Module 8

Jigs and Fixtures for Machine shop

Lesson 34

Design and Application of typical jigs and fixtures

Instructional objectives

This lesson will enable the students :

(i) Analyze economic viability and judge necessity of jig – fixture for specific production by machining
(ii) Plan for designing a fixture or jig
(iii) Design fixture or jig (configuration and working) for specific jobs and their machining requirements.

(i) Economic Viability Analysis And Judging Necessity Of Jig – Fixture.

The three possible modes of manufacturing a lot of a product by machining are :

- using ordinary machine and without jig or fixture
- using ordinary machine but with jig or fixture
- using automatic special purpose machine

The selection of the appropriate mode is governed mainly by,

- technological feasibility of those modes
- technical feasibility i.e. availability of the resources and facilities for the different modes
- economical viability, considering
  - Δ cost of manufacturing, based on
    - cost of the basic machine
    - cost of the jig or fixture, if to be used
    - volume of production (i.e. no. of pieces)
    - material and labour cost
  - Δ expected quality of the products and its sale value i.e., revenue
  - Δ total time that will be required to complete the assignment

It is to be borne in mind that sophisticated automatic system not only provides and maintains consistency of quality of the products but also drastically reduces the total time of completing the production, which have substantial socio-economic benefits. Use of jigs and fixtures also help to some extent in saving time and maintaining consistent quality. But sophisticated automatic machines are much more expensive. Use of jigs and fixtures also incur some additional cost.

Selection of appropriate mode for a specific machining task.
A specific case, for example, is taken up as follows to illustrate the selection procedure :

A lot of 120 pieces have to be machined. The estimated cost components in three different modes are as follows :

	Mode	Fixed cost (Rs.)	Machining cost / pc (Rs./piece)
1	W : In ordinary machine without any jig or fixture	200,000.00	5000.00
2	JF : In ordinary machine but with jig or fixture	3,00,000.00	2500.00
3	A : In automatic special purpose machine	6,00,000.00	1000.00

The most appropriate, is to be selected mode and it is to be decided whether use of the jig / fixture will be justified.

Considerations and steps

- assuming uniform quality possible, by all the modes, selection is made on the basis of total production cost
- with the given cost components a graph; total machining cost vs quantity of production, has been plotted as shown in Fig. 8.2.1. From the graph it appears that mode – 1 (W) is most economic when quantity of production i.e., number of pieces to be machined is less than 40 and the mode – 3 (A) will be most economical when the number of pieces exceeds 200. The mode – 2 (JF) appears to be economically most viable if the production volume lies within 41 to 199.
- Since the number of pieces desired to be produced is 120 only, it is clear that for 120 pieces, the mode – 2 (JF) i.e., machining in ordinary machine tool using jig – fixture is most justified.

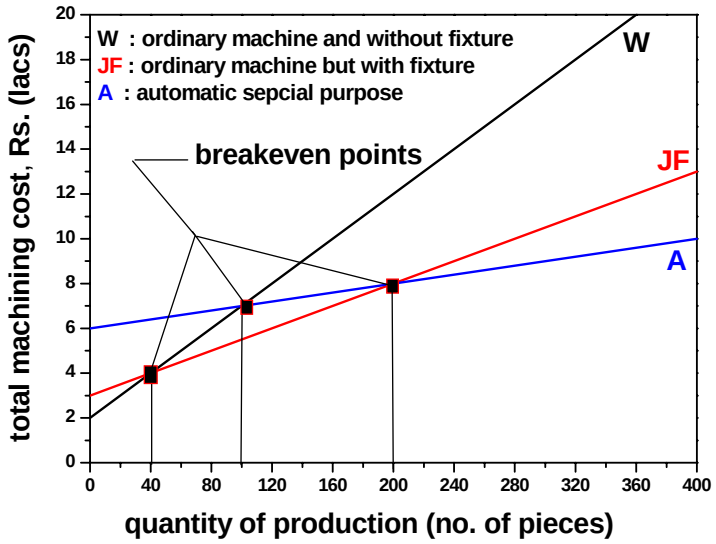

Fig. 8.2.1 *Economic viability of jig and fixture for batch production.*

(ii) Planning Prior To Design And Construction Of A Fixture Or Jig

After reasonably deciding that a jig or fixture will be used for a given machining work, a thorough planning has to be made prior to actual design and construction of the jig or fixture. This is explained by a specific example as follows :

Task : A fixture or jig has to be designed and built for drilling a through hole in pre-machined mild steel pins at a given distance from one end face as indicated in Fig. 8.2.2.

