UNIT -3

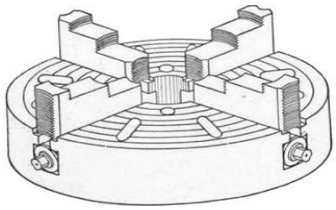
Holding Devices

When cutting operations are performed on the machine, lots of forces are generated. To balance these forces the work and the tool have to be held rigidly so that during cutting operation there should not be any vibration or jerk. The tool is held rigidly in the tool post with the help of bolts. The work is held in the various types of work holding devices like three jaw chuck, four jaw chuck, combination chuck, magnetic chuck, hydraulic chuck, face plate, driving plate, angle plate and lathe carriers.

Types of Work Holding Devices

The following are the various work holding devices used on lathe machine:

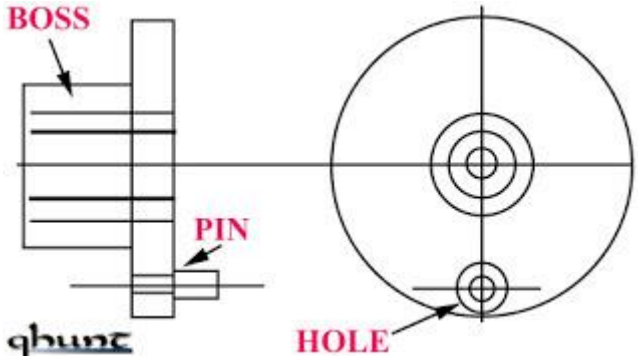
Chuck



Chucks is used for holding the work on the lathe during the operation. The most common types of chucks are:
(a) Three jaw chuck: It is also known as three jaw self centering chuck. It consists of a cylindrical body having three jaws fixed radially at its front. All the jaws move in the radial direction simultaneously.
(b) Four jaw chuck: All the jaws can be moved separately and adjusted at desired distance from the centre of the chuck. Due to this it is also known as independent jaw chuck. This enables the chuck to successfully hold irregular or eccentric jobs in addition to the regular cylindrical shaped jobs.
(c) Magnetic chuck: It holds the job by magnetic force
(d) Combination chuck: As the name implies, a combination chuck may be used as a self centering or as an independent chuck to take the advantages of both types. The jaws may be operated individually by separate screws or simultaneously by the scroll disc
(e) Collet chuck: It fits in to the spindle nose of the headstock. It can be used on a centre lathe, Capstan lathe, or turret lathe for producing items form bar stock. It is constructed with a hollow body having internal threads for screwing on the spindle nose.

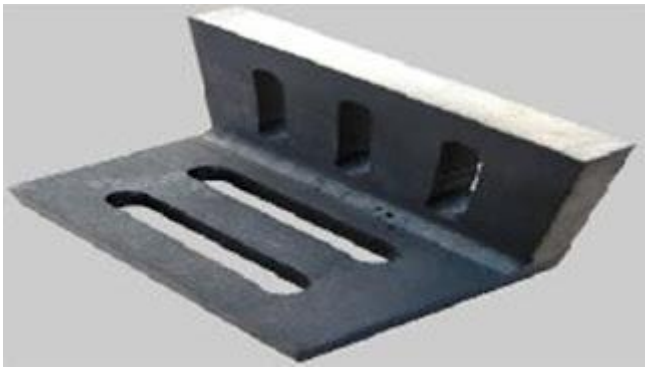
Face Plate: It is usually a circular cast iron disc having threaded hole at its centre so that it can be screw to the threaded nose of the spindle. It consists of number of holes and slots by means of which the  work can be secured.

Driving Plate



It is a cast circular disk having a projected boss at its rear. The boss carries internal threads so that it can be screwed on spindle nose. It also carries a hole to accommodate a pin which engages with the tail of a lathe dog or carriers.

Angle Plate



It is employed for holding odd shape work in conjunction with a faceplate. When the shape of the work is such that it is not possible to mount it directly on the face plate it can be mounted on angle plate.

