features
 - Locating elements for proper positioning and orientation of the blank
 - Supporting surfaces and base
 - Clamping elements
 - Tool guiding frame and bushes (for jig)
 - Auxiliary elements
 - Fastening parts

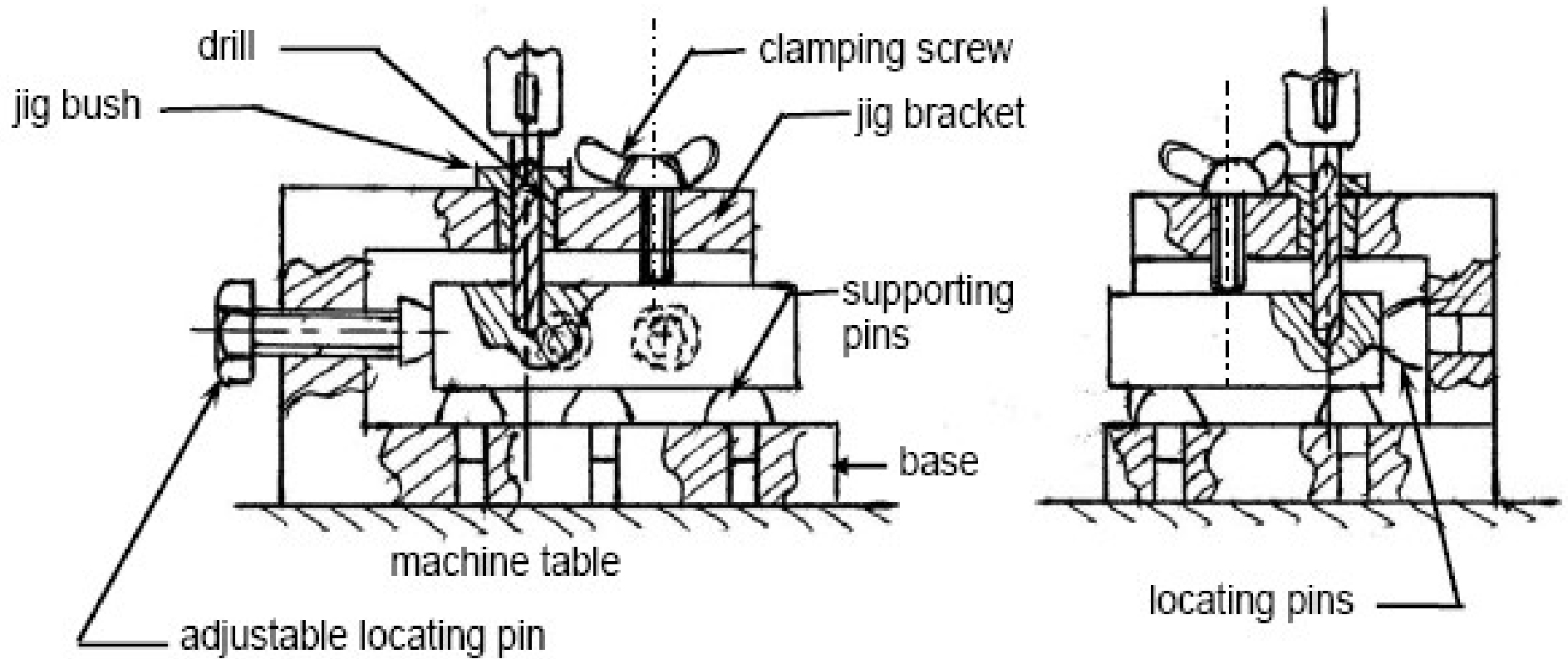
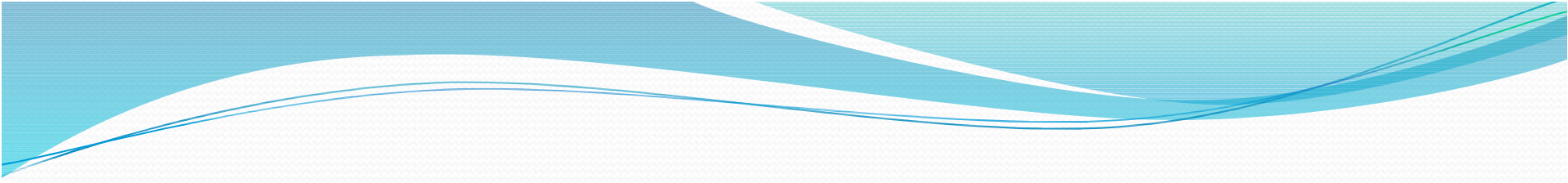


Fig. Major elements of jig and fixtures

3-2-1 Locating Principle

- A workpiece, just like any free solid body, has six degrees of freedom (some researchers have referred this to the twelve degrees of freedom by considering the +/- movements in each category)
- For locating it is necessary to arrest all these six degrees of freedom to ensure the mechanical stability.
- A single locator in Plane 1 would arrest the linear motion along the X-axis.
- A second locator in the same plane would arrest the rotary motion about the Z-axis.
- Another locator placed in the same plane would arrest the rotary motion about the Y-axis.

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- Adding one more locator in Plane 1 would not serve any purpose.
 - So fourth locator is placed in Plane 2 which is perpendicular to Plane 1. This would restrict the linear motion along the Y-axis.
 - The fifth locator is placed in the Plane 2 which can arrest the rotational motion about the X-axis.
 - The sixth locator placed in Plane 2 would not serve any purpose.
 - So, sixth locator is placed in Plane 3 which is perpendicular both the planes 1 and 2. This would arrest the linear motion along the Z-axis.