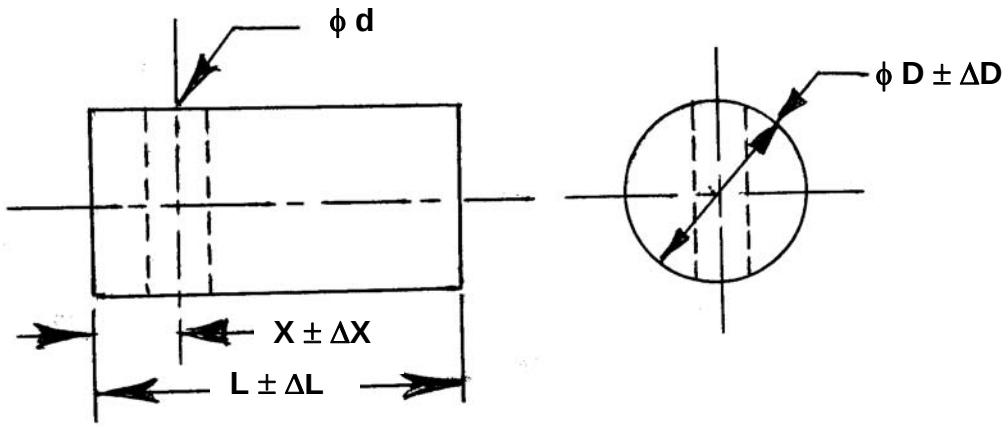

Fig. 8.2.2 *A through transverse hole to be drilled at a distance from end face.*

Planning in steps for design and construction of a jig or fixture suitable for the purpose

- **whether fixture or jig ?**
  Since a hole has to be drilled precisely at a particular location within tolerance a suitable drill – guide will be necessary. So it has to be a jig.
- **Positioning and orientation**
  Since a diametral through hole has to be drilled perpendicular to the rod – axis, and the drill – axis in the machine is vertical, the suitable orientation of the job in the jig and against the drill axis will be horizontal as shown in Fig. 8.2.3 (a)

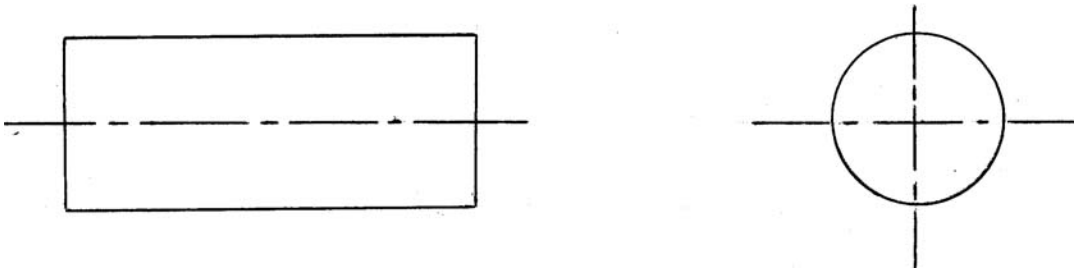

Fig. 8.2.3 *(a) Blank and its apparent positioning during drilling*

- **Locating the blank in the jig and w.r.t. the drill – axis**

The facts that

- The blanks are straight cylindrical and pre-machined
- Blank diameter may vary though within a tolerance and
- The blank axis is to be horizontal

clearly justify that the basic locating by V – block will be appropriate as indicated in Fig. 8.2.3 (b). To essentially maintain the desired distance of the hole-axis from one machined face of the block, a pin has also to be used for axial location and it should be adjustable type for likely variation in the part length as indicated in Fig. 8.2.3 (b)

