Problem 1  Design a lathe boring fixture for holding the workpiece for boring the 30 mm hole as shown in Fig. 8.67(a) and (b). Consider that the four holes of 16 mm diameters are accurately finished.

Solution: The given problem requires designing a lathe boring fixture to hold a particular workpiece on a lathe machine to carry out boring operation. The shape of the workpiece is such that it will be difficult to hold and centre using standard fixture on a lathe spindle. Therefore, there is a requirement of a special fixture to hold the workpiece on a lathe spindle.
The designed parts of the strap clamp are presented in the Table 8.1 with reference to the solid model and detailed drawing of individual parts.

<table>
<thead>
<tr>
<th>Sl. no.</th>
<th>Part name/Part description</th>
<th>Quantity</th>
<th>Figure Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Base Plate</td>
<td>1</td>
<td>8.67 (a) and (b)</td>
</tr>
<tr>
<td>2</td>
<td>Diamond Pin</td>
<td>1</td>
<td>8.69 (a) and (b)</td>
</tr>
<tr>
<td>3</td>
<td>Round Pin</td>
<td>1</td>
<td>8.70 (a) and (b)</td>
</tr>
<tr>
<td>4</td>
<td>Swing Clamp</td>
<td>2</td>
<td>8.71 (a) and (b)</td>
</tr>
<tr>
<td>5</td>
<td>Socket Head Screws</td>
<td>2</td>
<td>8.72 (a) and (b)</td>
</tr>
<tr>
<td>6</td>
<td>Faceplate</td>
<td>1</td>
<td>8.73 (a) and (b)</td>
</tr>
<tr>
<td>7</td>
<td>Hex bolts</td>
<td>4</td>
<td>8.74 (a) and (b)</td>
</tr>
<tr>
<td>8</td>
<td>Washer</td>
<td>4</td>
<td>8.75 (a) and (b)</td>
</tr>
<tr>
<td>9</td>
<td>Hex Nut</td>
<td>4</td>
<td>8.76 (a) and (b)</td>
</tr>
</tbody>
</table>

The fixture is designed using a standard lathe faceplate (refer to Fig. 8.73) along with specially designed base plate (refer to Fig. 8.68). The workpiece is located and clamped on the base plate (refer to Fig 8.78 and 8.79). The base plate along with the workpiece is bolted on to the faceplate (refer to Fig. 8.79). To mount the assembly, the threaded bore of the faceplate can be screwed on the lathe machine spindle. The complete assembly and the exploded view of the designed fixture are shown in Fig. 8.79 and 8.80. The individual parts of the assembly are indicated in the exploded view of the assembly in Fig. 8.80.

**Method of location** Workpieces can be conveniently located by per machined (drilled or bored) hole using two locating pins. In this case, two finished 16 mm holes on opposite corners of the workpiece are used for location. Two locating pins are used diagonally for the purpose of location (refer to Fig. 8.77). One of the locating pin is a round pin. A diamond pin is used as a secondary locator. Diamond pin is used to reduce angular error, to reduce the jamming tendency and to allow the linear variations of the workpiece. The design/selection of the diamond pin can be made based on the following calculations:
The diameter of the diamond pin, \( d \), is given as

\[
d = \sqrt{\frac{D}{4} - W^2 - P^2}
\]

where
- \( D \) = diameter of hole to be located = 16 mm (in this case)
- \( W \) = width of diamond pin = 4 mm (consider)
- \( P \) = axial error in diamond pin location = 0.2 mm (consider)

Then, the diameter of the diamond pin, \( d = 15.92 \) mm

**Method of clamping and unclamping**

The workpiece is clamped on the base plate using two swing clamps. The workpiece is first properly located on the base plate. The clamping surface of the swing clamps are brought over the workpiece surface and tightened over it using socket head screws. The socket head screws are
Design of Fixtures