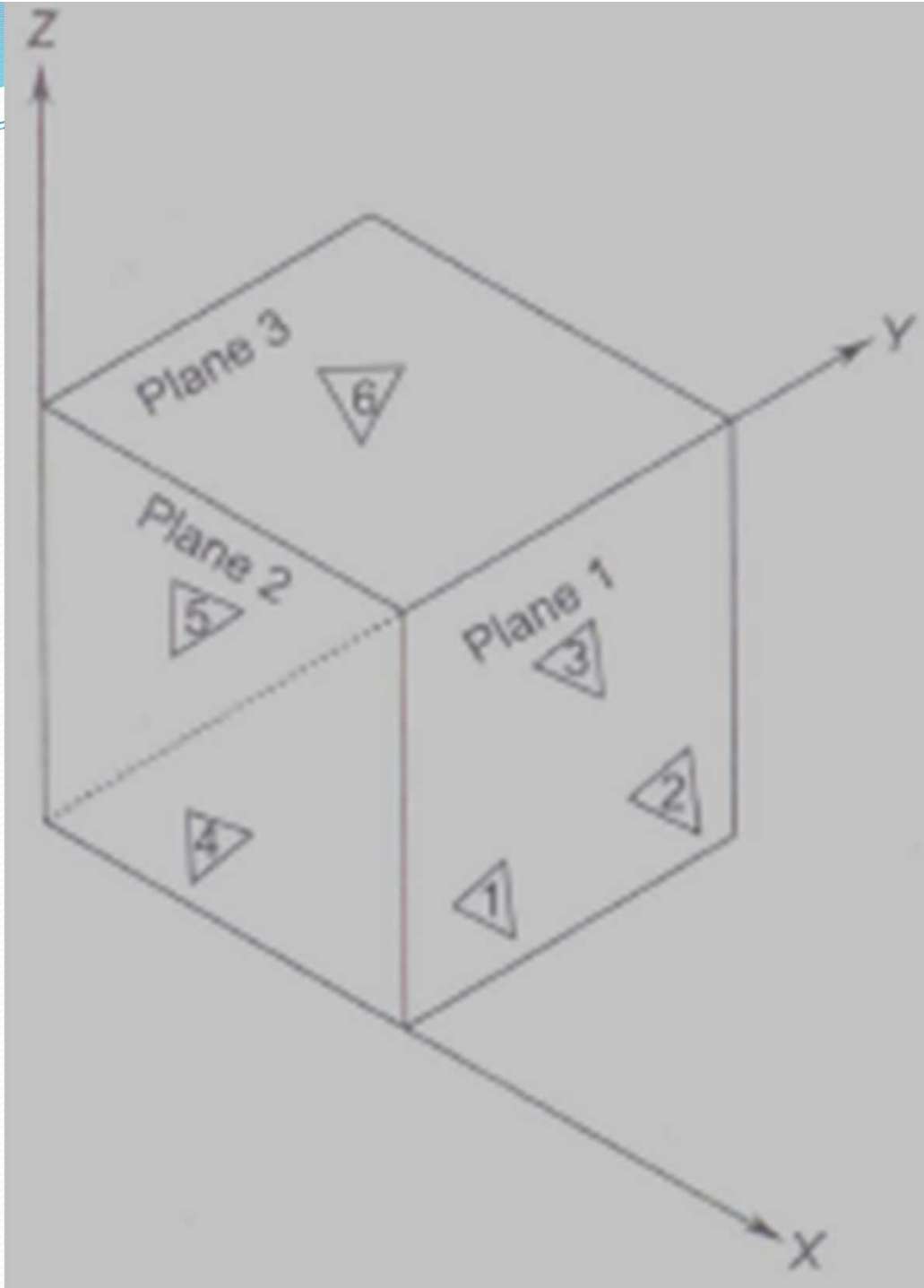


Fig. A
component with
six locators

Considering 12 DOF

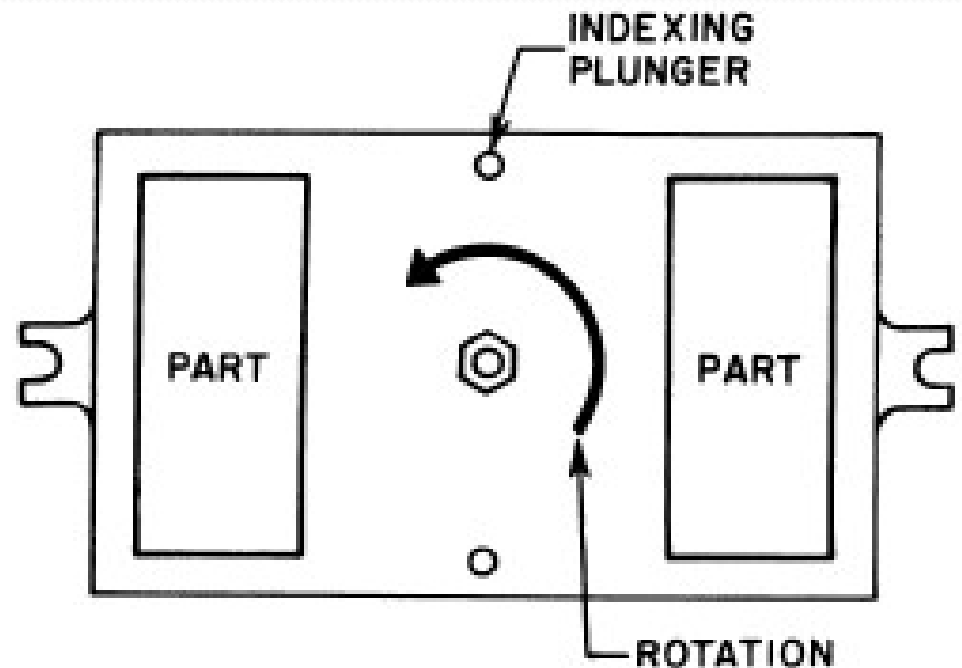
- You must fix all the 12 degrees of freedom except the three translational degrees of freedom (-X, -Y and -Z) in order to locate the work piece in the fixture. So, 9 degrees of freedom of the work piece need to be fixed.
- Rest the work piece on **three** non-collinear points of the bottom surface (XY), and you will be able to fix the **+Z, Clockwise Rotation-X, Anticlockwise Rotation-X, C Rot-Y** and **AC Rot-Y** degrees of freedom.
- Now, rest the work piece at **two** points of side surface (XZ), and you will be able to fix the **+Y** and **C Rot-Z** and **AC Rot-Z** degrees of freedom.
- Now, rest the work piece at **one** point of the adjacent surface (YZ), and you will be able to fix the **+X** degrees of freedom.

Points to ponder

- When more than one locator is placed on a surface (plane), they should be distributed as far apart as possible on the surface.
- While selecting the surface for the largest locators, consideration should be given to the largest area of the workpiece.

Duplex Fixture

- It is a type of multi-station fixtures used primarily for high speed, high volume production runs where the machining cycle must be continuous.
- It uses only two stations. Once the machining operation is complete at station one, the fixture is revolved and the machining is started at station two. During this period, the machined part is unloaded from station one and a fresh part is loaded there, and so on