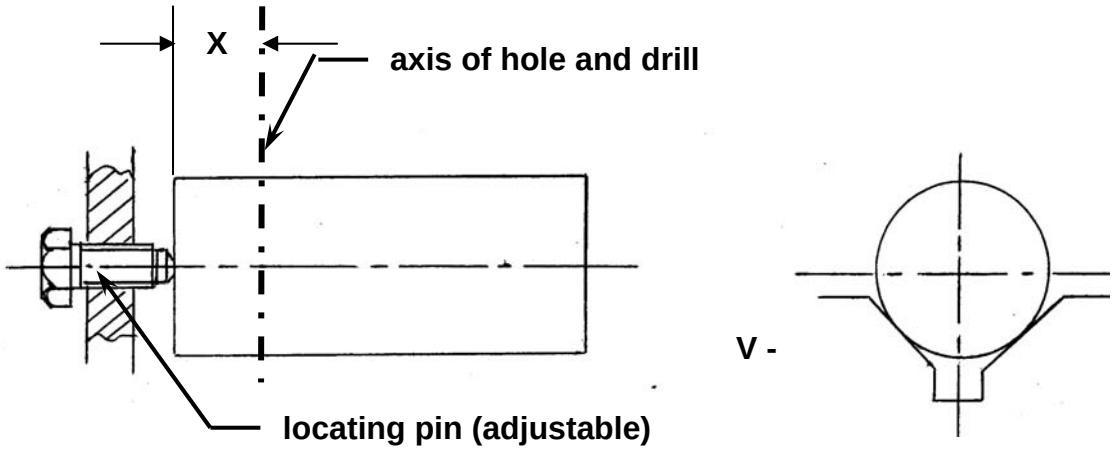

Fig. 8.2.3 *(b) locating by V – block and adjustable pin*

- **Supporting the blank against forces**

Since the blanks are solid steel rods of favourable L/D ratio and it has been reasonably decided to locate it on V – block, the same V – block can be used for the desired support. In that case the V – block need to be enough strong and rigid and also provided with necessary recess or relief at the central portion as indicated in Fig. 8.2.3 (c)

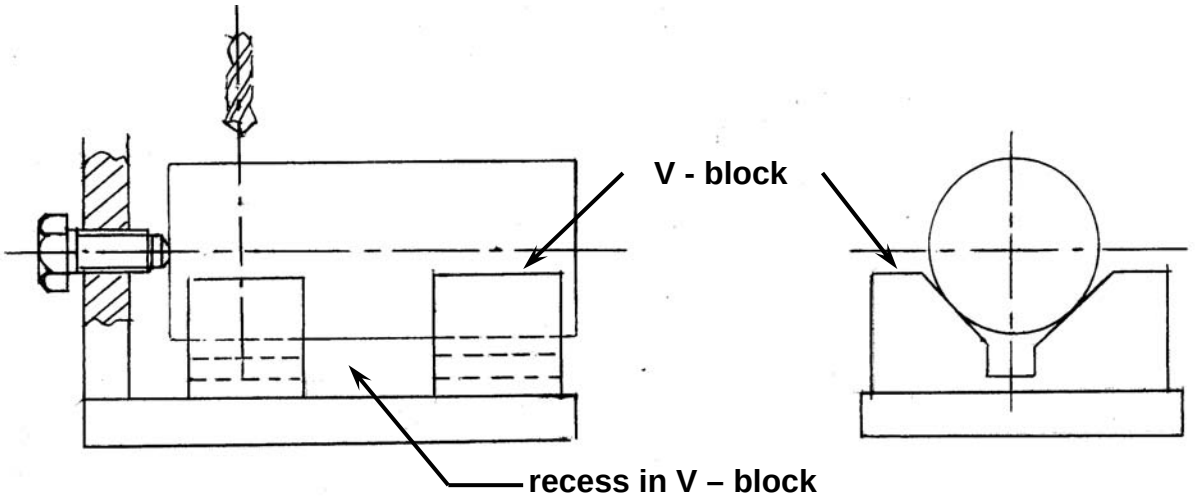

Fig. 8.2.3 *(c) supporting on V - block*

- **Clamping**

Clamping system should be, as far as possible, simple and quick but also need to be strong, rigid and stable. Clamping should not also obstruct or hamper blank's loading and unloading as well as machining work. Keeping all such factors a cam – clamping may be considered as indicated in Fig. 8.2.3 (d). The clamping plug should retreat sufficiently from the blank for its easier removal and entering of the next blank. A spring can be used. For more effective and stable clamping on cylindrical surface, a pivoted clamping would be more suitable as shown in the Fig. 8.2.3 (d).

