UNIT 3 DESIGN OF JIGS

3.1 INTRODUCTION

Mass production targets on increasing productivity and increasing accuracy by reducing the setup cost and manual fatigue. One of the common practices to achieve the goals of mass production is to use jigs. Let us consider an example that one gets an order of 1000 product in such a way that three holes are to be drilled in a workpiece. In such situations, designer will lay out the position of each hole with the help of square, straightness, scribers, centre punch etc. Generally, trial and error method is practiced until the axis of hole is properly aligned with the axis of drill. Thus, a lot of time will be consumed to maintain the accuracy. Ultimately it increases operator’s fatigue. Thus, instead of laying out the position of each hole on each workpiece with the aid of square, straightness, scribers, centre punch etc., the operator uses a jig to position and guide the drill into proper place. Drill jig increases productivity by eliminating individual marking, positioning and frequent checking. Interchangeability is one of the advantages of jigs. There is no need for selective assembly. Any of the parts will fit properly in the assembly and all similar components are interchangeable. In addition, a jig reduces the repetitive nature required for drilling a hole, as the locating, clamping and guiding are done by jig itself. The tool-guiding element helps in setting of tool in correct position. Hence, skilled workers are not required. Drill jig makes it possible to drill, ream and tap holes at much faster speed and with great accuracy as compared to holes produced by conventional hand methods. The responsibility for accuracy of hole location is taken from the operator and given to the jig.

Jig can be defined as a workpiece holding and locating device that positions and guides or controls the cutting tool. Drill jig is device to ensure a hole to be drilled, tapped or reamed in the workpiece at proper place.

Drill jig consists of a clamping device to hold the part in the position under hardened steel bushings. Drill passes through the steel bushings during drilling operation. The drill is guided by these bushings. Generally workpiece is held by jig and the jig is arranged in such a way that the workpiece can be quickly loaded and unloaded.
Objectives

After studying this unit, you should be able to

- know different types of locating elements,
- know different types of clamping elements,
- know different guiding elements,
- design various types of jigs, and
- differentiate various types of jigs.

3.2 DESIGN OF JIGS

3.2.1 Elements of Jig

Jig generally consists of locating element, clamping element and tool guiding or setting element.

Locating Elements

Locating elements position the workpiece accurately with respect to tool guiding elements in the jig.

Clamping Elements

Clamping elements hold the workpiece securely in the located position during operation.

Tool Guiding Elements

Tool guiding elements help in guiding the tools in correct position with respect to the workpiece. Drill bushes guide the drills accurately to the workpiece.

3.2.2 Design Consideration in Jigs

(a) The main frame of jig must be strong enough so that the deflection of jig is as minimum as possible. This deflection of jig is caused due to the forces of cutting, clamping of the workpiece or clamping to the machine table. The mainframe of the jig should have the mass to prevent vibration and chatter.

(b) Frames should be built from simple sections so that frames can be fastened with screws or welded, whenever necessary. Those parts of the frame that remain intact with the jig may be welded. The parts needing frequent changing may be held with the screws. Where the body of jig or fixture has complex shape, it may be cast from good grade of cast iron.

(c) Clamping should be fast enough and require least amount of effort.

(d) Clamps should be arranged so that they are readily available and may be easily removed.

(e) Clamps should be supported with springs so that clamps are held against the bolt head wherever possible.

(f) If the clamp is to swing off the work, it should be permitted to swing as far as it is necessary for removal of the workpiece.

(g) All locators, clamps should be easily visible to the operator and easily accessible for cleaning, positioning or tightening.

(h) Provision should be made for easy disposal of chip so that storage of chips doesn’t interfere with the operation and that their removal during the operation doesn’t interfere with the cutting process.
(i) All clamps and support points that need to be adjusted with a wrench should be of same size. All clamps and adjustable support points should be capable of being operated from the fronts of the jig.