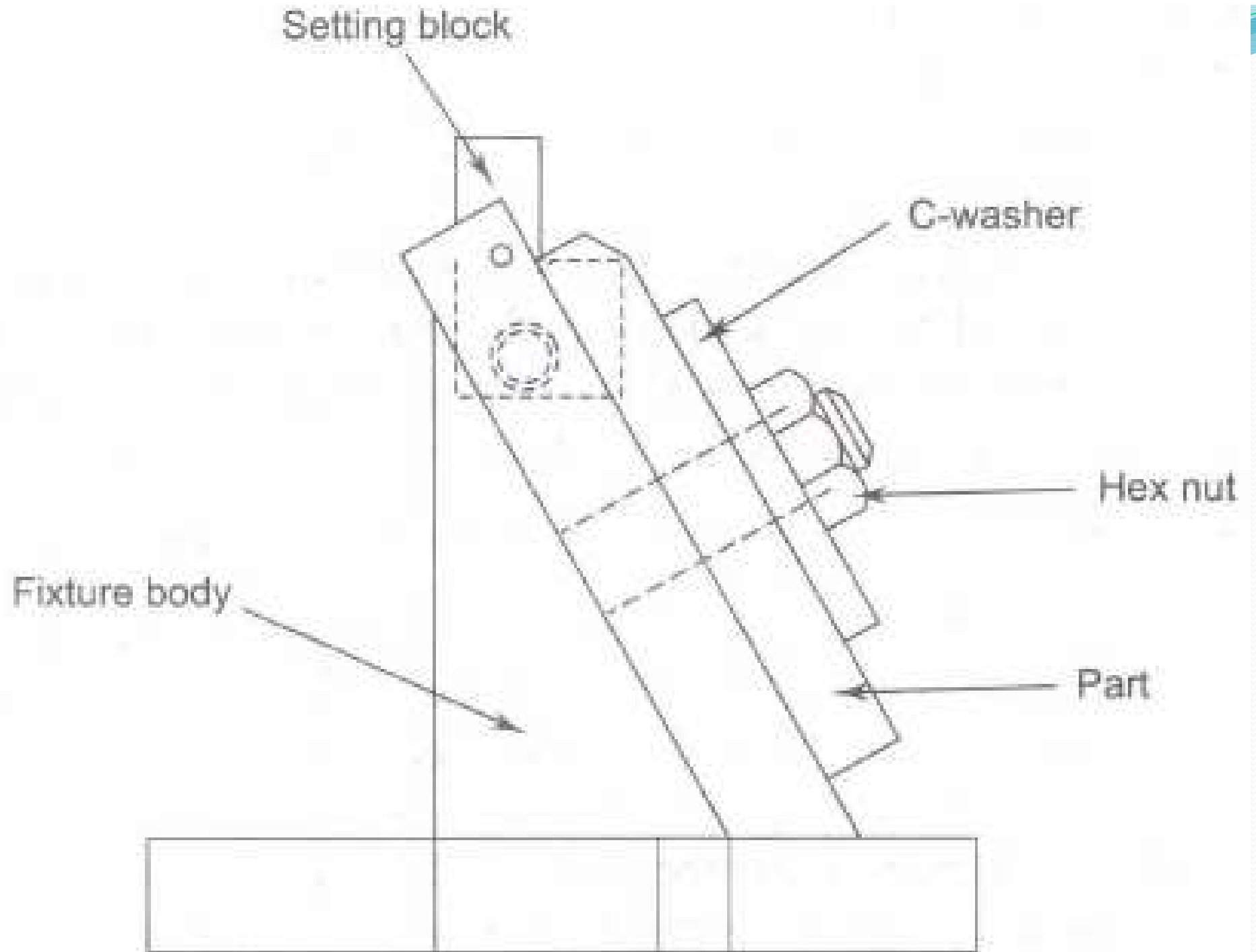


Milling fixtures

- Milling fixtures are the most common type of fixtures that are in general use today.
- The reason for this is the geometric complexity of the workpieces that are milled.
- The simplest type of milling fixture is a milling vise mounted on the machine table.
- However, as the workpiece size, shape, or complexity becomes more sophisticated, so too must the fixture. There are a variety of milling fixtures that are in use.
- **For Design:** The design should permit as many surfaces of the part to be machined as possible without removing the part.

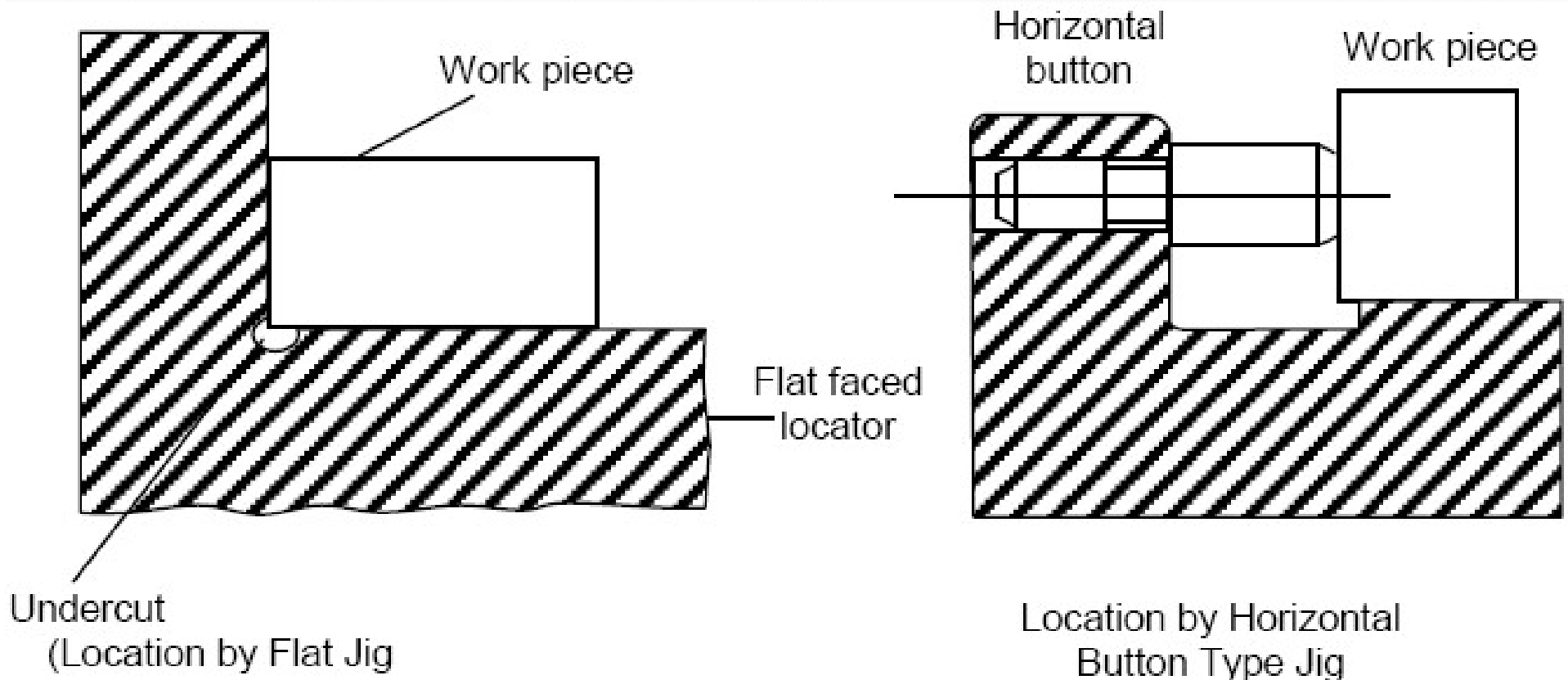
Milling fixtures

- Whenever possible, the tool should be changed to suit the part. Moving the part to accommodate one cutter for several operations is not as accurate or as efficient as changing cutters.
- Locators must be designed to resist all tool forces and thrusts. Clamps should not be used to resist tool forces.
- Clearance space or sufficient room must be allotted to provide adequate space to change cutters or to load and unload the part.
- Milling fixtures should be designed and built with a low profile to prevent unnecessary twisting or springing while in operation.