Lathe Carriers or Lathe Dogs

These are used with the driving plate. The work to be inserted in the ‘V’ shaped hole of the carrier and then firmly secured in position by means of a screw.

The following are the usual methods of holding work on the milling machine

Types of work holding devices

Various types of work holding devices are explained in the following paragraphs.

T- Bolts and clamps - Bulky work pieces of irregular shapes are clamped directly on the milling machine table by using T- bolts and clamps. Different types of clamps are used for different patterns of work. The common types of clamps are shown in Fig 10 of chapter 5. All these clamps carry a long hole, through which clamping bolt passes. This hole permits the bolts for adjustment according to the size and shape of the job.

Angle plates - When work surfaces are to be milled at right angles to another face, angle plates are used for supporting the work.

V block - The V blocks are used for holding shafts on milling machine table in which keyways and slots are to be milled.

Vices - Vices are most common appliance for holding work on milling machine table. According to its quick loading and unloading arrangement. Vices are of three types,

(a) **Plain Vice -** The plain vice is directly bolted on the milling machine table is the most common type of vice used on plain milling operations, which involves heavy cuts, such as in slab milling. Its especially low construction enables the work to remain quite close to the table. This reduces the chance of vibration to minimum. The base carries slots to accommodate 'T' bolts to fix the vice on the table. Work is clamped between the fixed and movable jaw and for holding work pieces of irregular shape special jaws are sometimes used.

(b) **Swivel Vices -** The swivel vice is used to mill an angular surface in relation to a straight surface without removing the work from the vice. It has got circular base graduated in degrees. The base is clamped on the table by means of T- bolts.

(c) **Universal Vices -** It can be swiveled in a horizontal plane similar to a swivel vice and can also be tilted in any vertical position for angular cut. The vice is not rigid in construction and is used mainly in tool room work. It enables the milling of various surfaces, at an inclination to one another, without removing the work piece.

Work Holding Devices Used on Milling Machine

Dividing Head - Dividing head or indexing head used to hold the work piece and divide the periphery into the number of divisions required. These are of three types:

(a) Plain dividing head
(b) Universal dividing head
(c) Optical dividing head

Tool Holding Devices:

There are two types of tool holding devices used in CNC machines:

1. Spindle Tooling

2. Flexible Tooling

1. Spindle tooling – It is mostly used on milling, drilling & borning machines. These are defined as follows

a. Collet Chuck

b. End mill adopter

c. Face mill adopter

d. Boring Head

e. Tapping Head

f. Shell mill adopter

Flexible tooling: Do flexible tooling from class notes

Work locating and holding devices

In order to have mass production we need devices that helps quick, easy mounting & removal of raw material. Mass production methods demand a fast and easy method of positioning work for accurate operations on it. So jigs & fixtures are used as work locating devices.

JIGS : It is a work holding device that holds, supports and locates the workpiece and guides the cutting tool for a specific operation. A jig is a type of tool used to control the location and/or motion of another tool. A jig's primary purpose is to provide repeatability, accuracy, and interchange ability in the manufacturing of products. A device that does both functions (holding the work and guiding a tool) is called a jig.
A device that does both functions (holding the work and guiding a tool) is called a jig.

FIXTURES : Fixtures are used to securely locate (position in a specific location or orientation) and support the work, ensuring that all parts produced using the fixture will maintain conformity and interchangeability. Using a fixture improves the economy of production by allowing smooth operation and quick transition from part to part, reducing the requirement for skilled labor by simplifying how workpieces are mounted, and increasing conformity across a production run**.**Fixtures must always be designed with economics in mind; the purpose of these devices is to reduce costs, and so they

must be designed in such a way that the cost reduction outweighs the cost of implementing the fixture.

Purpose[edit]

A fixture's primary purpose is to create a secure mounting point for a workpiece, allowing for support during operation and increased accuracy, precision, reliability, and interchangeability in the finished parts

How do jigs and fixtures differ?

