WEB CHAPTER 5 - JIGS AND FIXTURES

Jig is a structure to **locate** and **clamp** a component for **guiding** the cutting tool in operations like drilling, reaming, etc. They are used for inspection also.

The work is located for machine operations by different types of **locating devices**. Clamping forces due to friction only cannot be relied upon completely. A **cylindrical pin** is the cheapest and easy locator. **Cylindrical bush** locators are used for solid work pieces, but **conical locators** are preferred, because they offer self-centering. **V blocks** can be used for cylindrical as well as rectangular objects

Clamping of the work piece is necessary in addition to location, otherwise it may move due to cutting forces. To reduce the wear of clamping devices with continuous use, they are hardened. If there are chances of damaging the surface of the work piece, a soft nose can be provided on the clamp. The various types of clamping devices are:
A **bar clamp** uses a simple bar having a hole in the middle. One side of the bar is placed on the work piece and the other on a heel. A stud passes through the hole of the bar, and a nut over it clamps the work piece.
A **threaded heel** has the advantage that it can be adjusted to any height according to the height of the work piece.
A **swinging clamp** uses an arm which is hinged on one side and slotted on the other side. The work piece is located below this arm; a swinging bolt is fitted in the slot of this arm to clamp the work piece with a nut.
In a **side clamp,** the bar clamps the work piece from one side while the other side rests against the body of the jig. An arm having a pin joint at the middle and a bolt on the other end clamps the work piece.
In the **side clamp**, the clamping force is produced by rotating an eccentric with the help of a lever. It pushes the V block and work piece is clamped between the jig body and block.

Clamping force on the clamping device can be given by any one of the following method:
The **wing nut** or **knurled knob**, **stud and nut**, **cams** are useful where the clamping force is to be provided just by rotating a handle by 90 degrees or so. **Helical cam** can also be used as an alternate arrangement to the **eccentric**. **Hydraulic pistons** are used where a heavy clamping force is used.

Guides to the cutting tools for the jigs are called as **bushings**; generally for drilling and reaming.

Jig body is the main body, which supports the bushings, locating and clamping devices.. There are two common types of jig bodies: **open** type and **closed** type

Types of Jigs are the following:

Plate jig--The jig plate is clamped over the work piece.
Swinging leaf jig--The jig plate containing the bushing is swung about a pin, just for easy placement and withdrawal of the component.
Indexing jig uses an indexing plate to dill holes in pre-defined angular positions.

Fixture is an aid for manufacturing which is used to **hold** and **locate** the job for some manufacturing operation but **does not guide** the cutting tool. Fixtures can be used for any machine and are classified accordingly.
Turning fixture--A lathe fixture may be to hold a typical component, which may not fit in the jaws of a chuck in normal way.
Milling fixture--It may hold a typical job together to reduce clamping and manufacturing time.
Welding fixture--It is to locate two structural members for welding at specific position to each other.

W5.1 JIG

Jig is a structure to LOCATE and CLAMP a component for GUIDING the cutting tool in operations like drilling, reaming, etc. They are used for inspection also.

Suppose a hole is to be drilled inclined at 45 degrees in a cylindrical work piece (Figure W5.1). It may not be possible to drill this hole without the help of a jig, because the drill bit will have a tendency to slip. So a jig does three things:

a. Locate and align the part at the required position.
b. Clamp the part so that it does not move due to cutting forces while machining.
c. Guide the tool to work on the object.

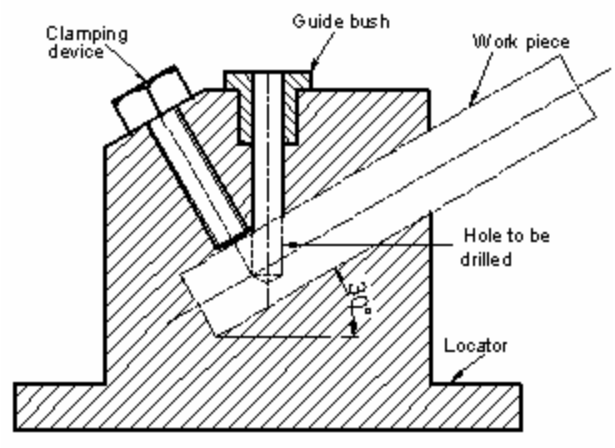


Figure W5.1 A drilling jig

W5.2 LOCATION DEVICES

The work piece has to be located for machine operations. These operations impart cutting forces and try to move the work piece from its original position. Clamping forces are generally due to friction only and cannot be relied upon completely. Hence surfaces to give the reaction to the cutting forces should also form a part of location devices. Various types of locating devices are shown in Figure W5.2.

The shape of the work piece decides the type of locator to be used. Finished surfaces are generally used to locate the work piece against the finished surface of the jig. If there is no finished surface of the work piece, then an unfinished surface can be used.

A cylindrical pin is the cheapest and easy locator. Number of pins can be one or many for accurate location. These pins are made of tool steel, hardened and ground (Figure W5.2A). Cylindrical bush locators can also be used for solid work pieces (Figure W5.2B), but conical locators are preferred, because they offer self-centering (Figure W5.2C). V blocks can be used (Figure W5.2D) for cylindrical as well as rectangular objects (Figure W5.2E).