(j) Workpiece should be stable when it is placed in jig. If the workpiece is rough, three fixed support points should be used. If workpiece is smooth, more than three fixed support points may be used. Support point should be placed as farthest as possible from each other.

(k) The three support points should circumscribe the centre of gravity of the workpiece.

(l) The surface area of contact of support should be as small as possible without causing damage to the workpiece. This damage is due to the clamping or work forces.

(m) Support points and other parts are designed in such a way that they can be easily replaced on failure.

3.2.3 Presentation of Workpiece

The representation of workpiece is shown in Figure 3.1. The workpiece is shown by chain dotted line. This is because workpiece is assumed to be transparent. The elements of jig such as clamps, locators, supports etc. are shown by continuous line.

![Figure 3.1: Representation of Workpiece](image)

3.2.4 Location

One of the most important requirements of a successful jig design is that when workpiece is machined and removed from the jig, the operator should be able to put another workpiece quickly into jig, clamp it and machine it to the dimensions with given tolerance.

3.2.5 Principles of Location

(a) Relate the location to dimensional requirements of workpiece.

(b) It is preferable to use most accurate machined surface for location. If there is variation on the selected surface, the new surface will also contain variations and one can get workpiece with defects. If most accurate machined surface is not available, select better machined surface out of available machined surfaces. Figure 3.2 shows how to select accurate surface for location.

(c) Prevent motion along and around X, Y, Z.

(d) Location system should provide easy and quick loading and unloading of workpiece with minimum motions.
(e) Avoid redundant locators. Redundant locator means more locators are provided than required for support. If three supports are sufficient and one places four supports also, then fourth support is redundant. There are stool stands on four legs. But stool can also stand comfortably on three legs. In this case fourth leg is redundant one.

(f) Prevent wrong loading of workpiece by fool-proofing.

Figure 3.2 (a) and (b) : Principle of Location

In order to locate the workpiece successively in holding device in the same plane, the device should provide control through six degrees of freedom in space. Six degrees of freedom refers to three linear motions and three rotational motions in the space. The movement along and around three mutually perpendicular axis is shown in Figure 3.2(a). When these six motions are controlled then only design of jig is said to be good. The steel block floating in the space is shown in Figure 3.2(b). Here the block is free to move or rotate in any direction along or around three axes. If obstruction is placed in path of these motions, it will eliminate degrees of freedom. The steel block is resting on three supports as shown in Figure 3.2(c). Hence, block is unable to move along z-axis. Also, block is unable to rotate about x- and y-axis. But, the block moves along x- and y-axis while rotate about z-axis only.

Figure 3.2(c) : Principle of Location

Similarly by adding two buttons (marked 2 as shown in Figure 3.2(d)), it is possible to prevent linear motion of block along y-axis and also rotational motion around z-axis. In addition, adding pin (marked 3) as shown in Figure 3.2(e), it is possible to prevent the motion of block along and around three mutually perpendicular axes.
Figure 3.2 (d) and (e): Principle of Location

Figure 3.2(e) also explains 3-2-1 principle of location. This 3-2-1 principle states that “a workpiece will be completely confined when placed against three points in one plane, two points in another plane and one point in third plane if the planes are perpendicular to each other”. Workpiece should be supported on three buttons support for any holding device.

To achieve dimensional requirement, proper surface for location is selected. Figure 3.3 shows how to select surface to achieve dimensional requirement. Here hole C is at larger distance from surface B as compared to surface A. Also hole depends upon one parameter from surface A, i.e. on distance D while hole depends upon two parameter from surface A i.e. on distance D as well as distance L. If surface B (if it has some errors) is selected as a reference surface, error will accumulate on final dimension. Hence, best choice is to select surface A for location.

Figure 3.3: Dimensional Requirement

It is preferable to use most accurate machined surface for location. If there is variation on the selected surface, the new surface will also contain variations and we get workpiece with defects. If most accurate machined surface is not available, select better machined surface out of available machined surfaces. Figure 3.4 shows how to select accurate surface for location.