Jig- It is a work holding device that holds, supports and locates the workpiece and guides the cutting tool for a specific operation

Fix.- It is a work holding device that holds, supports and locates the workpiece for a specific operation but does not guide the cutting tool

Jig- Jigs are not clamped to the drill press table unless large diameters to be drilled and there is a necessity to move the jig to bring one each bush directly under the drill.

Fix.- Fixtures should be securely clamped to the table of the machine upon which the work is done.

Jig- The jigs are special tools particularly in drilling, reaming, tapping and boring operation.

Fix.- Fixtures are specific tools used particularly in milling machine, shapers and slotting machine.

Jig- Gauge blocks are not necessary.

Fix.- Gauge blocks may be provided for effective handling.

Jig- Lighter in construction.
Fix.- Heavier in construction.

Advantages of Jigs and Fixtures

PRODUCTIVITY:

Jigs and fixtures increases the productivity by eliminating the individual marking, positioning and frequent checking. The operation time is also reduced due to increase in speed, feed and depth of cut because of high clamping rigidity.

INTERCHANGEABILITY AND QUALITY:

Jigs and fixtures facilitate the production of articles in large quantities with high degree of accuracy, uniform quality and interchangeability at a competitive cost .

- SKILL REDUCTION:

There is no need for skillful setting of work on tool. Jigs and fixtures makes possible to employ unskilled or semi skilled machine operator to make savings in labour cost.

- COST REDUCTION:

Higher production, reduction in scrap, easy assembly and savings in labour cost results in ultimate reduction in unit cost.

Fundamental principles of Jigs and Fixtures design

LOCATING POINTS: Good facilities should be provided for locating the work. The article to be machined must be easily inserted and quickly taken out from the jig so that no time is wasted in placing the workpiece in position to perform operations. The position of workpiece should be accurate with respect to tool guiding in the jig or setting elements in fixture.

FOOL PROOF: The design of jigs and fixtures should be such that it would not permit the workpiece or the tool to inserted in any position other than the correct one.

REDUCTION OF IDLE TIME: Design of Jigs and Fixtures should be such that the process, loading, clamping and unloading time of the workpiece takes minimum as far as possible.

- WEIGHT OF JIGS AND FIXTURES: It should be easy to handle, smaller in size and low cost in regard to amount of material used without sacrificing rigidity and stiffness.
- JIGS PROVIDED WITH FEET: Jigs sometimes are provided with feet so that it can be placed on the table of the machine.
- MATERIALS FOR JIGS AND FIXTURES: Usually made of hardened materials to avoid frequent damage and to resist wear. Example- MS, Cast iron, Diesteel, CS, HSS.

CLAMPING DEVICE:
It should be as simple as possible without sacrificing effectiveness. The strength of clamp should be such that not only to hold the workpiece firmly in place but also to take the strain of the cutting tool without springing when designing the jigs and fixtures.

Essential features of Jigs and Fixtures

- Reduction of idle time – Should enable easy clamping and unloading such that idle time is minimum
- Cleanliness of machining process – Design must be such that not much time is wasted in cleaning of scarfs, burrs, chips etc.
- Replaceable part or standardization – The locating and supporting surfaces as far as possible should be replaceable, should be standardized so that their interchangeable manufacture is possible
- Provision for coolant – Provision should be there so that the tool is
cooled and the swarfs and chips are washed away

Hardened surfaces – All locating and supporting surfaces should be hardened materials as far as conditions permit so

that they are not quickly worn out and accuracy is retained for a long time

- Inserts and pads – Should always be riveted to those faces of
the clamps which will come in contact with finished surfaces of the workpiece so that they are not spoilt

- Fool-proofing – Pins and other devices of simple nature incorporated in such a position that they will always spoil the placement of the component or hinder the fitting of the cutting tool until the latter are in correct pos

Economic soundness – Equipment should be economically sound, cost of design and manufacture should be in proportion to the quantity and price of producer

- Easy manipulation – It should be as light in weight as possible
and easy to handle so that workman is not subjected to fatigue, should be provided with adequate lift aids

- Initial location – Should be ensured that workpiece is not located on more than 3 points in anyone plane test to avoid rocking, spring loading should be done