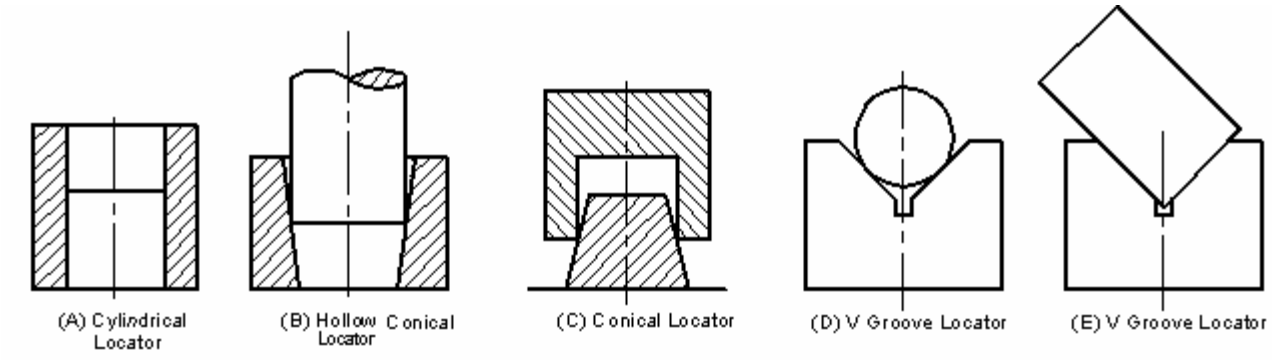


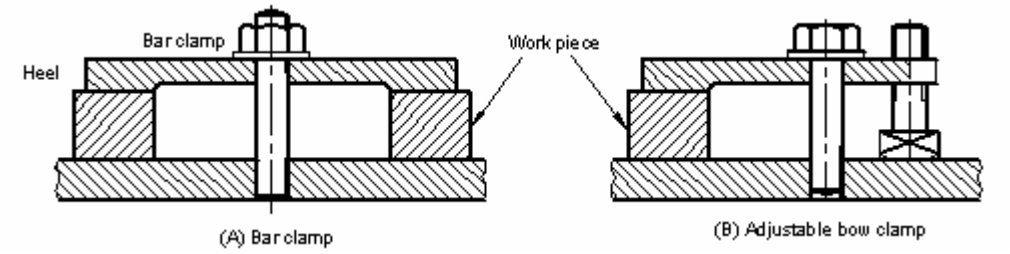
Figure W5.2 Location devices

W5.3 CLAMPING DEVICES

As described earlier, clamping of the work piece is necessary in addition to location, otherwise it may move due to cutting forces. There are a number of clamping devices. Only a few commonly used are shown in Figure W5.3.

Clamping force should be applied at a point which does not obstruct the manufacturing process and will offer reaction so as to withstand the forces developed. To reduce the wear of clamping devices with continuous use, they are hardened. If there are chances of damaging the surface of work piece, a soft nose can be provided on the clamp which can be replaced, when worn out. The various types of clamping devices are:

- Bar clamps (Figure W5.3A)
- Adjustable bow clamp (Figure W5.2B)
- Swinging bar clamp (Figure W5.3C)
- Side clamp (Figure W5.3D)
- V slide(Figure W5.3E)



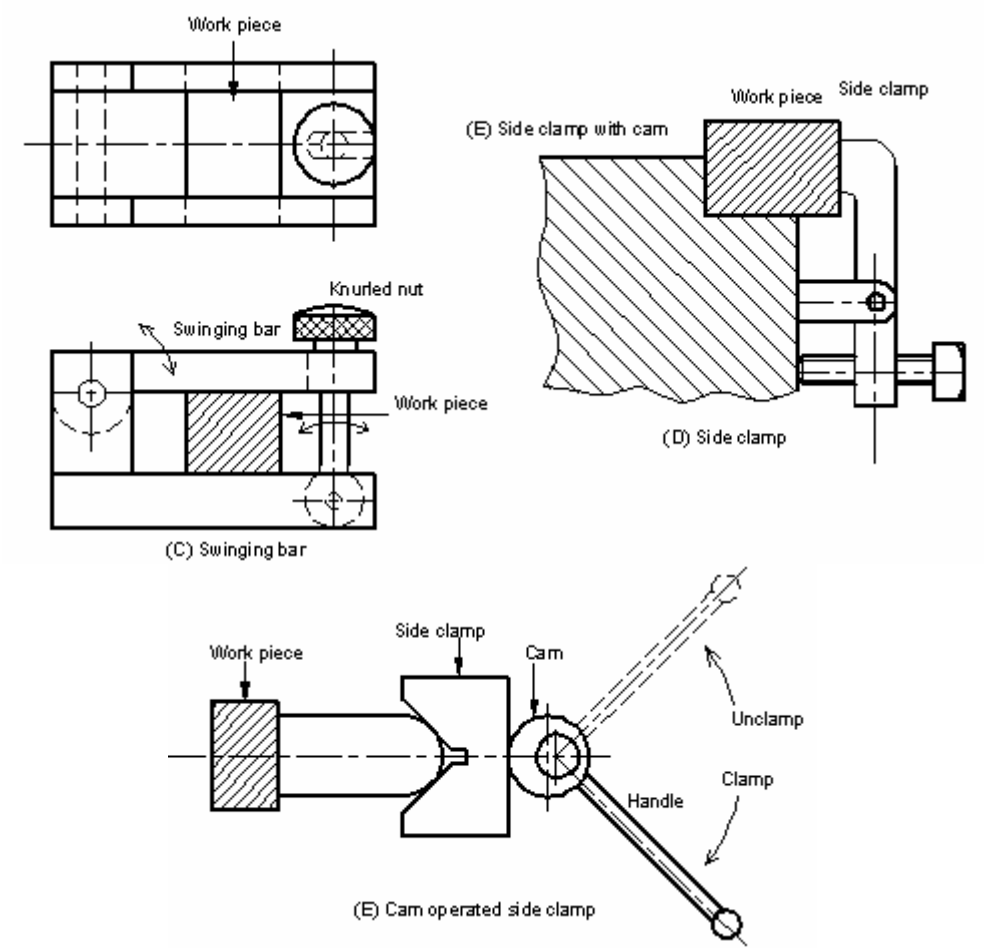


Figure W5.3 Clamping devices

Bar clamp uses a simple bar having a hole in the middle (Figure W5.3A). One side of the bar is placed on the work piece and the other on a heel approximately of the same height as the work piece. A stud passes through the hole of the bar. When the nut is tightened, it clamps the work piece.