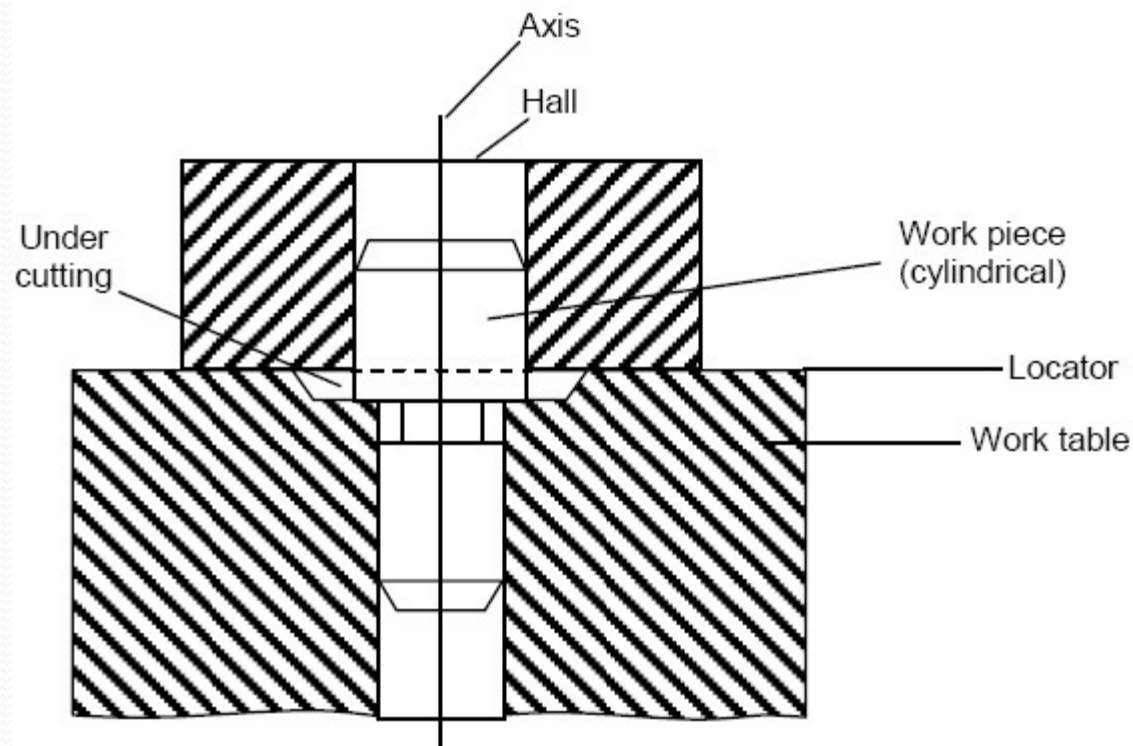


Different methods used for Location

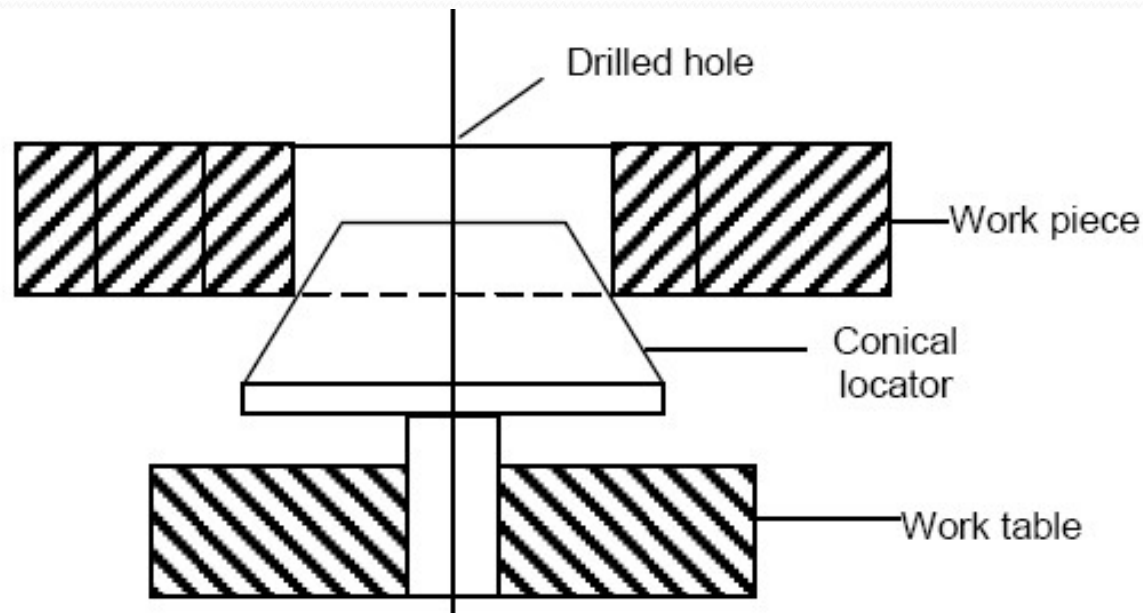
- **Flat Locator** : Used for location of flat machined surfaces of the component.



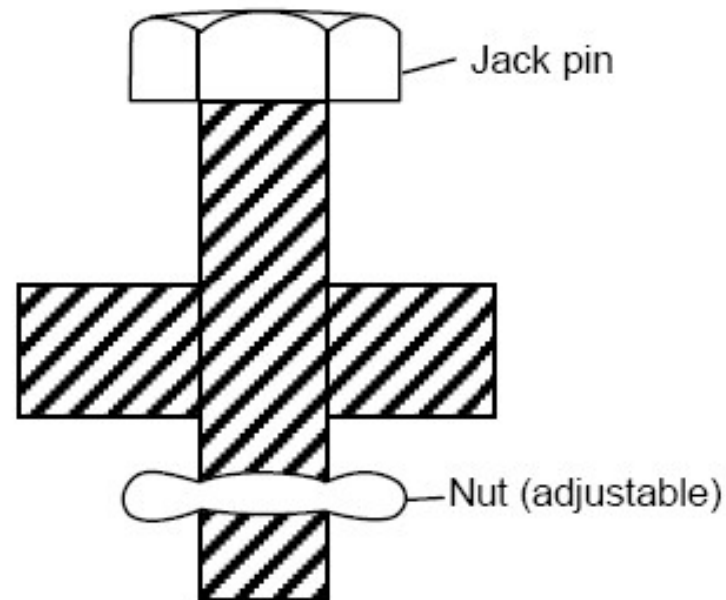
- **Cylindrical Locators:** Used for locating components having drilled holes.
- The cylindrical component to be located is gripped by a cylindrical locator fitted to the jig's body and inserted in the drilled hole of the component.



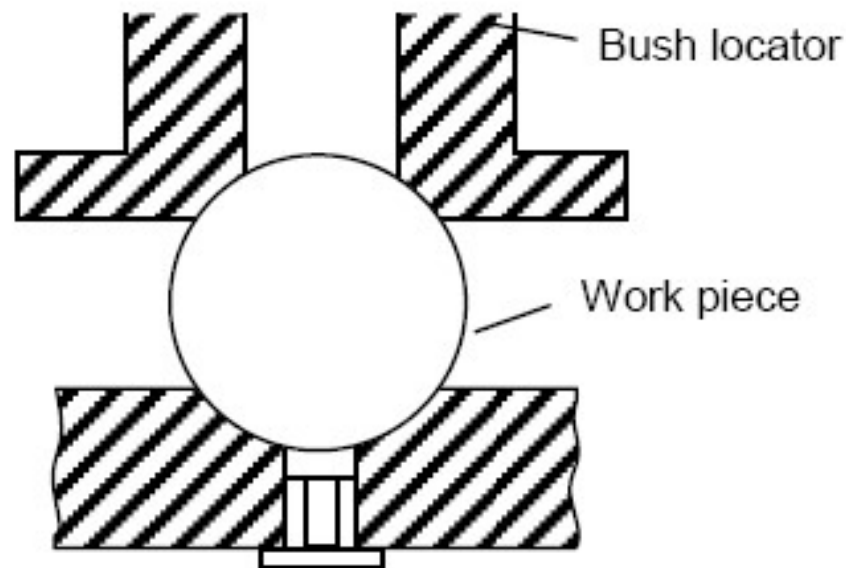
- **Conical Locator** : Used for locating the workpieces having cylindrical hole.
- It is superior as it has a capacity to accommodate a slight variation in the hole diameter of the component without affecting the accuracy of location.