- Position of clamps – Clamping should occur directly above the points supporting the workpiece to avoid distortion and springing

Clearance – Sufficient amount of clearance should be provided
around the work so that operator's hands can easily enter the

body for placing the workpiece and any variations of work can be
accommodated

- Ejecting devices – Proper ejecting devices should be incorporated
in the body to push the workpiece out after operation

- Rigidity and stability – It should remain perfectly rigid and stable
during operation. Provision should be made for proper positioning
and rigidly holding the jigs and fixtures

- Safety – The design should assure perfect safety of the operator

MEANING OF LOCATION

It is very important to understand the meaning of location before understanding abut the jigs and fixtures. The location refers to the establishment of a desired relationship between the workpiece and the jigs or fixture correctness of location directly influences the accuracy of the finished product. The jigs and fixtures are desired so that all undesirable movements of the workpiece can be restricted. Determination of the locating points and clamping of the workpiece serve to restrict movements of the component in any direction, while setting it in a particular pre-decided position relative to the jig. Before deciding the locating points it is advisable to find out the all possible degrees

of freedom of the workpiece. Then some of the degrees of freedom or all of them are restrained by making suitable arrangements. These arrangements are called locators.

General rules for designing

Compare the cost of production of work with present tools with the expected cost of production, using the tool to be made and see that the cost of buildings is not in excess of expected gain.
Decide upon locating points and outline clamping arrangement
Make all clamping and binding devices as quick acting as possible
Make the jig fool proof
Make some locating points adjustable
Avoid complicated clamping arrangements
Round all corners
Provide handles wherever these will make handling easy
Provide abundant clearance
Provide holes on escapes for chips
Locate clamps so that they will be in best position to resist the pressure of the cutting tool when at work
Place all clamps as nearly as possible opposite some bearing point of the work to avoid springing action
Before using in the shop, test all jigs as soon as made

Factors to be considered for design of Jigs and Fixtures

1. Component-

Design to be studied carefully

Ensure work is performed in a proper sequence
Maximum operations should be performed on a machine in single setting

2. Capacity of the machine-

Careful consideration to be performed on type and capacity of machine.

3. Production requirements-

Design to be made on basis of actual production requirements. Then comes decision on manual and automatic tooling arrangements.

4. Location-

- Location should ensure equal distribution of forces throughout all sequence of operation.
- Location should be hard resistant, wear resistant and high degree of accuracy.
- Movement of workpiece should be restricted.
- Should be fool proofed to avoid improper locations of the workpiece.
- Should facilitate easy and quick loading of workpiece.
- Redundant locators should be avoided.
- Sharp corners must be avoided.
- At least one datum surface should be establised.

5. Loading and Unloading arrangements-

There should be adequate clearance for loading and unloading. Hence process becomes quick and easy.
Size variation must be accepted.
It should be hardened material and non sticky.

6. Clamping arrangements-

Quick acting clamps must be used as far as possible.
The clamping should not cause any deformation to the workpiece

It should always be arranged directly above points supporting the work.
Power driven clamps are favoured as they are quick acting, controllable, reliable and operated without causing any fatigue to the operators.

Features of clamps:

Clamping pressure should be low
Should not cause distortion
Simple and fool proof
Movement of clamp should be minimum
Case hardened to prevent wear
Sufficiently robust to avoid bending

7. Clearance between Jig and Component-

To accommodate various sizes if work
Chips to pass out of the opening between them

8. Ejectors-

To remove work from close fitting locators.
Speeds up unloading of the part from the tool and hence production rate.

9. Base and Body construction-

Methods used: Machining, Forging and machining, Casting, Fabricating, Welding.

10. Tool guiding and cutter setting-

By adjusting the machine or using cutter setting block, the cutter is set relative to the work in a fixture. The drill bushes fitted on jig plates guides the tools.

11. Rigidity and vibration-

Must possess enough rigidity and robustness.
Should not vibrate as it may lead to unwanted movement of workpiece and tools.

12. Safety-

Operation should be assured full safety.

13. Cost-

Should be simple as possible.

Cost incurred should be optimum.