Instead of using a heel of fixed size, one can use a threaded heel (Figure W5.3B). It has the advantage that it can be adjusted to any height according to the height of the work piece.

A swinging clamp type jig (Figure W5.3C) uses an arm which is hinged on one side and slotted on the other side. The work piece is located below this arm, by lifting it. A swinging bolt is fitted in the slot of this arm. The nut is tightened over it to clamp the work piece.

In a side clamp (Figure W5.3D), the bar clamps the work piece from one side while the other side rests against the body of the jig. An arm having a pin joint at the middle and a

bolt on other end clamps the work piece when the bolt is tightened.

Figure W5.3E also shows a side clamp, but the clamping force is produced by rotating an eccentric with the help of a lever. It clamps the work piece quickly. It pushes the V block and the work piece is clamped between the jig body and block.

The force on the clamping device can be given by any one of the following methods:

- Wing nut or knurled knob (Figure W5.4A and B)
- Stud and nut (Figure W5.4B)
- Cams are useful where the clamping force is to be provided just by rotating a handle by 90 degrees or so. Use of spiral cam and an eccentric is shown in figures W5.4C and W5.4D respectively.
  Helical cam can also be used as an alternate arrangement to the eccentric (Figure W5.4E).
- Hydraulic pistons are used where a heavy clamping force is required (Figure W5.4F).

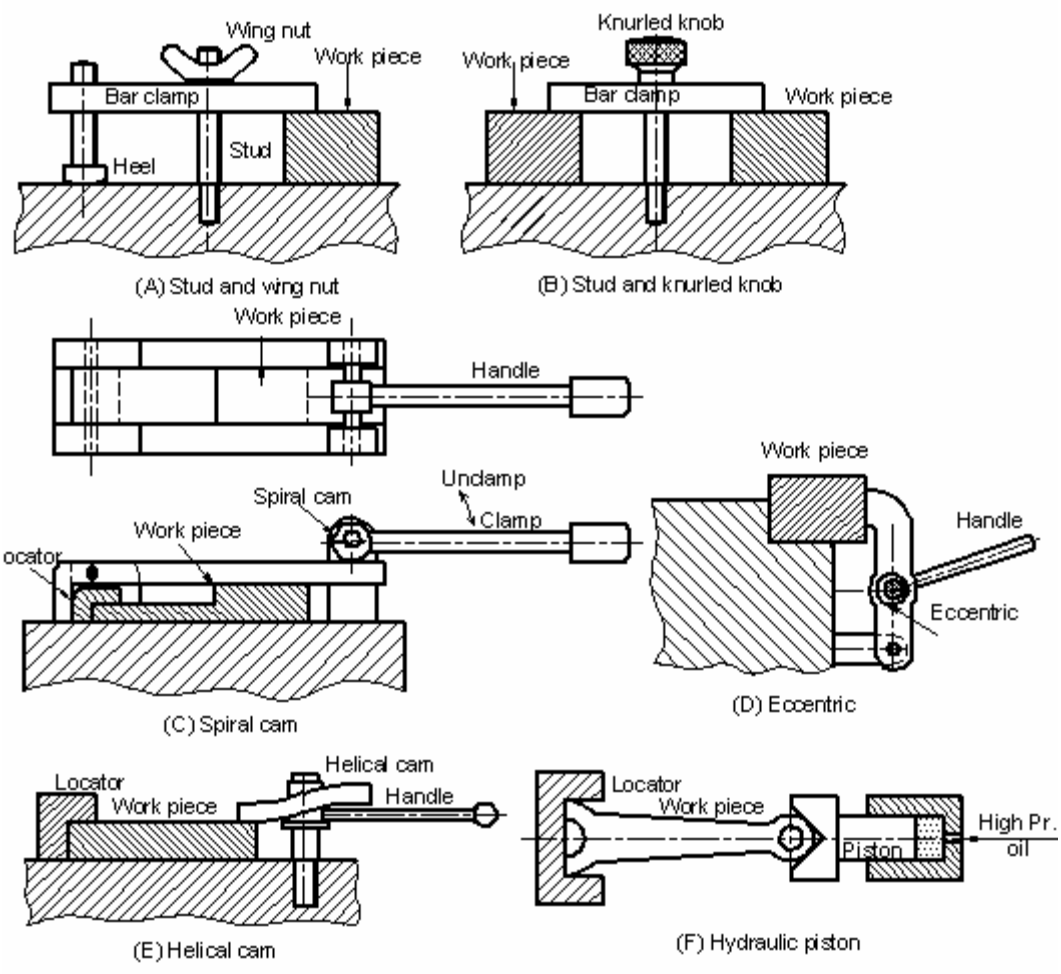


Figure W5.4 Clamping force methods

W5.4 GUIDES

Guides to the cutting tools for the jigs are called BUSHINGS; generally for drilling and reaming. Bushes are used to guide the cutting tool. These bushes are pressed into a plate which is screwed to the body of the jig. Various types of bushings are used as shown in Figure W5.5.