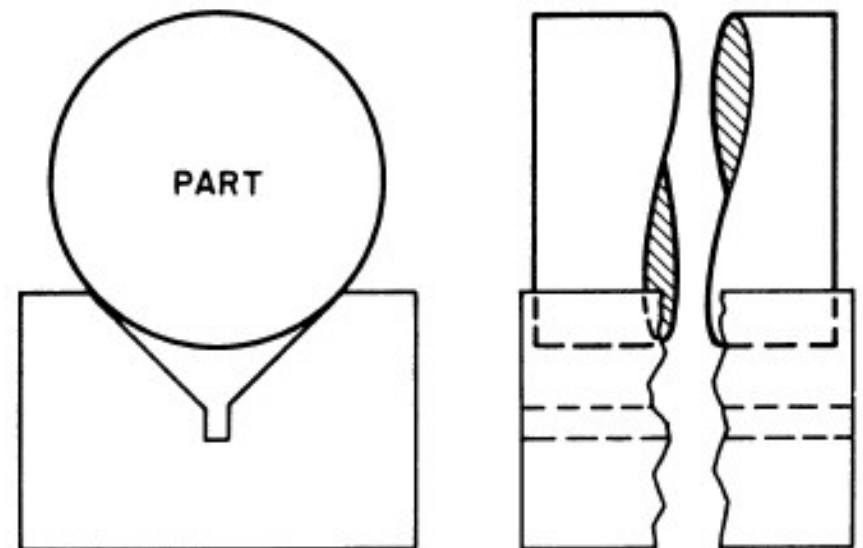
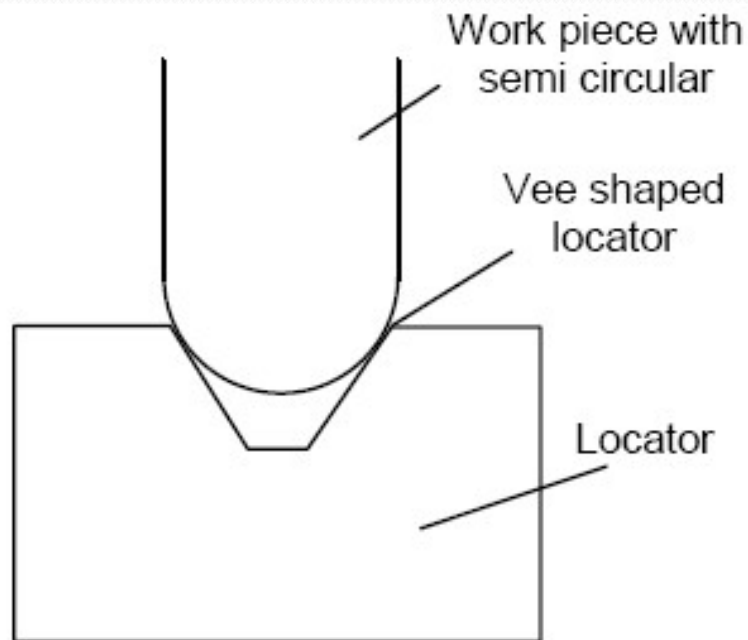
- **Jack Pin Locator** : Used for supporting rough workpieces.
- A suitable method to accommodate the components which are rough and un-machined.



- **Drill Bush Locator** : Used for holding and locating cylindrical workpieces.
- The bush has conical opening for locating purpose and it is sometimes screwed on the jig's body for the adjustment of height of the work.

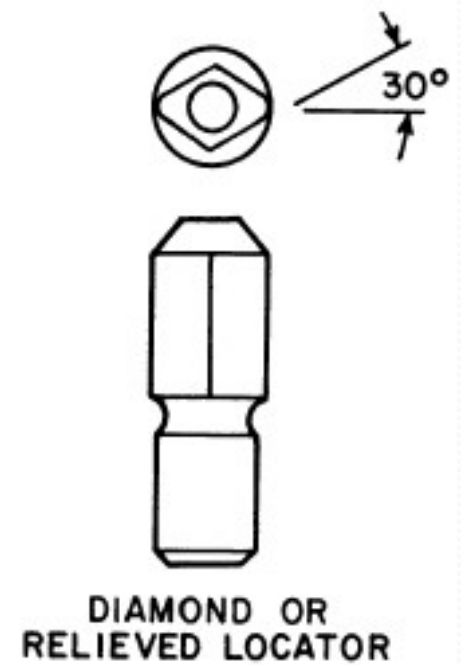
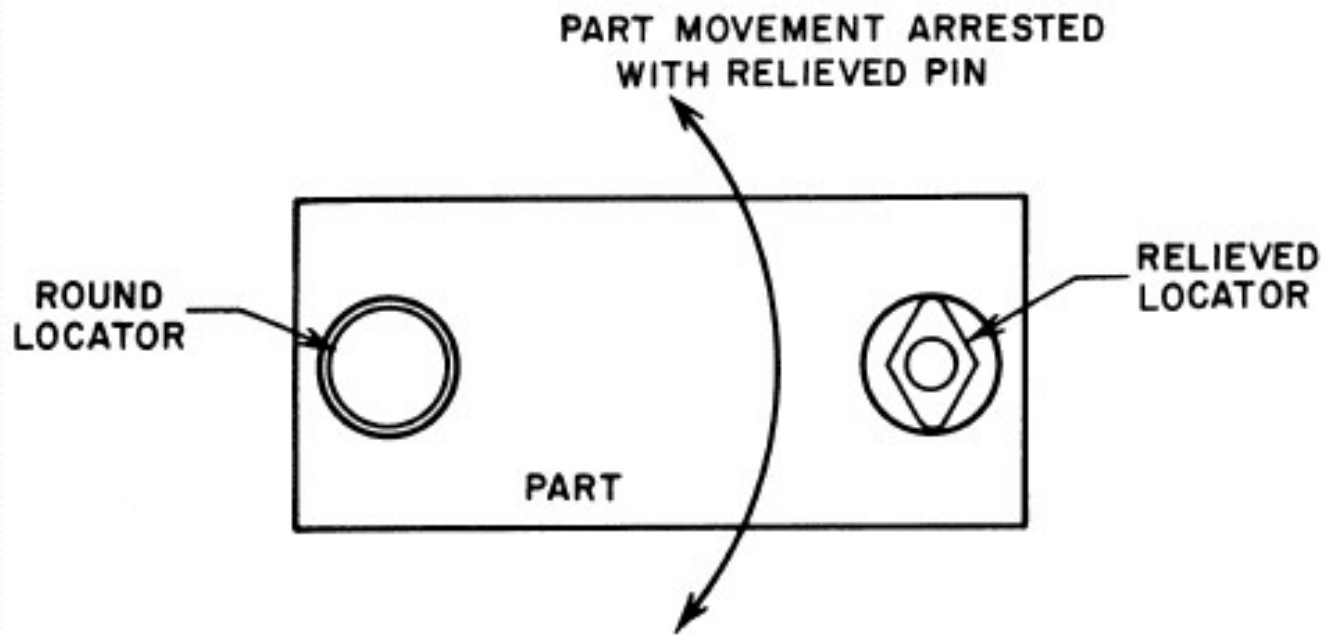


- **Vee Locators:** Quick and effective method of locating the workpiece.
- Used for locating the circular and semi-circular type of workpieces.



