10 Shaping and Slotting Machines

10.1. INTRODUCTION

Shaper is a versatile machine which is primarily intended for producing flat surfaces. These surfaces may be horizontal, vertical or inclined. This machine involves the use of a *single point tool* held in a properly designed tool box mounted on a reciprocating ram. The main significance of this machine lies in its greater flexibility on account of ease in work holding, quick adjustment and use of tools of relatively simple design. On account of this fact it is almost an indispensable machine in tool rooms, die making shops and general repair shops, where only a very few jobs of identical shapes are produced. If properly handled, it can be safely adopted for producing curved and irregular surfaces also.

10.2. WORKING PRINCIPLE OF A SHAPER

The working principle of a shaper is illustrated in Fig. 10.1. In case of shaper, the job is rigidly held in a suitable device like a *vice* or clamped directly on the machine table. The tool is held in the tool post mounted on the ram of the machine. This *ram* reciprocates to and fro and, in doing so, makes the tool to cut the material in the forward stroke. No cutting of material takes place during the return stroke of the ram. Hence, it is termed as *'Idle'* stroke. However, in case of a *draw-cut* shaper, the cutting takes place in the return stroke and the forward stroke in an idle stroke. The job is given an indexed feed (equal amount after each cut) in a direction normal to the line of action of the cutting tool.

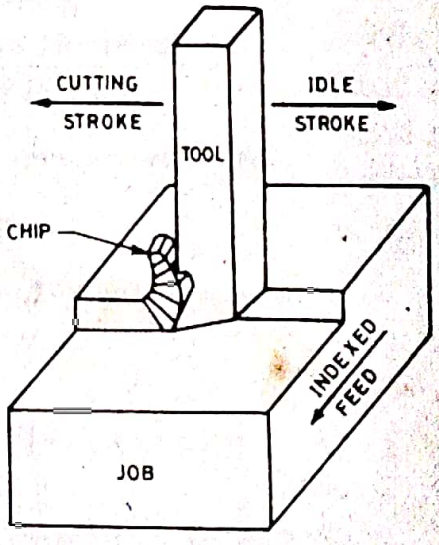

Fig. 10.1. Principle of working of a shaper.

10.3. PRINCIPAL PARTS OF A SHAPER

Principal parts of a shaper, as illustrated in Fig. 10.2, are the following :

1. **Base.** It is a heavy and robust cast iron body which acts as a support for all the other parts of the machine which are mounted over it.

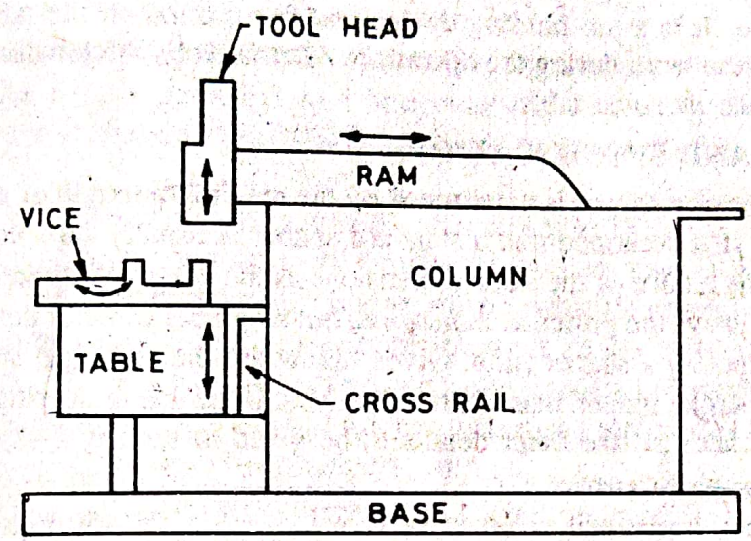

Fig. 10.2. Main parts of a shaper.

2. **Column.** It is a box type cast iron body, mounted on the base and acts as a housing for the operating mechanism of the machine and the electricals. It also acts as a support for other parts of the machine such as cross rail and ram, etc. In case of a hydraulic shaper, it carries the hydraulic drive mechanism inside it. On its top it carries machined ways, in which the ram reciprocates, and vertical guideways at its front.

3. **Cross-rail.** It is a heavy cast iron construction, attached to the column at its front on the vertical guideways. It carries two mechanisms ; one for elevating the table and the other for cross traverse of the table.

4. **Table.** It is made of cast iron and has a box type construction. It holds and supports the work during the operation and slides along the cross-rail to provide feed to the work. T-slots are provided on its top and sides for securing the work to it.