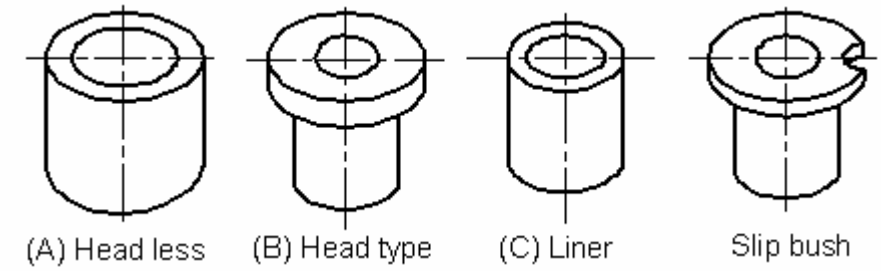


Figure W5.5 Bushings for jigs

Basically bushes are of two types: headless and head type. If the centre between the adjacent holes is small, then a headless bushing is preferred. Sometimes a liner is used inside the bushing, which can be replaced when the bush is worn and one has not to replace the complete bush.
Slip busing is used, if it is to be replaced for different sizes of drills or reaming operations after drilling.

W5.5 JIG BODY

It is the main body, which supports the bushings, locating and clamping devices. There are two common types of jig bodies:

- Open type (Figure W5.6A)
- Closed type (Figure W5.6B)

If drilling is to be done in one plane only, an open type of body can be used, but if the jig is to be used from different directions and planes, a closed type of the body is to be provided. Figure W5.6 shows two such types of the jig bodies; one open type and the other, closed type.

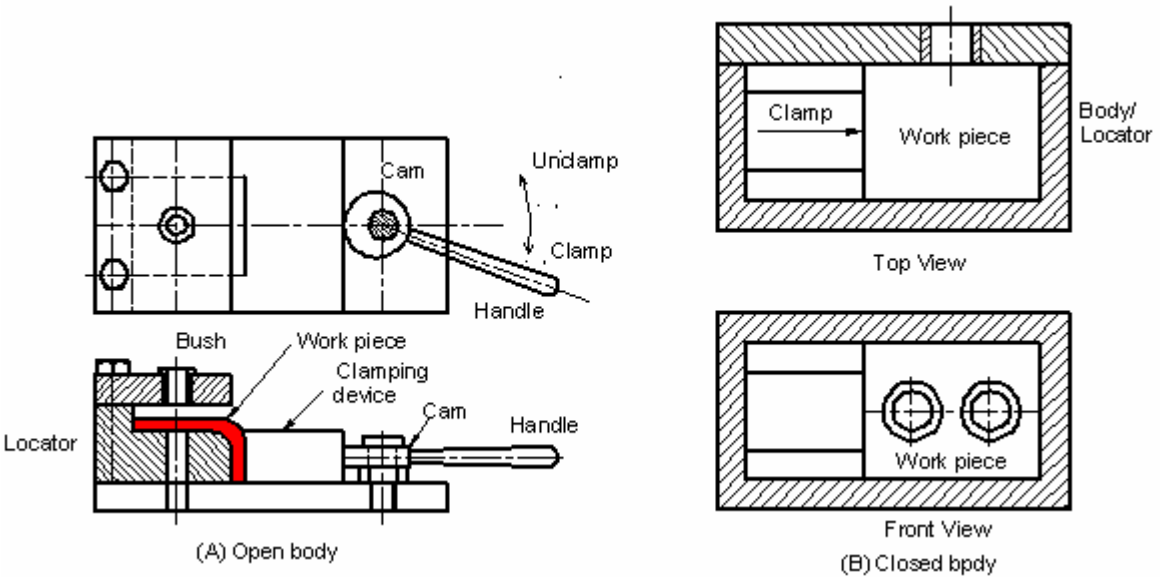


Figure W5.6 Jig bodies

A jig body is made of cast iron or sometimes fabricated by welding steel parts. The body has to be rigid for maintaining the accuracy. Sharp corners and edges should be avoided for the safety of the operator. Small size of the jigs can be fixed on the table, but large jigs should be provided by means of fixing on the machine securely.

Open type of jigs can be further classified as:

A. Plate jig - The jig plate is clamped over the work piece (Figure W5.7A)

B. Swinging leaf jig - The jig plate containing the bushing can be swung about a pin, just for easy placement and withdrawal of the component (Figure W5.7B).

C. Indexing jig - It uses an indexing plate to dill holes in pre-defined angular positions (Figure W5.7C). The indexing plate is kept in position by a spring-loaded plunger.