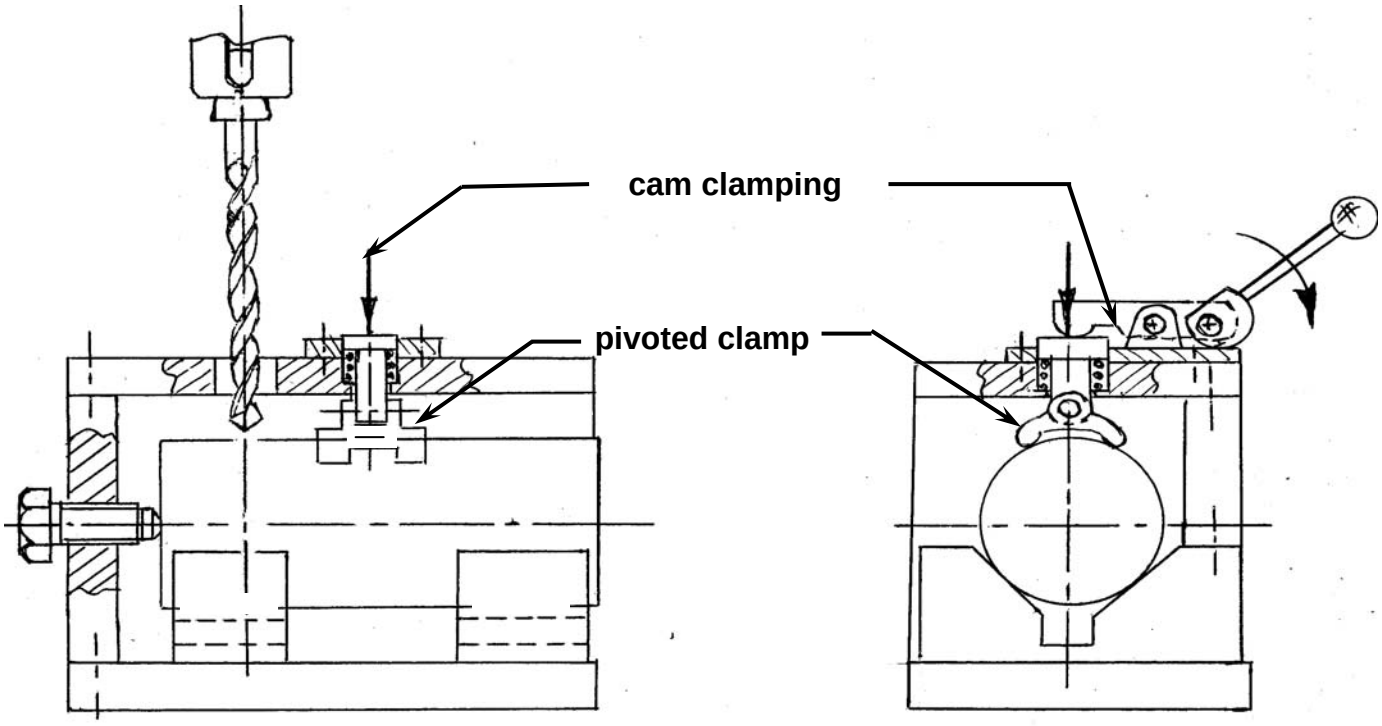

Fig. 8.2.3 *(d) Quick clamping by cam*

- **Tool guidance**

  Since it is drilling and over a deep hole, specially on a cylindrical surface, tool guidance must be provided as indicated in Fig. 8.2.3 (e) which also shows holding of the slip type bush by a pin for replacement of the bush.