Fig. 8.74 Hex bolt (a) Solid model (b) Detailed drawing

Fig. 8.75 Hex nut (a) Solid model (b) Detailed drawing

Fig. 8.76 Washer (a) Solid model (b) Detailed drawing

Fig. 8.77 Assembly of faceplate base plate

Fig. 8.78 Assembly of faceplate base plate and locating pins

Fig. 8.79 Complete assembly of the designed lathe boring fixture

Fig. 8.80 Exploded view of the designed lathe boring fixture

The socket head screws are first loosened and both the swing clamps are swung away from the workpiece surface. The workpiece is now free to be removed through the vertical axis.
The fixture is designed using a standard lathe faceplate (refer to Fig. 8.83). The workpiece is located with specially designed angle plate (refer to Fig. 8.82). The workpiece is clamped on the angle plate and clamped on the faceplate (refer to Fig. 8.81). To mount the assembly, the threaded hole of the faceplate can be screwed on the faceplate and the angle plate, additional weight is attached to the fixture to balance the mass of the workpiece and the angle plate.

**Solution:** The shape of the workpiece is such that it will be difficult to hold a central fixture using standard fixture on the lathe spindle. Therefore, there is a requirement of a special fixture to hold the workpiece on the lathe spindle. The designed parts of the strap clamp are presented in Table 8.2 with reference to a solid model and detailed drawing of individual parts.

**Problem 2:** Design a lathe boring fixture for holding the workpiece for boring.

45 mm hole as shown in Fig. 8.15(a) and (b).

The complete assembly and the exploded view of the designed fixture shown in Figures 8.82 and 8.86. The individual parts of the assembly are indicated in the exploded view of the assembly in Fig. 8.86.
For unclamping, the socket head screws are first loosened and both the swing clamps are swung away from the workpiece surface. The workpiece is now free to be slid out of the cavity locator.

Method of clamping and unclamping. The workpiece is clamped on the angle plate using two swing clamps. The clamp is first properly located on the angle plate surface. The clamp is tightened over it using the swing clamps screws. The socket head screws are screwed on the angle plate for clamping (refer to Fig. 8.3).

Production jobs often require accurate locating and holding of the workpiece. This is achieved using fixtures. Unlike jigs, fixture does not guide the tool. In this chapter, the fixtures comprise different standard or specially designed work holding devices, which are clamped on the machine table in proper location. This chapter deals with principles, methods, and devices used for fixtures.
**Design of Fixtures**

**Design Problems**

1. Design a milling fixture to machine the end surfaces and flange edges of the blank shown. Assume that the end surfaces have been previously bored to size.

2. When the cross section of work is shown in Fig. 8.57(a), assume that the end faces have been machine dimensions from manufacturing considerations.

3. When the cross section of work is shown in the sketch, it is necessary to determine the type of machine tool required to perform the milling operation. Assume that the machine tool shown in the sketch is the one to be used. The student will be required to determine the type of machine tool required for the milling operation, using the tool design formula explained in Chapter 1. The finished tool drawing and the tool design formula are included in the solution.

4. Each student will be assigned one of the following fixtures design problems. Complete the details of the fixture shown in the sketch. The student is responsible for the design of the fixture. The student must include the following:
   - The type of machining operation and the type of fixture required.
   - The size and type of tool to be used.
   - The clamping method and the type of clamping device required.
   - The location of the workpiece on the fixture.

5. The student is required to draw the fixture and the workpiece, including all necessary details. The student must provide a detailed description of the fixture design, including:
   - The type of workpiece.
   - The type of workholding fixture.
   - The type of tool to be used.
   - The method of clamping the workpiece.
   - The location of the workpiece on the fixture.

6. The student must provide a detailed description of the fixture design, including:
   - The type of workpiece.
   - The type of workholding fixture.
   - The type of tool to be used.
   - The method of clamping the workpiece.
   - The location of the workpiece on the fixture.

7. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
   - The type of workpiece.
   - The type of workholding fixture.
   - The type of tool to be used.
   - The method of clamping the workpiece.
   - The location of the workpiece on the fixture.

8. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
   - The type of workpiece.
   - The type of workholding fixture.
   - The type of tool to be used.
   - The method of clamping the workpiece.
   - The location of the workpiece on the fixture.

9. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
   - The type of workpiece.
   - The type of workholding fixture.
   - The type of tool to be used.
   - The method of clamping the workpiece.
   - The location of the workpiece on the fixture.

10. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
    - The type of workpiece.
    - The type of workholding fixture.
    - The type of tool to be used.
    - The method of clamping the workpiece.
    - The location of the workpiece on the fixture.

11. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
    - The type of workpiece.
    - The type of workholding fixture.
    - The type of tool to be used.
    - The method of clamping the workpiece.
    - The location of the workpiece on the fixture.

12. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
    - The type of workpiece.
    - The type of workholding fixture.
    - The type of tool to be used.
    - The method of clamping the workpiece.
    - The location of the workpiece on the fixture.

13. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
    - The type of workpiece.
    - The type of workholding fixture.
    - The type of tool to be used.
    - The method of clamping the workpiece.
    - The location of the workpiece on the fixture.

14. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
    - The type of workpiece.
    - The type of workholding fixture.
    - The type of tool to be used.
    - The method of clamping the workpiece.
    - The location of the workpiece on the fixture.

15. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
    - The type of workpiece.
    - The type of workholding fixture.
    - The type of tool to be used.
    - The method of clamping the workpiece.
    - The location of the workpiece on the fixture.

16. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
    - The type of workpiece.
    - The type of workholding fixture.
    - The type of tool to be used.
    - The method of clamping the workpiece.
    - The location of the workpiece on the fixture.

17. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
    - The type of workpiece.
    - The type of workholding fixture.
    - The type of tool to be used.
    - The method of clamping the workpiece.
    - The location of the workpiece on the fixture.

18. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
    - The type of workpiece.
    - The type of workholding fixture.
    - The type of tool to be used.
    - The method of clamping the workpiece.
    - The location of the workpiece on the fixture.

19. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
    - The type of workpiece.
    - The type of workholding fixture.
    - The type of tool to be used.
    - The method of clamping the workpiece.
    - The location of the workpiece on the fixture.

20. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
    - The type of workpiece.
    - The type of workholding fixture.
    - The type of tool to be used.
    - The method of clamping the workpiece.
    - The location of the workpiece on the fixture.

21. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
    - The type of workpiece.
    - The type of workholding fixture.
    - The type of tool to be used.
    - The method of clamping the workpiece.
    - The location of the workpiece on the fixture.

22. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
    - The type of workpiece.
    - The type of workholding fixture.
    - The type of tool to be used.
    - The method of clamping the workpiece.
    - The location of the workpiece on the fixture.

23. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
    - The type of workpiece.
    - The type of workholding fixture.
    - The type of tool to be used.
    - The method of clamping the workpiece.
    - The location of the workpiece on the fixture.

24. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
    - The type of workpiece.
    - The type of workholding fixture.
    - The type of tool to be used.
    - The method of clamping the workpiece.
    - The location of the workpiece on the fixture.

25. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
    - The type of workpiece.
    - The type of workholding fixture.
    - The type of tool to be used.
    - The method of clamping the workpiece.
    - The location of the workpiece on the fixture.

26. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
    - The type of workpiece.
    - The type of workholding fixture.
    - The type of tool to be used.
    - The method of clamping the workpiece.
    - The location of the workpiece on the fixture.

27. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
    - The type of workpiece.
    - The type of workholding fixture.
    - The type of tool to be used.
    - The method of clamping the workpiece.
    - The location of the workpiece on the fixture.

28. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
    - The type of workpiece.
    - The type of workholding fixture.
    - The type of tool to be used.
    - The method of clamping the workpiece.
    - The location of the workpiece on the fixture.

29. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
    - The type of workpiece.
    - The type of workholding fixture.
    - The type of tool to be used.
    - The method of clamping the workpiece.
    - The location of the workpiece on the fixture.

30. The student is required to design a fixture for the workpiece shown in the sketch. The student must include all necessary details and provide a detailed description of the fixture design, including:
    - The type of workpiece.
    - The type of workholding fixture.
    - The type of tool to be used.
    - The method of clamping the workpiece.
    - The location of the workpiece on the fixture.

**Questions**

1. How was the term fixture derived?
2. How is the term fixture used today?
3. When designing fixture, the basic difference between a single and a multiple fixture should be considered.
4. How are fixture designs classified?
5. Why is it necessary to use a fixture when machining?