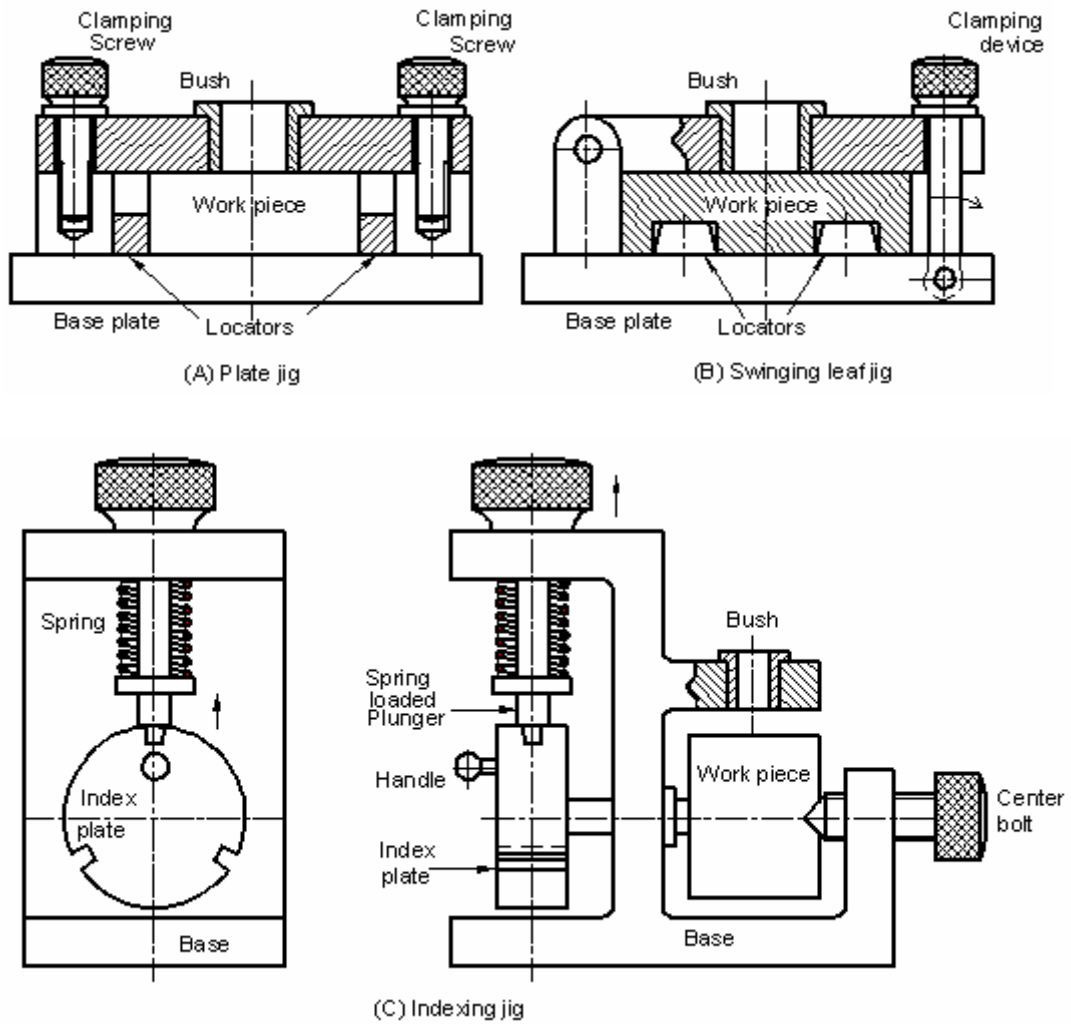


Figure W5.7 Types of jigs

W5.6 FIXTURES

It is an aid for manufacturing which is used to HOLD and LOCATE the job for some manufacturing operation but does NOT GUIDE the cutting tool. Fixtures can be used for any machine and are classified as:

- Lathe fixture
- Milling fixture
- Welding fixture

W5.6.1 LATHE FIXTURE

A lathe fixture may be to hold a typical component, which may not fit in the jaws of a chuck in the normal way. Turning fixtures can be held in the jaws of the chuck or can be mounted on the face plate of the lathe.

A bracket is shown in Figure W5.8 in which two holes are to be drilled at the position indicated in the figure. It can be seen, that this component cannot be put on a lathe chuck easily. A special fixture to hold it is shown in Figure W5.8B. An angled block is bolted on the front side of the face plate and then the work piece is clamped on it. A balance weight is mounted to avoid unbalanced forces on the lathe spindle.