Figure 3.4: Accurate Surface
Loading and unloading should be easy and quick. Figure 3.5 shows principle of motion economy. Principle of motion is selecting surface for location with minimum motions. Here we will have to drill two holes namely A and C. We can drill hole by two ways: First drill hole A and then drill C. Here as the axis of hole A and B is same, our first task is to align the axis of A with B. By locating hole B by pin (restricts the movement along the axis), we can first drill hole A. Then hole A is used for location to drill hole C. And by removing the pin the work is completed. Hence there is only one motion to complete the work.

![Figure 3.5: Motion Economy](image)

In the second case, Drill hole C first and then drill hole A. If we drill hole C, we will have to lock its movement. Hence, here movement is more. Thus, we will go for drilling of hole A first and then hole C. Therefore, first select the surface which gives minimum motion in order to reduce loading and unloading time that will automatically reduce operator’s fatigue.

If the workpiece is like as shown in Figure 3.6(a), we will get different orientation. The other orientation is shown in Figure 3.6(b). Reorientation is very difficult to avoid even after locating the workpiece. In such situation, pin is provided to obstruct the movement of workpiece. This pin is shown in Figure 3.6(c).

![Figure 3.6: Foolproofing](image)

### 3.2.6 Location Methods

A workpiece can be located from

- (a) Plane surface
- (b) Profile surface
- (c) Cylindrical surface
**Plane Surface**

A plane surface can be located by three pins. The pin locator is shown in Figure 3.7. A rough surface can be located by means of location pads having point contact. This is achieved by providing spherical surface at the locating point on locating pins. Pins should be located as wide as possible from each other. The height of pins should be equal so that the located surface is parallel to the base plate. This base plate is rested on machine table.

![Pin Locator](image)

**Figure 3.7 : Pin Locator**

If workpiece is undersize or oversize, the fixed pin should not provide adequate support. Adjustable locator can take care of variation in workpiece. This adjustable pin locator is shown in Figure 3.8. An adjustable pin takes care of uneven surface also. There should be provision for collection of chips. Sometimes 3-2-1 principle is not useful for larger workpiece. Hence, extra workpiece should be used to maintain stability and rigidity.

![Adjustable Pin Locator](image)

**Figure 3.8 : Adjustable Pin Locator**

**Profile Surface**

The profile is generally located by means of sighting plate. Sighting plate is slightly greater than workpiece. The workpiece is located by means of sighting plate and is shown in Figure 3.9. There is generally uniform clearance in between workpiece and sighting plate. Sighting plate provides visual justification of surface of workpiece.

![Clearance](image)

**Figure 3.9**
The profile is also located by means of pin as shown in Figure 3.10. These pins act as a restriction to the movement of the workpiece.

![Figure 3.10 : Pin Locator for Profile](image)

**Cylindrical Surface**

Location for cylindrical surface is the most common and convenient form of location. When cylinder is located on its axis and base, it can rotate only about its axis and all other motions are constrained. Cylindrical locator is shown in Figure 3.11. The length of locator should be small to prevent jamming. As large area comes in contact with workpiece surface, friction may occur. Hence, more force is required to remove the locator. By providing relief, the force is minimized to great extent. Also, recess will help in removing burr.

![Figure 3.11 : Diamond Locator](image)

**Diamond Locator**

Diamond shaped pin should be used to constrain pivoting of the workpiece around principle locator. The principle locator should be longer than diamond pin so that workpiece cannot be located and pivoted around it before engaging with diamond pin. This will help in removing of the workpiece quickly. Figure 3.12 shows locating the workpiece with diamond shaped pin. If two fixed pins are provided, it will not accommodate the variation in the central distance of hole. This problem is avoided by using diamond pin. Also one diamond pin is sufficient to position the hole in the workpiece while other hole is positioned with the help of fixed pin.