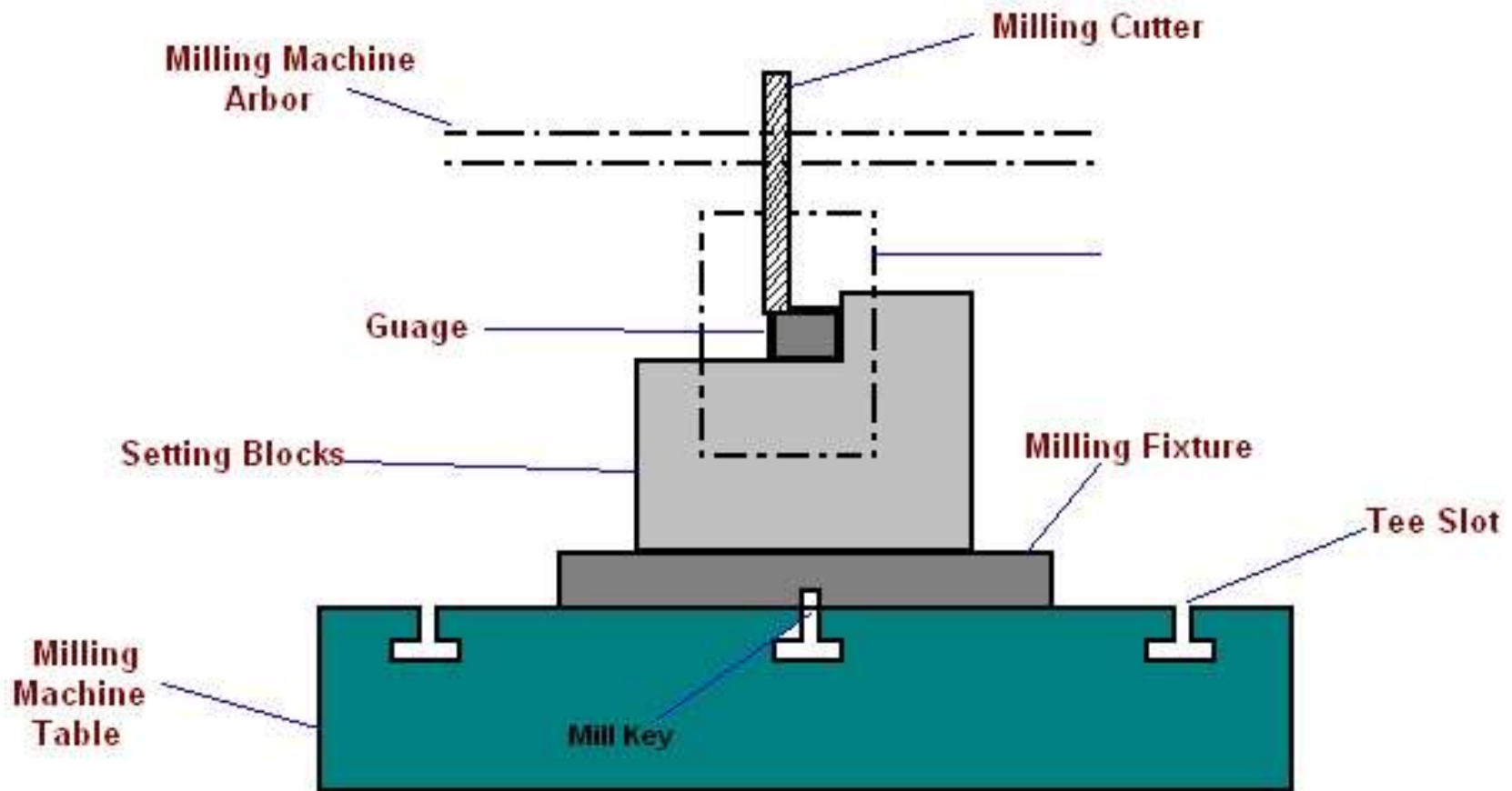
Diamond Pin Locator

- Diamond pins are often used for radial location .
- One cylindrical locator (Pin A) arrests five degrees of freedom, second cylindrical locator at the position B will arrest the sixth degree of freedom.
- If the two holes are identical in size then any pin can be made the principal locator. However, if one of the holes is larger then the principal locator will be placed in the larger hole.
- The second locator is made slightly smaller than the hole and relieved from both sides to take care of the variation in the X direction. The cylindrical surfaces will locate the part in the Y direction.



Setting Blocks

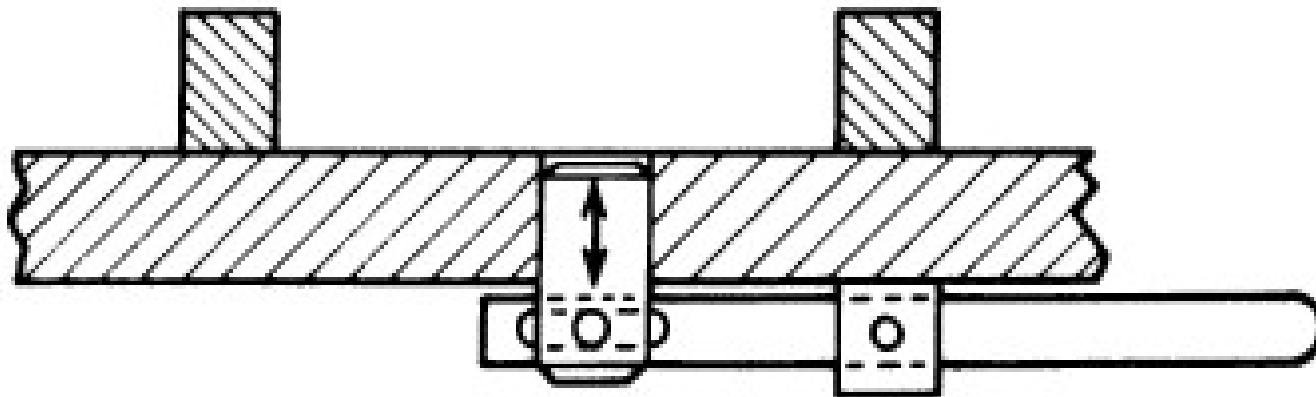
- After the fixture has been securely clamped to the machine table , the work piece which is correctly located in the fixture , has to be set in correct relationship to the cutters.
- This is achieved by the use of setting blocks and feeler gauges.
- The setting blocks is fixed to the fixture.
- Feeler gauges are placed between the cutter and reference planes on the setting block so that the correct depth of the cut and correct lateral setting is obtained.



Setting Blocks

Ejectors

- Used to remove work from close-fitting locators, such as full nests or ring nests.
- These devices speed up the unloading of the part from the tool, which reduces the in-tool time and increases the production rate.