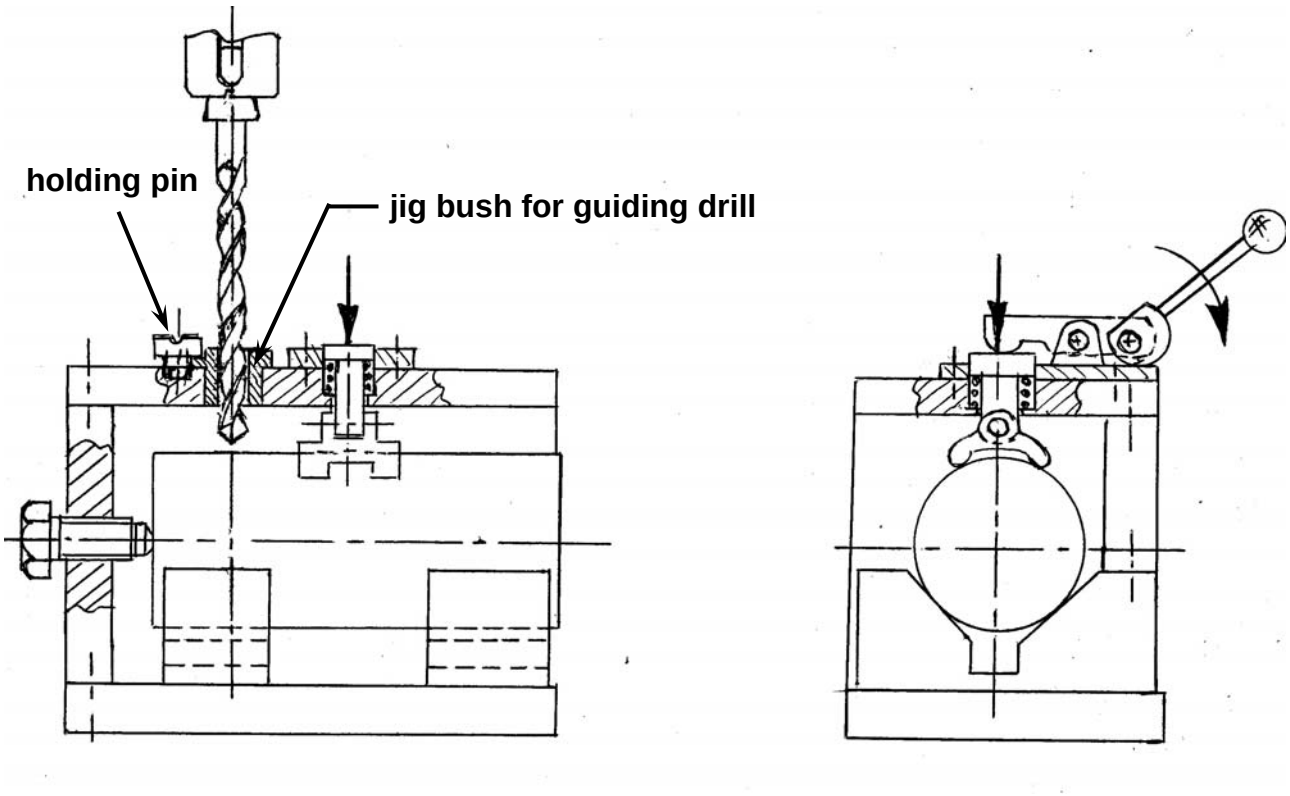

Fig. 8.2.3 *(e) Jig bushing for tool(drill) guidance*

- **Consistent effective locating and ejection**

  It is to be assured that the locating pin is in proper contact with the locating surface and preferably under the same amount of force all the time. This can be done by applying a spring loaded force on the blank and against the locating pin as indicated in Fig. 8.2.3 (f). Such pushing system, again, should not hinder placing and removal of the blank in and from the jig or fixture. One of the possible methods has been shown in Fig. 8.2.3 (f) where the swing type lever holding the spring loaded pushing – pin is manually operated with the help of a spring and a stop – pin.
  For easy removal of the machined job from the jig or fixture an ejector may be used. Fig. 8.2.3 (f) also shows such an ejector to facilitate unloading of the job after sequentially withdrawing the tool and the clamping unit and shifting the push – lever.