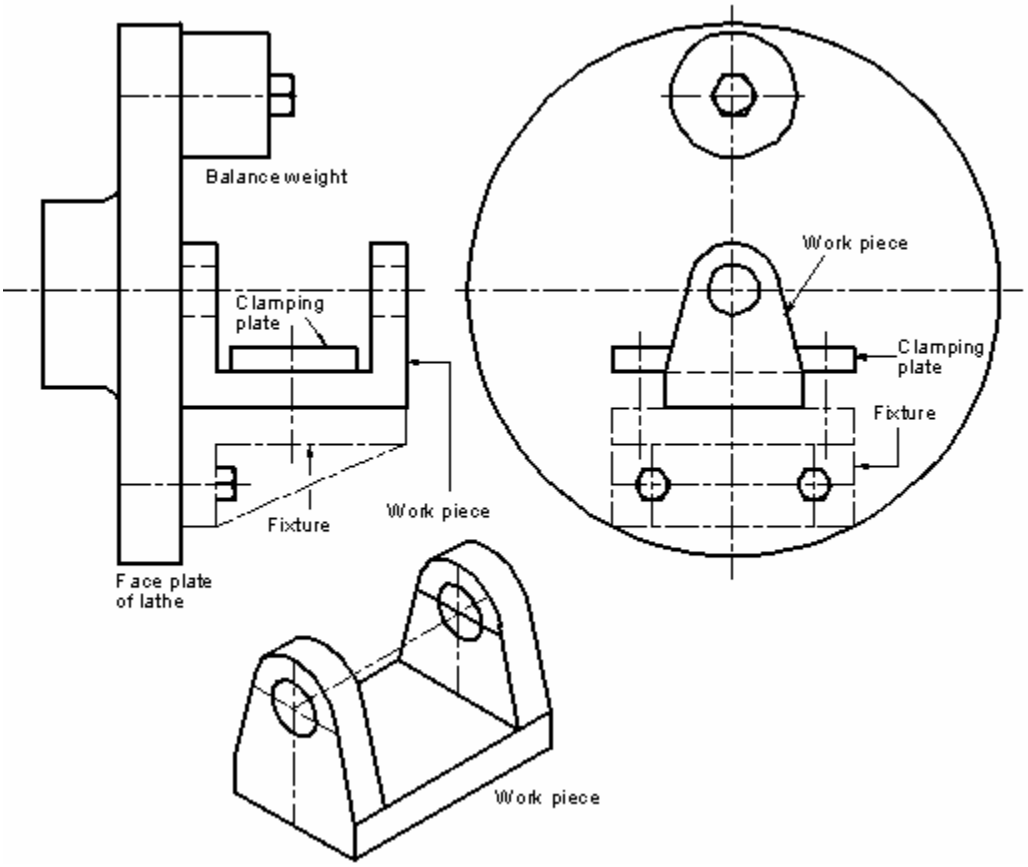


Figure W5.8 A lathe fixture.

W5.6.2 MILLING FIXTURE

A milling fixture may hold a typical job together to reduce clamping nda manufacturing time. A setting block is used in conjunction with the holding device to achieve correct alignment of the tool with respect to the component and accuracy of machining. Figure W5.9 shows a milling fixture to make slots on a component as shown in Figure W5.9A. Four pieces can be positioned simultaneously to mill a diagonal slot.

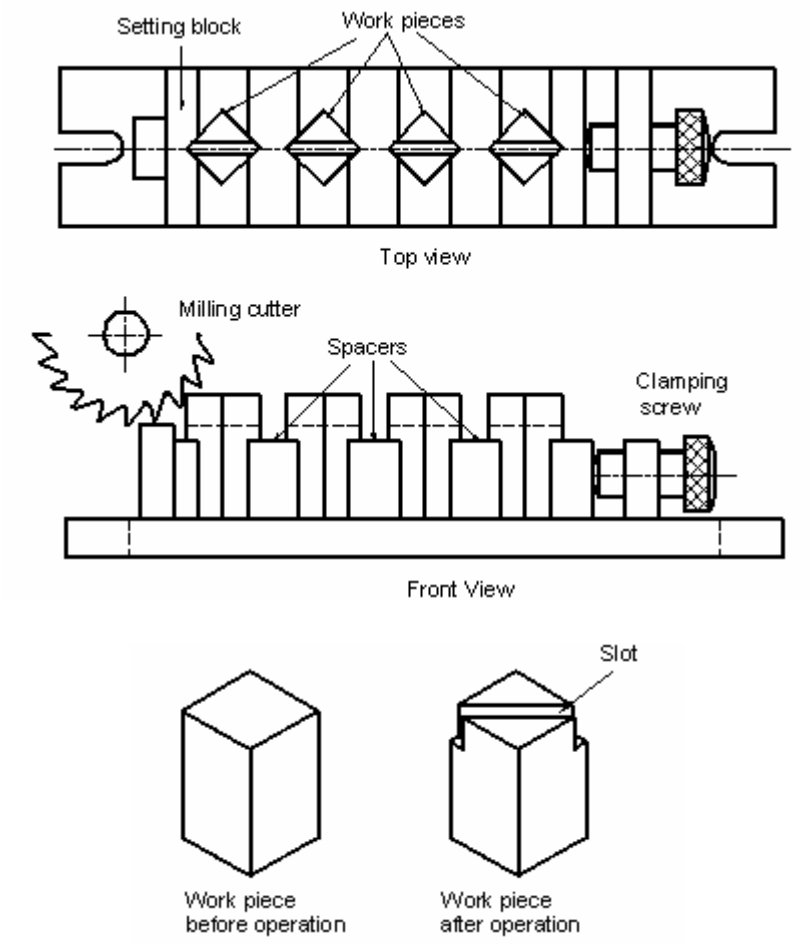


Figure W5.9 A milling fixture

W5.6.3 WELDING FIXTURE

Figure W5.10 shows a welding fixture to locate two structural members (angle irons) for welding at 30° to each other to a gusset plate.

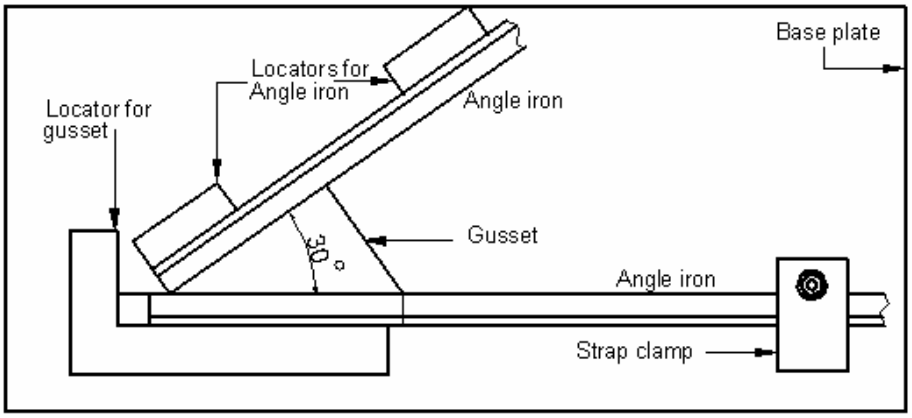


Figure W5.10 A Welding fixture

THEORY QUESTIONS

Q.1. Differentiate between a jig and fixture.
Q.2. What is the importance of a locator? Describe different types of locators.
Q.3. Why is clamping necessary in a jig? Explain any four types of clamping devices.
Q.4. What is the function of a bush in a jig ? Discuss various types of bushes used in a jig.
Q.5. Explain the different types of jig bodies. Give the typical use of each.
Q.6. Sketch any turning fixture and explain its construction.
Q.7. Explain the construction and use of a milling fixture.
Q.8. Describe and sketch a welding fixture for any typical work.