MECHANICAL EJECTOR

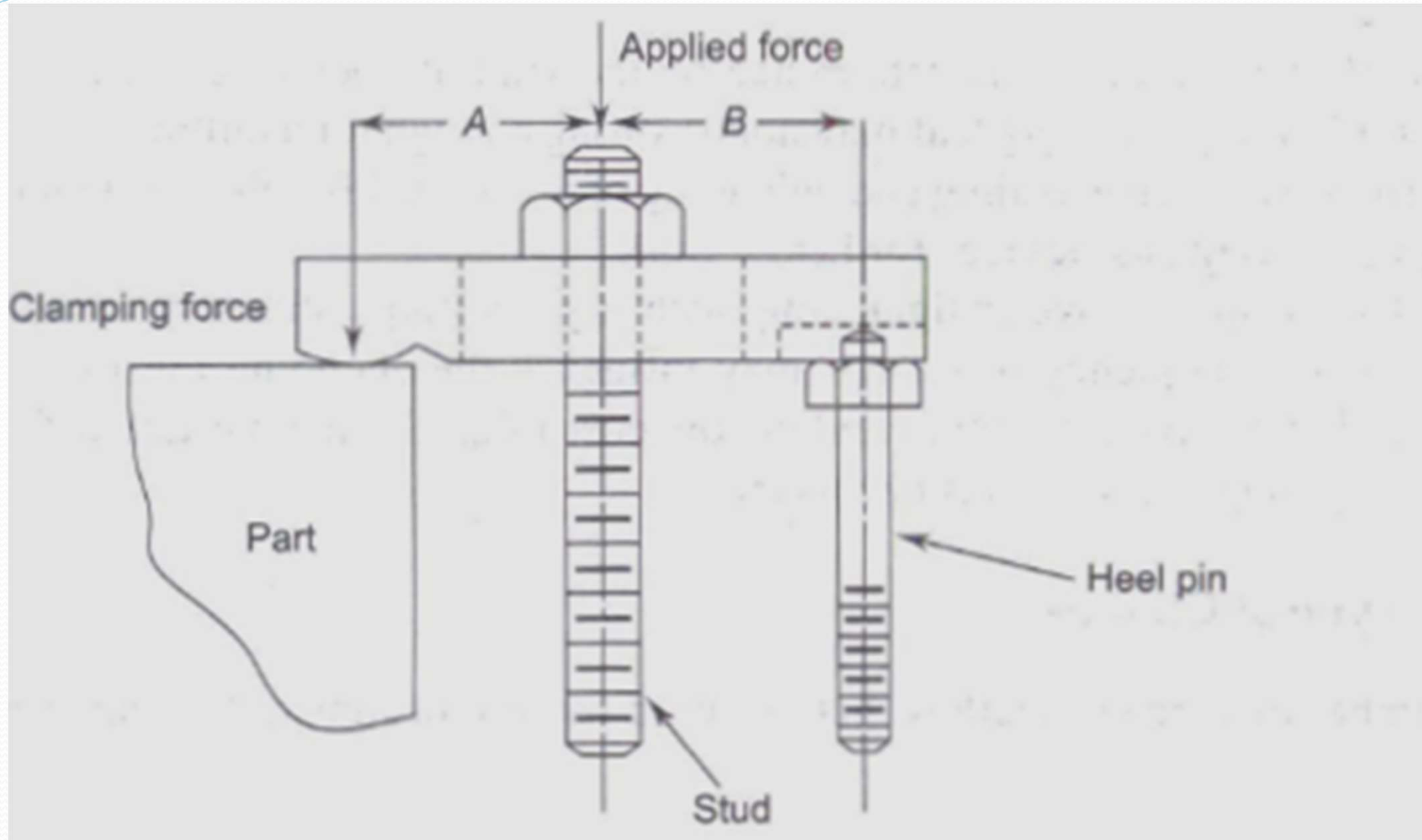


Clamping

- To restrain the workpiece completely a clamping device is required.
- Holds the workpiece securely in a jig or fixture against the forces applied over it during on operation.
- Device should be incorporated into the fixture, proper clamp in a fixture directly influence the accuracy and quality of the work done and production cycle time.

Strap Clamps

- Based upon the lever principles to amplify the clamping force required.
- By tightening the stud the clamping force is transferred to the part.
- Heel pin is the fulcrum about which the lever acts while the clamping force is applied at the stud by tightening the screw.
- The actual amplification of the applied force depends upon the distance between the stud and the heel pin (B), and that between the stud and the part (A).



Screw Clamps

- A much faster way of applying clamping is to make use of either a swing washer or a cee-washer if the workpiece has a bore for clamping.
- A swing washer can be used to clamp a part having a hole.
- This helps in loading and unloading the part quickly.
- The only condition is that the hole used for clamping should be larger than the nut used for clamping.
- A cee-washer is similar to a swing washer, which remains loose unlike a swing washer. Other-wise, application is very similar.



Cam Clamps

- Provide clamping force because of the contour of the cam surface that comes into contact with the plate used for the clamping.
- Plate is pushed down by the cam against the spring pressure to hold the part in place.
- Cam clamps are quick in operation.
- Cam clamps are of three types, eccentric cam, flat spiral cam and cylindrical cam.
- The design shown in Fig. is flat spiral and is the most commonly used clamp.

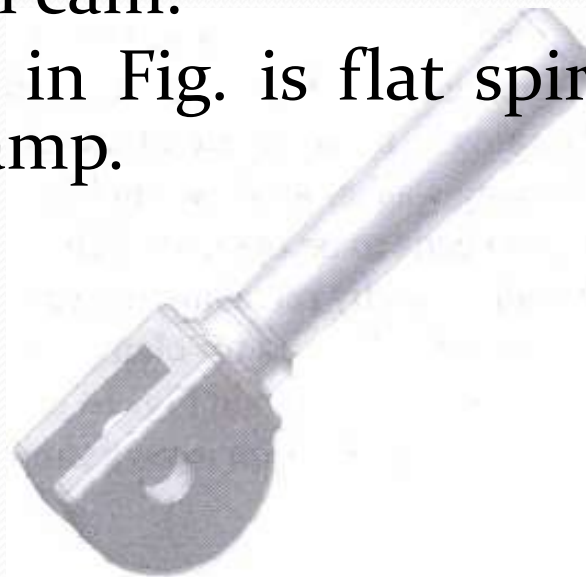


Fig. A cam clamp used for quick and easy clamping a part

- The design shown is indirect pressure clamping where the pressure is transmit to the part through the plate. This is more stable and the vibrations during machining do not affect the a part clamping.

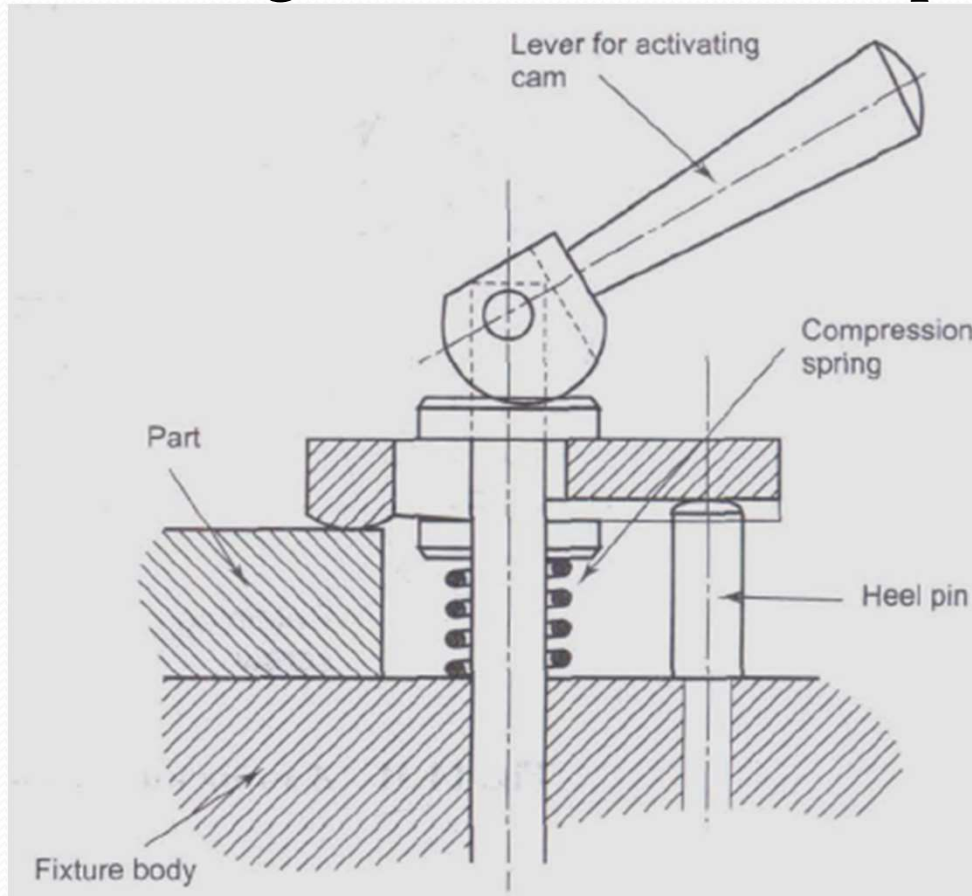


Fig. An example of a fixture held by a cam clamp

Toggle Clamps

- A toggle clamp is a quick acting mechanical linkage where two of the elements make up a toggle action.
- Toggle clamps are mainly used because of their fast action for clamping and unclamping, their ability to completely clear the work piece and the force Fixture amplification possible for clamping.