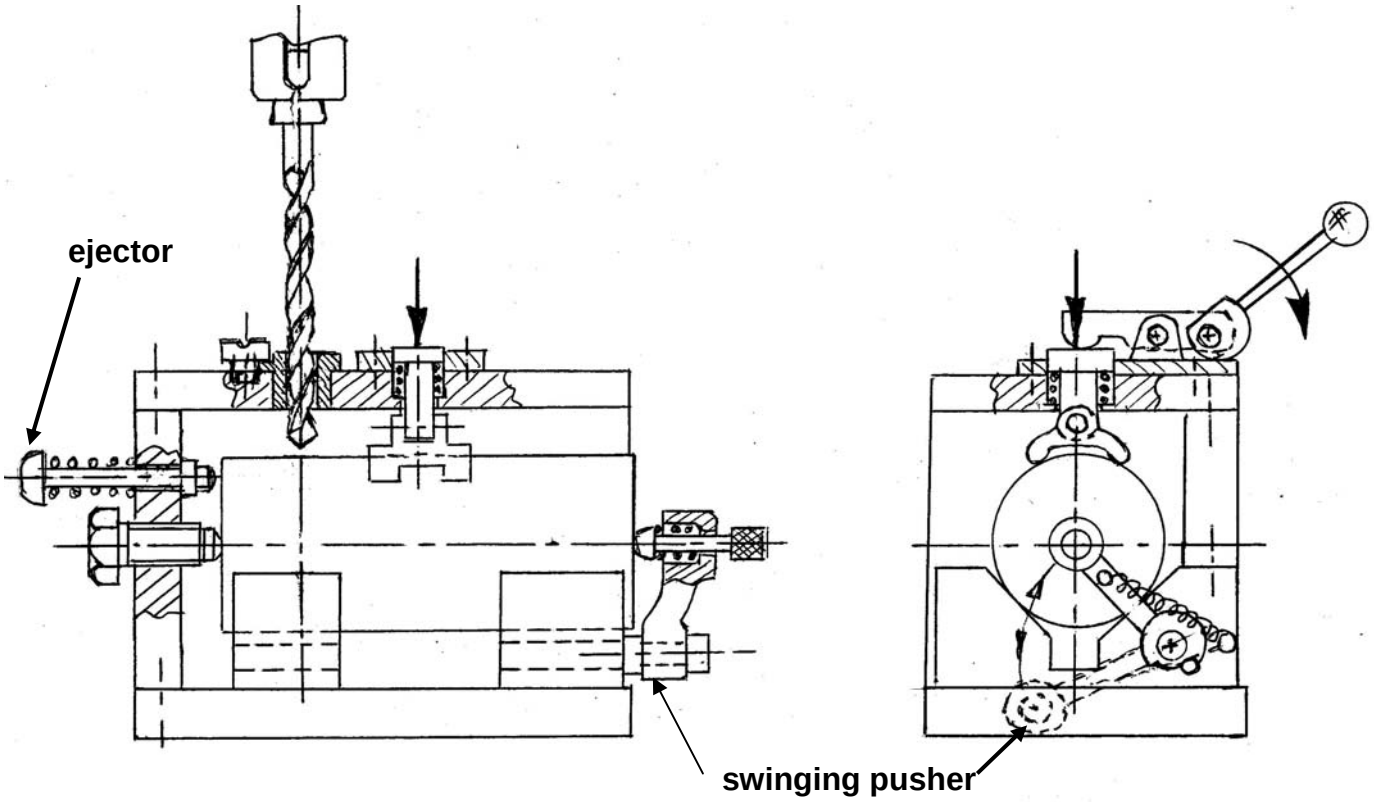

Fig. 8.2.3 *(f) complete jig with assured locating and ejection*

This way, the planning work enables get proper schematic layout of the entire jig or fixture with its vital parts and configuration.
Next step, for the design, will be selection of materials for various parts and determination of their dimensions based on strength and rigidity.

(iii) Design Of Fixtures And Jigs For Some Specific Jobs

Example – 1 In a pre-machined hollow metallic disc six equispaced blind holes have to be drilled radially as indicated in Fig. 8.2.4.

Design the configuration and working method of the fixture or jig for such drilling work in a batch production.

Design – The proposed design is schematically shown in Fig. 8.2.4

- Since the machining requirement is drilling where the tool will essentially need guidance, a jig has to be designed
- Since it is required to produce equi-angular spaced holes by drilling an indexing system has to be considered

- The indexing work can be accomplished by indexing the jig, holding the job clamped inside, manually by bringing the desired hole axis aligned with the fixed drill axis by manual adjustment. Six bushes are fitted equispaced in the jig. The design of the jig is schematically shown in Fig. 8.2.4. The same work could be done by indexing the workpiece only within the fixed jig having only one bush (example 2).

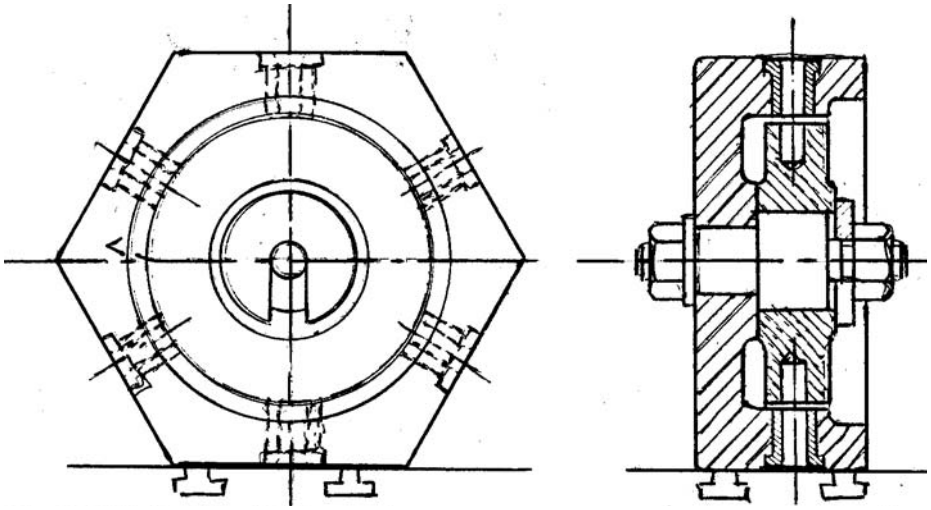

Fig. 8.2.4 *Jig for drilling six equispaced radial blind holes in a disc*.

Example – 2 Four equispaced through holes have to be drilled radially in a disc, (like rotor of radial piston pump) as shown in Fig. 8.2.5 (a). A jig is to be designed for batch production of such discs.