![Figure 3.12 : Locating Workpiece by Diamond Locator](image)

The diamond locator should be positioned in smaller hole. As the width of diamond pin is less than the diameter of diamond pin, the variation in the hole is accommodated by diamond pin. The diamond pin locator is shown in Figure 3.13.
Design of Jigs

**V Locator**

*V* locators are widely used for locating cylindrical surfaces from outside. Fixed *v*-locator is shown in Figure 3.14. It is used for approximate location. It is generally fixed by screws to jig body and dowelled to avoid any shift during operation.

![Fixed V Locator](image)

By making *V*-locator adjustable along its axis, one can decide accurate location. The position of *V*-block is adjusted by a screw to take care of the variation in the size of the workpiece. An adjustable *V*-block is guided by a guide plate to control its motion along the axis of *V*-block. The guide should be dowelled to avoid shifting during the operation.

![Adjustable V Locator](image)

**Conical Locator**

Conical locators are extensively used for locating rough unmachined cylinders generally made from castings and forgings. Cored holes and bosses are centralized by conical locators. Conical locator is shown in Figure 3.16.
Design of Cutting Tools and Holding Devices

Conical locators have axial adjustment with a screw, which is also used to clamp the located workpiece in position. When casting has a single boss, which is to be drilled, a bush is made integral bush with locator to help in drilling of the workpiece in the desired position.

3.2.7 Clamping

Clamping is accomplished by clamps. Clamps hold the workpiece, which is firmly engaged with locators during operation. The clamping system should be strong enough to withstand forces developed during operation. At the same time, clamping force should not damage the workpiece. The timing required for loading and unloading must be as minimum as possible. Clamping must be positive when subjected to vibration, chatter etc.

Principles of Clamping

(a) Clamps should be positioned in such a way that clamping force shall act as a strong, supported part of the workpiece. Clamping on unsupported part bends the workpieces as shown in Figure 3.17. This will affect the accuracy of the operation. A vertical hole drilled in bent workpiece will become angular when the unclamped workpiece come back to original shape as shown in Figure 3.17 by dotted line.

(b) Clamping system should not obstruct the path of loading and unloading.

(c) Clamping system should be capable of holding the workpiece securely against the forces developed during the operation. Also clamping system should not damage the workpiece with excessive pressure. For clamping weak workpiece, the clamping force should be distributed over larger area of the workpiece. While clamping soft workpiece, clamp should be fitted with pads of softer material such as nylon or fibre to prevent damage to the workpiece.
Clamping time should be minimized by using handles, hand wheels, hand knobs, tommy bars, knurled screws etc. Clamp can be loosened or tightened manually without using spanners because spanner will increase the motion of picking, aligning etc.

If the number of clamps are to be loosened or tightened repeatedly, then it is preferable to use hydraulic or pneumatic clamping. This will reduce operators fatigue and saves clamping time also. Power clamping provides loosening and tightening simultaneously.

The clamping points should be provided with sufficient radius. This radius will take care of variation in the workpiece. Sphere heel pin is used to allow tilting of the clamp. Clamping variable workpiece is shown in Figure 3.18.

Spherical washers between clamp and nut will take care of the misalignment between clamp surface and clamping nut due to tilting of nut. Two pairs of washers have matching male female spherical seats. The spherical bearing permits the washer to tilt with respect to each other. As the lower female washer tilts with the clamp, upper male washer below the nut can remain square with the nut. The clamping pressure from the nut to the clamp is transmitted by the spherical seat.

**Types of Clamp**

**Strap Clamp**

Strap clamp is simple and easy to operate, hence it is used extensively everywhere. It is rectangular in shape and acts as a lever. The clamp is tightened by rotating hexagonal nut on a central screw. Strap clamp is shown in Figure 3.19. One end of clamp presses against the workpiece and other on the heel pin, thus loading the clamps like simply supported beam. The clamping face of the clamp is curved while press face of the heel pin is of spherical shape to take care of variations in workpiece. The spherical washers between the clamp and hexagonal nut provide a spherical joint, which permits clamp to tilt with respect to the screw and the nut. Thus, clamp will take care of variations in the workpiece. Generally, strap clamps are provided with washer and a spring below the clamp.
The spring lifts the clamp as the nut is loosened. The workpiece becomes free from even the gravitational load due to clamp weight. The spring holds the clamp in a raised position during loading and unloading of the workpiece.