5. **Ram.** It is also an iron casting, semi-circular in shape and provided with a ribbed construction inside for rigidity and strength. It carries the tool head and

travels in dovetail guideways to provide a straight line motion to the tool. It carries the mechanism for adjustment of ram position inside it.

6. Tool head. It is the device in which is held the tool. It can slide up and down and can be swung to a desired angle to set the tool at a desired position for the operation.

7. Vice. It is a job holding device and is mounted on the table. It holds and supports the work during the operation. Alternatively, the job can be directly clamped to the machine table.

2. When the work is to be clamped in a vice always use brass, copper or tin liners in order to protect the vice jaws from being dented, particularly when a job having rough surface is being held, such as forgings and castings.

3. Always maintain the parallels clean. Frequently check them for straightness, parallelism and squareness.

4. Never hammer a piece, having rough surface, against a parallel.

5. Ensure, before use, that the parallels are free from burrs.

6. Take care that no chips remain on the workseat, otherwise the work will not be clamped properly. Also, if these chips come in contact with a machined surface, the latter may be spoiled.

7. Once a work is set in position, do not tighten the vice jaws, otherwise the work may be lifted up.

8. Once a vice has been removed from the worktable, ensure, before using the vice again, that the table top and workseat are clean and free from burrs and chips, etc.

9. Always select a proper tool and grind it to correct angles to suit the operation to be done and the material to be machined.

10. Ensure that the clapper block swings freely out during the return stroke.

11. Never use hammer for swivelling the apron.

12. Set the tool to the correct angle according to the operation to be done.

13. Check up all the controls of the machine before starting the operation.

14. Adjust the proper length of stroke before starting the operation.

15. Always use correct speed and feed.

16. For machining cast iron, set the tool enough deep to start cutting under the scale as the same is very hard and if the tool is allowed to rub on it, its cutting edge will be spoiled.

10.29. SHAPER OPERATIONS

Several different shapes of jobs can be produced on shapers. However, the basic operations done on a shaper can be broadly classified as follows :

1. Horizontal cutting,
2. Vetical cutting,
3. Angular cutting, and
4. Irregular cutting.

The various shapes of surfaces are the results of either one or a combination of more than one of the above four operations. In the forthcoming articles we will discuss these operations in details.

10.30. HORIZONTAL CUTTING

It is the most common operation performed on a shaping machine. In this, the work is fed in a horizontal direction under the reciprocating tool and the surface

produced is horizontal and flat. For this, the work is either held in a vice or clamped directly on the machine table, depending upon its size. Before clamping the work, the vice jaws, workseat or table top are tested for accuracy. Parallels are used for clamping the work, if it is held in the vice. The tool is held in a proper tool holder. It is set at proper inclination and at correct height above the work, as described later in this article. The depth of cut is adjusted and the machine started. Cross feed to the table is given initially by hand, till the cut starts. After that power feed can be employed. After the cut is finished, the machine is stopped and the work inspected. If more material is to be removed, the procedure is repeated till the desired surface is obtained.

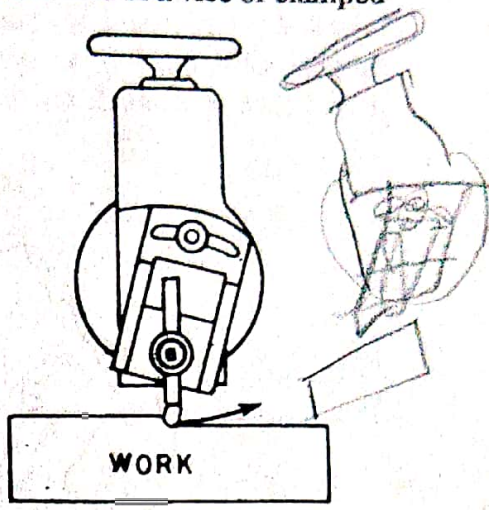

Fig. 10.34. Tool setting in horizontal cutting.

A special precaution is reqired in setting the tool for horizontal cutting. The tool should be held vertically in such a way that its cutting edge points in a direction slightly away from the work, as shown in Fig. 10.34. It is set so for the reason that, if sometimes the tool moves, due to the cutting pressure, it will move away from the work instead of digging into it. The arrow in Fig. 10.34 indicates this possible direction of movement of the tool under cutting pressure.