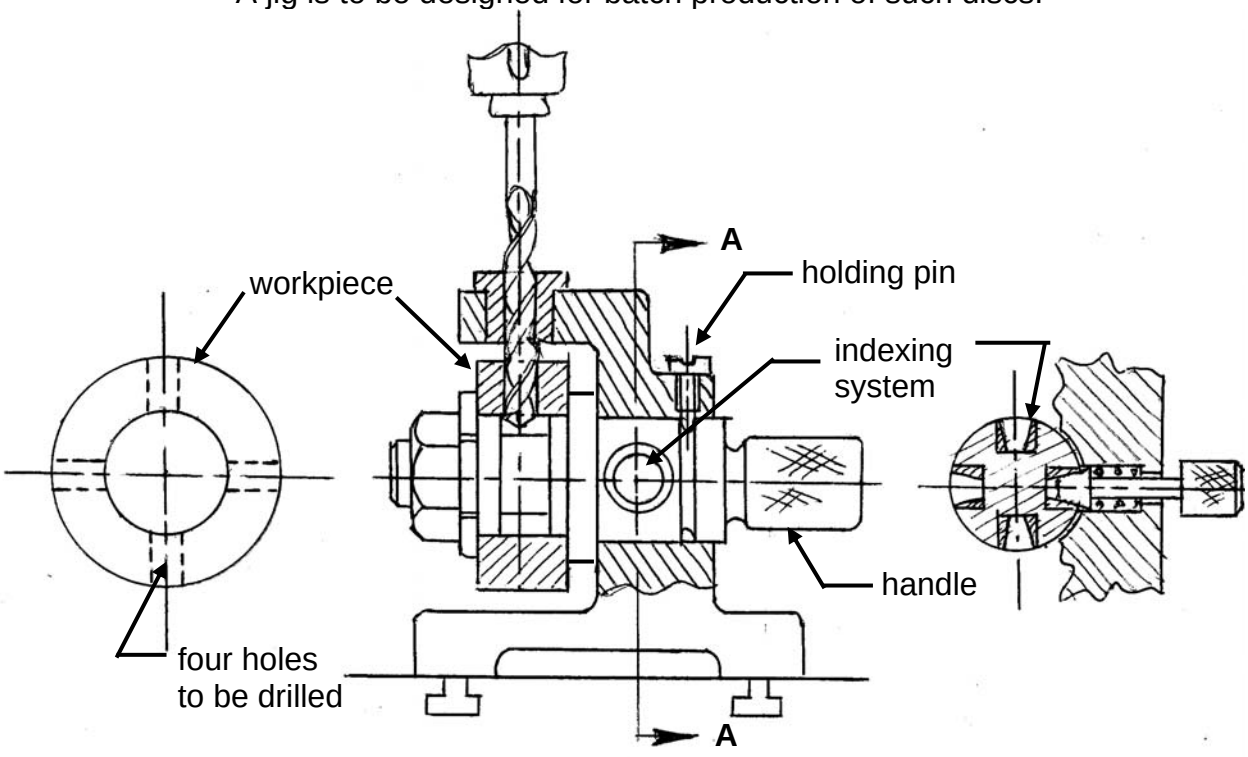

Fig. 8.2.5 *Jig for drilling four equispaced through radial holes in a ring.*

Design : The proposed design is schematically shown in Fig. 8.2.5

- Drilling four equispaced through radial holes will need indexing in the jig to be designed.
- The jig possesses a rotable mandril on which the pre-machined blank (hollow disc) will be mounted as shown
- The axial location of the blank with respect to the axis of the desired hole i.e. drill is provided by the step in the mandril
- The blank gets desirably strong support from the mandril; both radially and axially
- Only one bush is mounted coaxially with the drill for necessary tool guidance
- The blank will be strongly and rigidly clamped by the front nut. A quick acting nut could also be used.
- A suitable indexing system has been incorporated which will enable 90^{o} – rotation of the blank, within the fixed jig, by unlocking the indexing pin and rotating the mandril with the help of the handle shown. The small fixed (screwed) pin will prevent any axial shift of the mandril during its rotation under unlocked condition.
- This jig will remain clamped on the drilling machine bed (table) with the axis of the bush aligned with that of the drill i.e., spindle

Example – 3 A through rectangular section slot has to be cut on a rod as shown in Fig. 8.2.6 (a). A fixture or jig is to be designed for cutting the slot in batch production

Design : The proposed design is schematically shown in Fig. 8.2.6 (b)

- It will be a fixture, not jig, since there is no need of making holes
- A slot milling cutter of width equal to the width of the slot desired has to be used as shown
- Since the blank is a cylindrical piece, V – block type system has been used for locating and supporting
- The axial location (and supporting) will be accomplished by the axial pin and the contact will be assured by the swing type spring loaded pusher as shown.
- Clamping will be done quickly by the cam pressing the strap as shown
- The fixture holding the workpiece will be properly fixed on the table of the milling machine and will move along that table
- After completion of the work, i.e. cutting of the slot, the fixture will be removed. A spring loaded ejector (cum locator) can also be used as shown in the Fig. 8.2.6 (b).