FILL UP THE BLANK QUESTIONS

Q 1 A jig is used for _____. _____ and _____.
Q 2. Fixtures _____ to fix a job.
Q 3. Swinging bar is a _____ device.
Q 4. _____ are used where a heavy clamping force is required.
Q 5. An eccentric can be used as a clamping device for _____ clamping.
Q 6. Bushings are used as _____ in jigs.
Q 7. _____ is used if it is to be replaced for different operations.
Q 8. Two important jig bodies are: _____ and _____.
Q 9. _____ jig is used to locate angular positions.
Q 10. Fixture holds and locates the job but does not _____.
Q 11. Milling fixture can be used to hold _____ simultaneously.
Q 12. Welding fixture helps to _____ the parts to be welded.

MULTIPLE CHOICE QUESTIONS

Q 1 A jig is used to
a. drill a hole
b. locate and clamp a work piece
c. locate, clamp the work piece and guide the cutting tool
d. set the work piece for measurement

Q 2. Common feature between jig and fixture is that both are used for
a. cutting the work piece
b. holding the work piece
c. locating the work piece
d. testing and inspection of the work piece

Q 3. Slip bush is used in jig where

a. the drill bit can slip on the work piece
b. holes are too close
c. the bush is to be replaced every time
d. a liner is used along with bush

Q 4 Liner in a bush of a jig

a. saves the bush from wear
b. strengthens the bush
c. offers lubrication
d. aligns the bush in a hole

Q 5 A cam is used in a jig to

a. locate the work piece
b. lift a heavy work piece
c. move the work piece frequently
d. to clamp the work piece

Q 6 A turning fixture is used on the lathe

a. to turn a non-symmetric job
b. so that the surface finish of the work piece is not spoiled
c. to turn the work piece which otherwise cannot be fitted on the lathe
d. to turn long jobs

Q 7 An indexing jig is used to

a. plane surfaces
b. one angular settings
c. multi angular settings
d. multi plane settings

Q 8 A fixture is used to

a . save time
b. fix odd shaped jobs
c. easy machining
d. none of above

Q 9 The quickest clamping device is a

a. wing nut
b. knurled nut
c. cam/eccentric
d. Conventional nut

Q10 A conical locater has the advantage of

a. easy location
b. self centering
c. easy location and self-centering
d. offers good grid

Answers to Fill up the blank questions

1 – Locate, fix, and guide the tool 2- helps 3- clamping 4 - Hydraulic pistons
5 – quick 6 – tool guide 7 – Slip bushings
8 – Open, closed 9 – Indexing 10 – guide the tool 11 – many
12 - locate

Answers to multiple choice questions

1 – c 2 – a 3 – c 4 – a 5 – d 6 – c 7 – c
8 – b 9 – c 10 -c

PROBLEMS FOR PRACTICE

Q1-5 Sketch a suitable jig to drill a hole in the work pieces as shown in figures W5P.1 to W5P.5.

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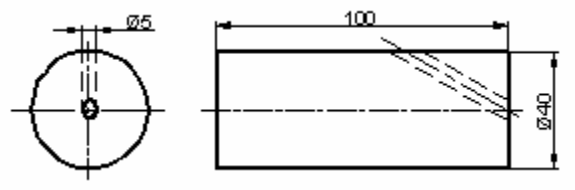