**Screw Clamp**

Screw clamp has a screw thread to clamp a workpiece. The screw clamp has knurled collar, head knob, tommy bar or spanner flats for rotating and tightening the screw. Screw clamp is shown in Figure 3.20. Screw clamp exerts adequate force. It also resists tendency of loosening set up by vibration. But the disadvantage is that they are slow and may not be suitable for high production. The screw clamp with pad is shown in Figure 3.20.

![Figure 3.20 : Screw Clamp](image)

**C-Washer**

C-washer is a strap clamp with open slot. This clamp is simple and quick in operation. The slot permits removal of C-washer after a slight loosening of the hexagonal nut. The pivot shoulder screw makes the C-washer captive. The cross corner distance of the hexagonal nut should be less than the bore of the workpiece so that it can permit the passage of the nut through bore during loading and unloading the workpiece.

**Cams**

Cams are also easy to operate and quick in operation. Cam tends to shift their mating faces. There is a risk of the cam clamp getting loose due to vibrations. The coefficient of friction between the cam and mating surface must be taken into account while determining the eccentricity of the cam. The eccentric pivoting of a cylinder converts it to a cam. The eccentricity of the cam should be more than 1.5 times the variations in the workpiece. The outside diameter of eccentric depends upon the coefficient of friction between eccentric and mating surface.
Toggle Clamp

Toggle is also quick action clamps. Toggle cam is shown in Figure 3.22. These can be withdrawn by considerable distance for loading and unloading of the workpiece. These depend upon the movement of rigid links for their movement. These clamps are used extensively to hold the sheet metal parts in position while they are being welded or otherwise being fastened. They provide heavy clamping pressure.

![Figure 3.22: Toggle Clamp](image)

3.2.8 Drill Bushes

Jigs uses drill bushes for guiding the drill, reamer and other cutting tool to the workpiece. Generally, these are made up of tool steel and are hardened to RC60 to 64 to provide wear resisting surface. They are precision made, i.e. outside being ground and inside either ground or lapped within 0.008 mm concentricity. Generally, the length of bush should be twice the diameter of the bushing hole. The bushing hole should be very close to the diameter of the drill but should not be so tight that drill will drag into the bushing.

There are three types of drill bushes.

Press Fit Bushes

These are the most common type of bushes and are pressed interference fit in the bush plates, i.e. jig plates. The press fit bushes are further categorized into two types: headed bushes and headless bushes. Figures 3.23(a) and (b) shows the headed bushes and headless bushes. Headed bushes are generally preferred over headless bushes because collar provides the stops against the jig plate. Also it is found that chances of the bush getting loose in the jig plate and sliding axially with the drill are lesser in collared bushes. But, when spacing of bushes is close, headless bushes are preferred over headed one. In addition, as the top surface of the jig plate is required free from projecting collars, the headless bushes are used. The press fit bushes are also used as a liner for renewable bushes.

![Figure 3.23: (a) Headed Press Fit Bush; and (b) Headless Press Bush](image)

Renewable Bushes

The inside diameter of bush is subjected to severe wear due to continuous contact with hard cutting tool for continuous or large batch production. The guide bushes require periodic replacement. The replacement is avoided by making outside
diameter precision location fit. The renewable bushes are shown in Figure 3.24. By providing flat on the collar the renewable bush should be prevented from rotating and causing axial movement with the cutting tool. The flat arrests with the collar of the retainer shoulder screw to avoid rotation. Also bush flange below collar of shoulder screw avoids the bush getting lifted with cutting tool. The liner used in the jig plate provides hardened wear resistant mating surface to the renewable bush.