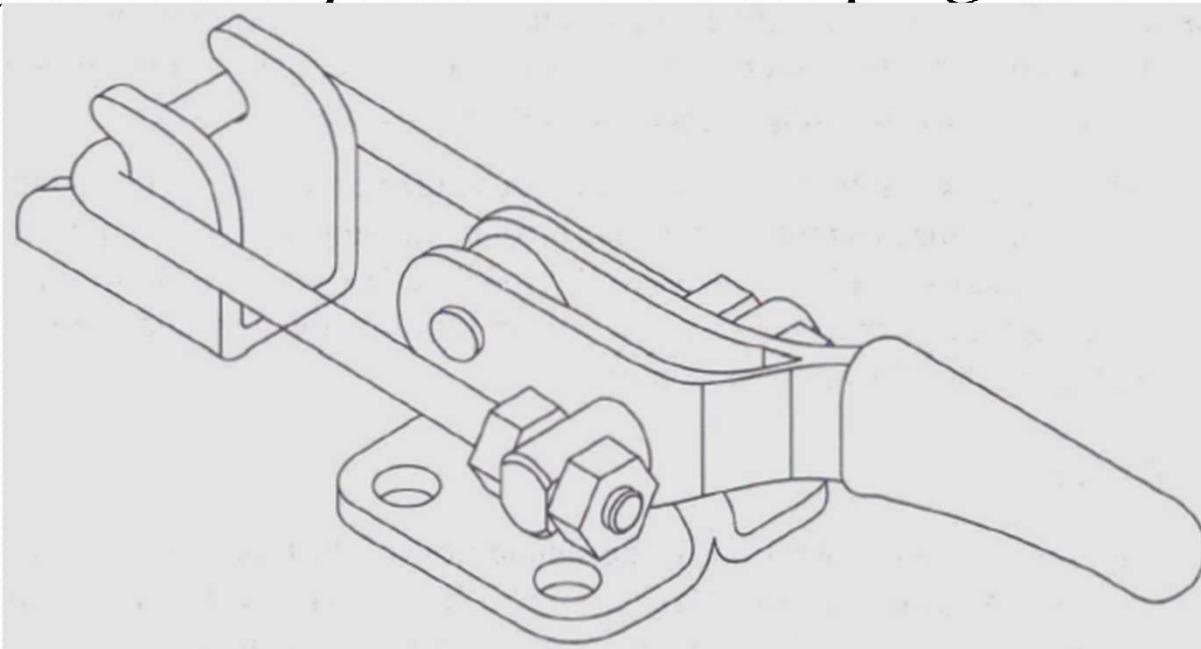


Fig. A push-pull type toggle clamp

Equalizers

- When the clamping force is to be applied at more than one location then an equalizing clamp is useful. In this type of clamp the link arm system is being used to apply an equally divided clamping force to a pair of clamps acting on the same component. It is also possible to use this system of clamping to clamp two parts.
- This is particularly useful in a condition where the operator may be denied easy access to one or other of the clamps.

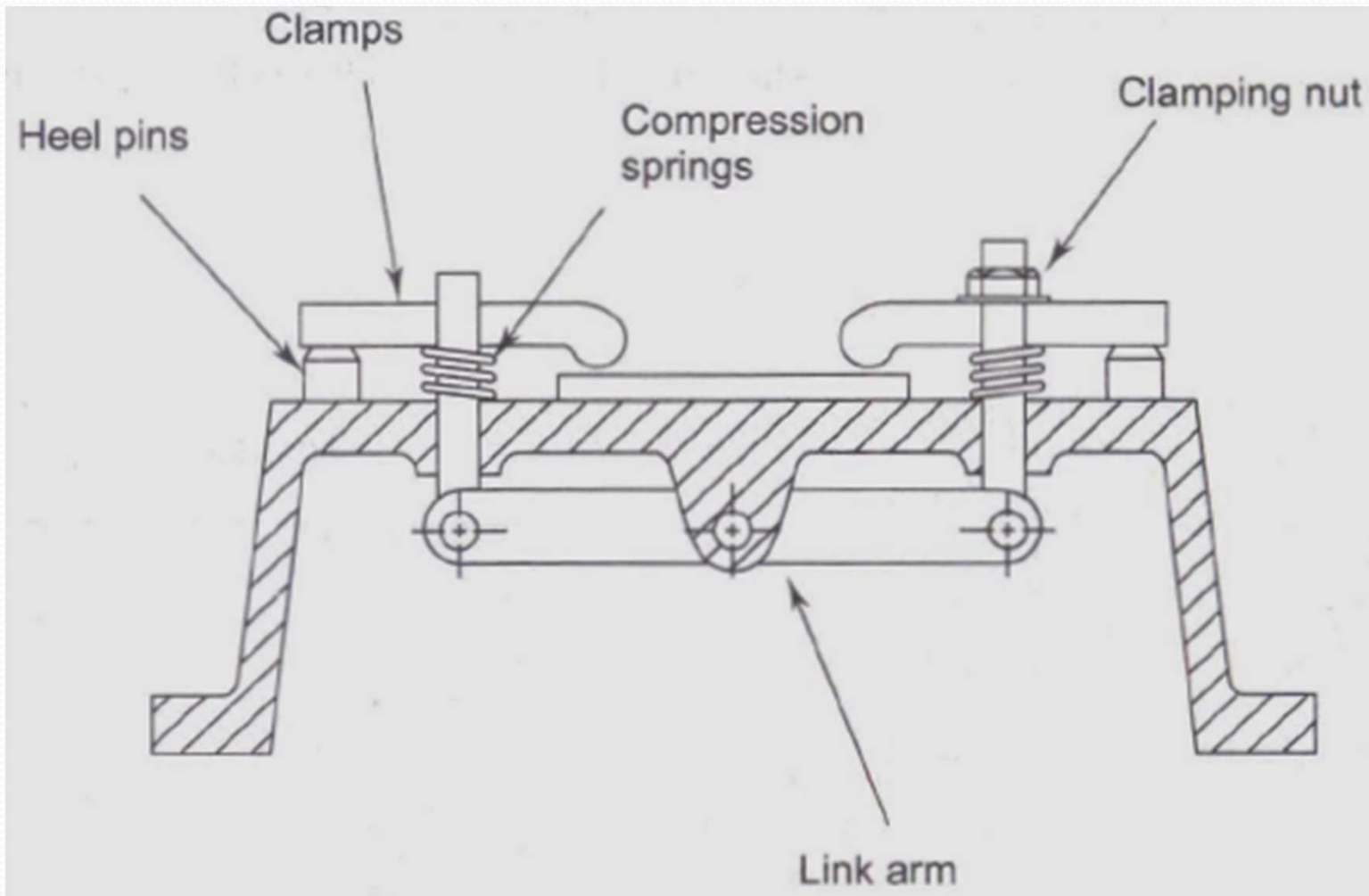


Fig. An equalizing clamp



Thank You