Figure W5P.1

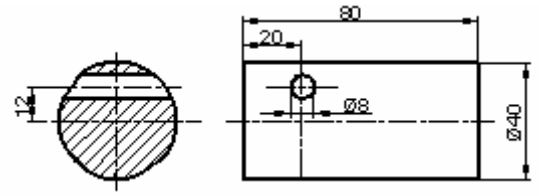

Figure W5P.2

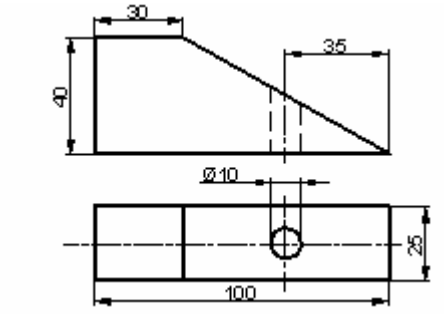

Figure W5P.3

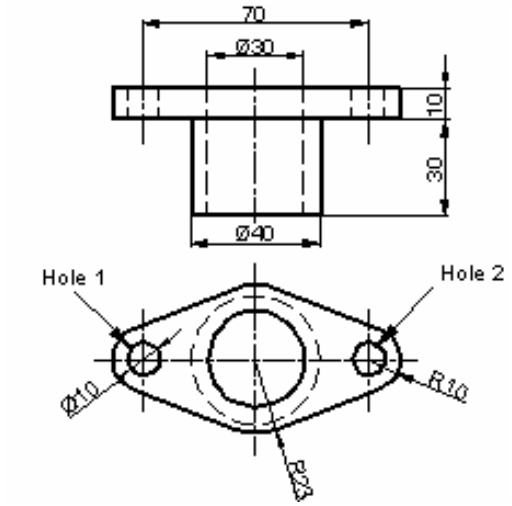

Figure W5P.4

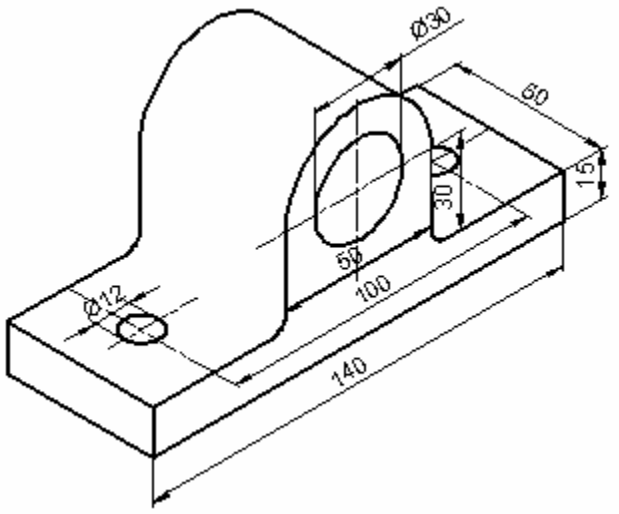

Figure W5P.5

Q 6-8 Sketch a fixture for lathe for the work pieces shown in figures W5P.6 to W5.P8.

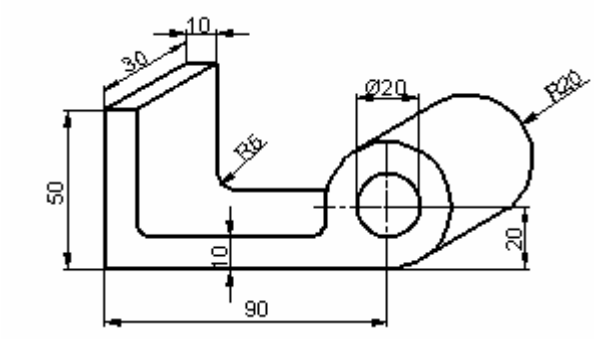

Figure W5P.6

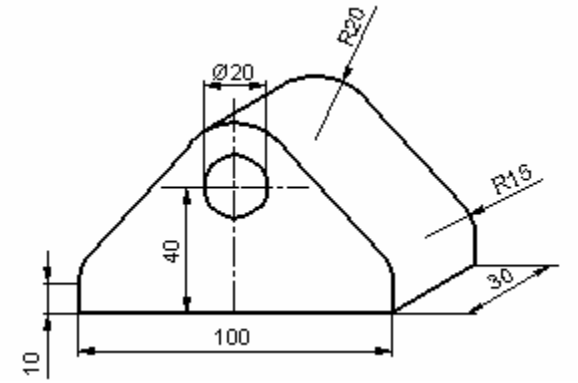

Figure W5P.7

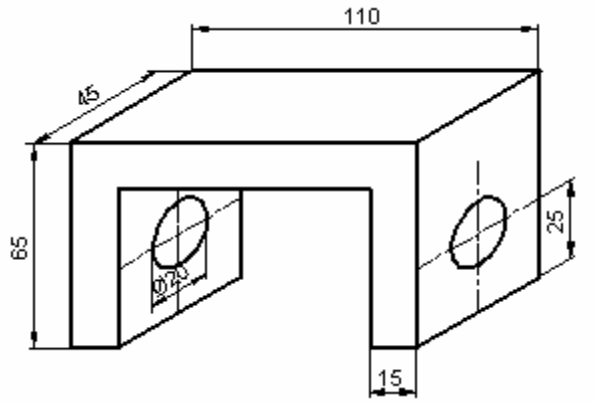

Figure W5P.8

Figure W5P.5 Figure W5P.6 Parts are mating with each other

Q9 Draw a milling fixture for the work pieces (shown in Figure W5.P9) to a suitable scale.

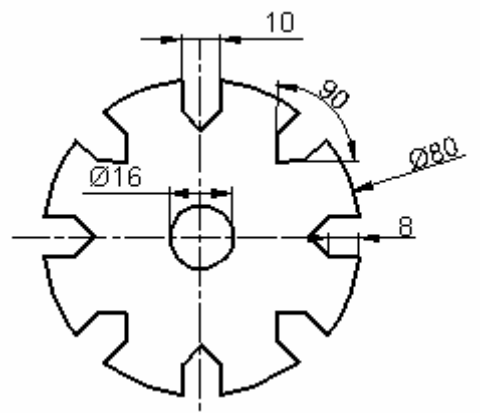

Figure W5P.9

Q 10 Draw a suitable jig for welding the steel sections to the gusset plate as shown in Figure W5P.10.

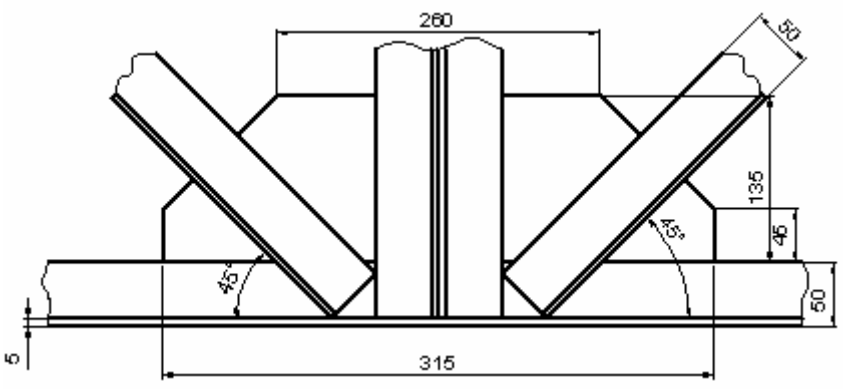

Figure W5P.10