![Figure 3.24: Renewable Bush](image)

**Plate Bush**

In plate bushes drilled hole themselves act as a bush. As shoulder is not provided, holes can be placed as close as possible. Liner bushing is also called master bushing. These are with head or without head. The liner bushing is shown in Figure 3.25. This bushing eliminates the need for locking device.

![Figure 3.25: Plate Bush](image)

### 3.2.9 Jig Feet and Legs

A drill jig should stand on four legs instead of flat surface. If the jig stands on flat surface, chips will get under flat surface and imbalance the jig. To avoid imbalance, jigs stand on four legs. Jig legs may be built into the jig body or purchased as a standard part. They should be placed on these legs so that all bushings are within the area covered by legs, which are placed on extremes of the jig. Legs should be ground so that they all lie in one plane after they are mounted on jig base.

- Coolant should reach to the drill. Sometimes coolant will come out from sides instead of through drill bushing. There should be holes for escape of coolant.
- Sharp corners and projection should be avoided.
- Jig should be large enough to enable the operator to hold the jig against the torque of drilling machine.
- Jig should be as light as possible.
• If the operators hands are covered with coolant then it is very difficult to hold the jig. Hence gripping surfaces should be knurled.

3.2.10 Chip Control

Two types of chip generally occur in drilling operation, viz. segmental and continuous chip. Segmental chips are in the form of small particles. Segmental chips are produced while drilling cast iron. Segmental type of chip is easy to remove from the drill jig. Continuous chips are long and stringy and tend to take the form of long coils. These chips are produced while drilling ductile steel. Enough space should be provided between work and bottom of drill bushing. It will allow chips to pass between the workpiece and bushing plate instead of through the drill bushing. This eliminates storing of chip in drill flutes. This arrangement allows more coolant to reach the cutting edge of drill and helps to prevent wear of drill bushings due to abrasion of chip. If the chips are continuous, they may tangle between the workpiece and bushing and become very difficult to remove. This is avoided by locating the bushing closer to work so that bushing will force the long stringy chip through the bushing where any entanglement can be easily removed by the operator.

Chips are removed from jig in three ways:
(a) Coolant helps to clean chips whenever they formed.
(b) Chips may be removed manually with the help of brush or hook.
(c) Chips may be removed by compressed air. Guards should be provided to prevent scattering of chips throughout the working area.

SAQ 1
(a) What are various elements of jig? Explain
(b) State and explain 3-2-1 principle of location.
(c) State locating principle.
(d) Explain different types of locators.
(e) Where do you use diamond locator?
(f) State clamping principle?
(g) List various types of clamps with appropriate use.

3.3 TYPES OF JIG WITH EXAMPLES

Depending upon method of operation and construction, drill jigs can be broadly classified as follows:
(a) Plate Jig
(b) Leaf Jig
(c) Box jig
(d) Indexing Jig
(e) Pump jig

Plate Jig

This is the simplest type of jig. Plate jig consists of single bush plate. This plate has a provision of loading and unloading of workpiece, clamping and chip removal. Figure 3.26 shows the construction of plate jig. The workpiece profile is located by six location pins and clamp by two knurled screws against location pins. In any drill jig the workpiece should be supported adequately against bending due
to the downward thrust of drill. The disadvantage of plate jig is that only one surface can be drilled at one loading and drilling forces are generally directed toward the clamping element. Hence, clamps should be rigid enough to withstand drilling forces.

**Figure 3.26 : Plate Jig**

**Box Jig**

The shape of box jig is of box type. Figure 3.27 shows the construction of box jig. The working of box jig is as follows: Hole is drilled and then reamed when the workpiece is held by jig. The workpiece is inserted in the jig. The cam rod is taken out of the jig and the workpiece placed in the position inside the jig. The cam rod is then replaced and rotated to its locking position. This holds the workpiece firmly so that drilling operation can be performed.