Another precaution to be taken in tool setting is that its cutting edge should not be projected much below the tool holder and vertical slide of the toolhead should not be made to overhang too far below the ram. If otherwise, the tool will be weakened and subjected to undue strain. Also, a lot of *chatter* will result.

10.31. VERTICAL CUTTING

The tool is fed downward in vertical cutting. This sort of tool feed is commonly employed in cutting grooves, key-ways, tongues, parting off and squaring ends and shoulders. When the down feed of the tool is used, except in parting off, the apron top is swivelled in a direction away from the surface to be machined. A proper tool setting for vertical cutting is shown in Fig. 10.35. The down feed to the tool is given by rotating down feed screw of the toolhead.

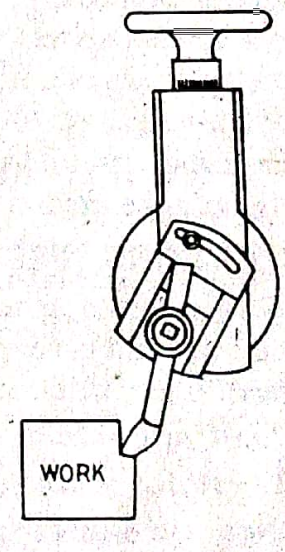

Fig. 10.35. Tool setting for vertical cutting.

10.32. ANGULAR CUTTING

The operation of angular cutting is employed for machining inclined surfaces,

bevelled surfaces and dovetails, etc. Here again, the down feed of the tool is used. Proper tool setting is again an important factor here also. The apron top is swivelled in a direction away from the surface to be machined as in vertical cutting. In

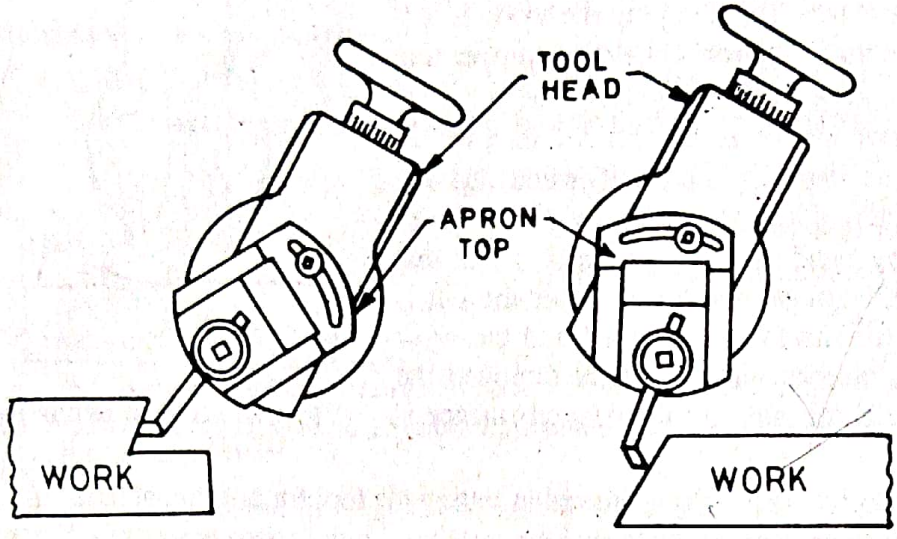

Fig. 10.36. Tool setting for angular cutting.

addition to that, the toolhead is also swivelled, as shown in Fig. 10.36. Alternatively, sometimes an inclined surface is obtained by setting the job in inclined position by setting it on tapered parallels or by other suitable means.

10.33. IRREGULAR CUTTING

If an irregular surface is to be machined and it is appreciably narrow a form tool can easily be used for machining the same. Against this, if a wide irregular surface is to be machined the shape is marked on the side of the job. The usual and preferable procedure for such machining is to first rough machine the surface to about 1.5 mm above the marked shape. Then, bevel the edges at about 45° or more by means of a file and machine off the bevelled portion. Thus the job is machined right up to the marked shape. For machining such surfaces, a combination of vertical hand feed to the tool and horizontal power cross feed to the table is to be used.

10.34. CUTTING SPEEDS AND FEEDS

With regard to the selection of proper cutting speed and feed it is advisable to use the standard tables provided by the manufacturers alongwith the machine. However, if needed, the cutting speed can be calculated thus :

Let L metres be the length of stroke.

and, S = No. of strokes per minute.

Now, the distance travelled by the tool per minute

$= L \times S$ metres.

Or, in other words, we can say that the length of metal cut per minute by the tool $= L \times S$ metres.