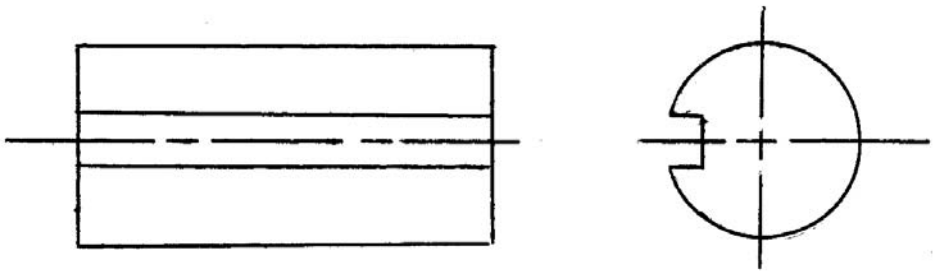

Fig. 8.2.6 *(a) A through slot to be produced on a rod*

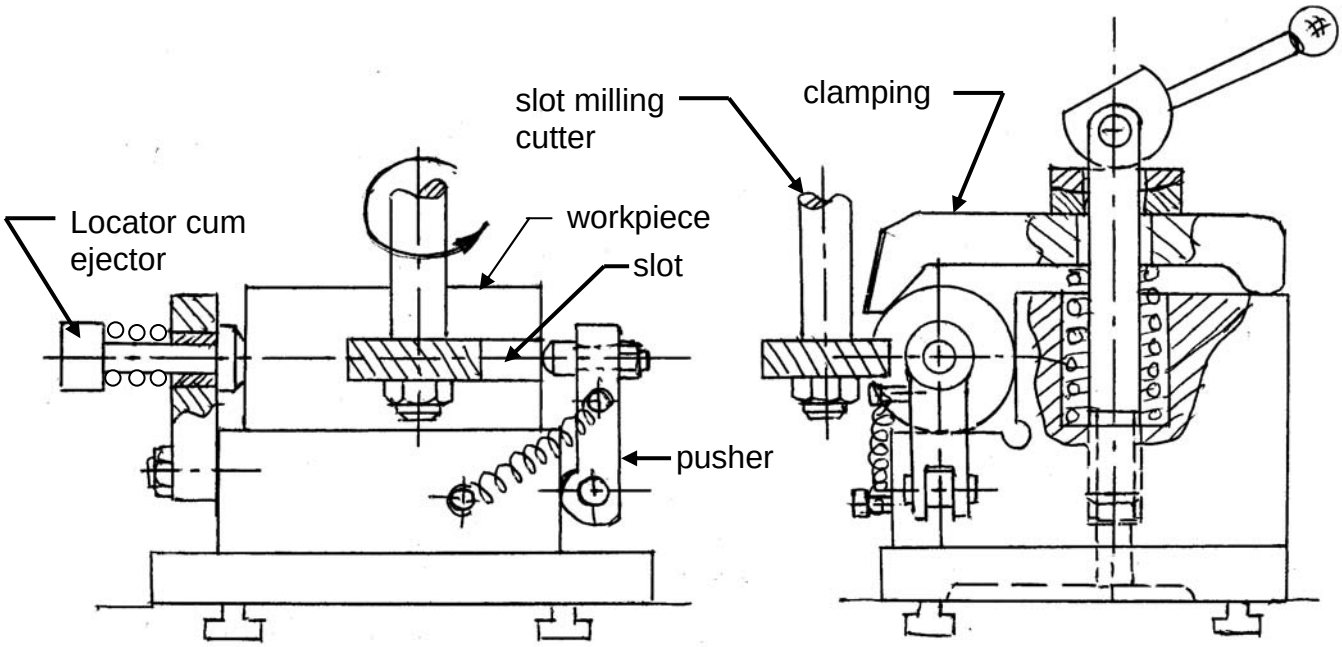

Fig. 8.2.6 *(b) Fixture for milling the slots on the rod.*

It is to be noted, jigs and fixtures are not standard items and are as such not available in the market. It has to be designed and built as and when required based on the exact requirements.