**Figure 3.27 : Box Jig**

**Leaf Jig**

These generally have hinged jig (bush) plate. The jig plate can be swung aside as shown by dotted line in Figure 3.28 to load or unload the workpiece from the top. After the workpiece has been located inside the jig, the leaf is firmly closed and locked. The jig plate must have the resting face to ensure that the axis of bushings is vertical during drilling. Jig plate must be clamped against the resting face by an eye bolt. The open slot in jig plate and swinging eye bolt facilitate quick clamping and unclamping of the jig plate. The hand knobs need to be loosened by only half a turn and the eye bolt swung to the position shown by chain dotted line in order to
permit swinging of the jig plate aside for loading and unloading of workpiece from the top. Leaf jigs are particularly suitable for workpieces having location surfaces and holes to be drilled on opposite sides.

**Figure 3.28 : Leaf Jig**

**Indexing Jig**

When number of holes with the same size and pitch are to be drilled in a workpiece, then conventional drilling takes more time to drill each hole individually and requires skilled worker for complete production run. Also one cannot get required accuracy. This automatically increases the cost.

This arrangement is shown in Figure 3.29. Such situation is avoided by using indexing jig. Indexing jig not only saves the time and the cost but also increases accuracy. And unskilled worker may operate the indexing jig. Linear indexing jig is shown in Figure 3.30.

**Figure 3.29 : Workpiece for Linear Indexing Jig**

(a) Indexing pin is first inserted into hole A. It is used as a stopper for drilling the first hole through the drill bush.
(b) The pin is removed from hole A after drilling. Then workpiece is moved toward right till the centerline of drilled hole coincides with the centerline of bush B.

(c) The indexing pin is inserted into the drilled hole in the workpiece through bush B.

(d) In this way workpiece is indexed linearly to drill the next hole at 100 mm distance (i.e. pitch) from the hole drilled previously.

(e) By repeating step c, we can make number of holes at 100 mm pitch in the workpiece.

**Rotary Indexing Jig**

Rotary indexing helps in positioning a part accurately around the axis. It can be used conveniently for drilling equi-spaced holes in cylindrical workpieces. Rotary Indexing is shown in Figure 3.31.

(a) Workpiece is clamped and first hole is drilled through bush A.

(b) Workpiece is unclamped and rotated clockwise to coincide the axis of drilled hole with the axis of indexing pin.

(c) The indexing pin is inserted in the drilled hole to index the workpiece for drilling the next hole.

(d) The workpiece is clamped again before drilling the next hole. In this way, the rotary indexing can be used to drill number of equi-spaced holes with only two guide bushes.

**SAQ 2**

(a) What are various design considerations while designing jigs?

(b) List various types of jig with examples.

(c) Explain with neat sketch the principle of indexing jig.

**3.4 SUMMARY**

Jigs are used to hold and locate the workpiece that positions and guides or controls the cutting tool. Drill jig is used to ensure a hole to be drilled, tapped or reamed in the workpiece at proper place. Jigs are generally used for mass production. Jig reduces
Design of Jigs

operators fatigue and increases productivity. Jig consists of locating, clamping and tool guiding elements. A workpiece can be located from plane surface, profile surface and cylindrical surface. Location of workpiece is achieved by providing pins or diamond pin locator or v-block or conical locator. Clamps hold the workpiece which is firmly engaged with locators during operation. Strap clamps, screw clamps are widely used for clamping purpose. C-washer, cam, toggle clamps are quick acting clamps. Jigs uses drill bushes for guiding the drill, reamer and other cutting tool to the workpiece. Press fit bushes, plate bushes and renewable bushes are commonly used for guiding the drill into hole. Jig differs from workpiece to workpiece. Plate jig, box jig, leaf jig, indexing jig are various types of jig.

3.5 KEY WORD

Jig : Jig is workpiece holding and locating device that positions and guides or controls a cutting tool.

3-2-1 Principle : Workpiece will be completely controlled when positioned against three points in one plane, two points in another plane and one point in third plane.