UNIT 7 METAL SAWING

Structure

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7.1 INTRODUCTION

Materials like wood and metals are often cut using sawing machines. Metal sawing is like any other metal processing method and it is governed by similar cutting requirements. Sawing is used because of its some characteristics advantages like speed of cutting, low wastage of material, good quality of dimensional accuracy and low power consumption.

Saw is a multipoint cutting tool, which is used in sawing operation. In this operation a large number of teeth move through the workpiece, each successive tooth deepens the cut made by its predecessor tooth. Feed is given either to the saw or the workpiece. Straight or curved profile may be cut by controlling the direction of feed motion. Most of the stock materials are received in its standard size and shape. Therefore, the stock material is required to be cut to convenient length before being fed to the machine tool for its further processing. Not only in length, but quite often we may have to cut the bar stock in all direction to bring it roughly to the required shape and sized. This may save lots of processing time. All these requirements and the economic considerations have made the power driven metal cutting saws almost indispensable now-a-days.

Objectives

After studying this unit, you should be able to

• different types of sawing machines, applications and their components and construction,
• different type of sawing blades, and
• applications of sawing operations and machines.

7.2 CLASSIFICATION OF SAWING MACHINES

In general the sawing machines are classified as :

(a) Reciprocating saw (Power Hacksaw)
(b) Band saws
(c) Circular saws (details are not covered in this unit).

Before describing each of the above sawing machines it will be better to understand the common components of any type of sawing machines. The common components of a sawing machine are:
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(a) The saw (saw blade)
(b) Machine
(c) Fixture holding the saw
(d) Driving mechanism
(e) Work table
(f) Feed mechanism.

7.3 SAW

The saw or saw blade is one of the most important component of a sawing machine. Saws are characterized by their material, tooth form, teeth set, tooth spacing and size. Good quality metal cutting saws are made of high carbon or high speed steel. However, some circular saws may have inserted cemented carbide teeth. Hack saw (power saw) and band saws are generally made solid. Circular saws may made solid or segmental with several teeth on each segment or with individual tooth inserts. Diamond tooth blades are used for machining of ceramics or likewise hard materials. The geometry of the teeth is singular to that of the single point tools. Two commonly used forms for saw blades are shown in Figure 7.1. The straight tooth form is suitable for finer pitches whereas the under cut face tooth forms are used for coarser pitches. Undercut tooth form is better from design point of view, because the cutting edges are backed up by more metal. It is very difficult to have this tooth form if teeth are very small in size.

![Figure 7.1: Tooth Forms](image)

Saw teeth are given an offset to the side known as tooth set to produce cuts which are wider than thickness of the back of the blade or disc. This enables the saw to move freely without friction. Three common types of saw teeth are shown in Figure 7.2. Tooth set refers to how the teeth are bent or offset to one side of the other and the amount of the offset. The set makes the cut or kerf wider than the blade thickness so that the blade will not stick or bind.

![Figure 7.2: Saw Tooth Sets](image)
Common types of tooth sets are described below.

**Straight Set**

When the teeth are offset alternatively to the right and left, it is called straight set or alternated set. This set is most suitable for non-ferrous metals and non-metals.

**Wavy Set**

It is also called circular set. In this case several teeth are offset in one direction and then several other teeth are offset in opposite direction. This set is employed with small teeth. It is used for sawing thin sheets and sections.

**Raker Set**

It consist of one tooth is offset to the left, the next tooth is offset to the right then third tooth is unbent. This form is repeated in raker set. This set is used for cutting ferrous metals unless the metal thickness is too thin.

There is a specialty of circular saw that, it is made with alternate high and low teeth, straight and beveled teeth as shown in Figure 7.2. These profiles help in breaking the chips, permit load distribution and allow some teeth to take finishing cuts.

In addition to the tooth form some other parameters concerned with saw characteristics are described below.

**Blade Material**

Generally blades are made of carbon steels, tungsten alloy steel, high speed tungsten steel, molybdenum steel and cemented carbide. Most of the saws are solid, however, some saws have the teeth of hard material backed by a flexible steel. A few of the saws have tipped or (brazed) inserted bits as teeth.

**Tooth Spacing (Pitch)**

Tooth spacing or pitch has a significant influence on the performance of saw. The space between the teeth provides room for chips removed during the cutting operation. Smaller pitches are said finer pitches and larger pitches are said coarse pitches. Coarse pitches are required for longer cuts required in case of softer materials to accommodate the larger chips. Fine pitches are recommended for harder materials. To cut the this sections a fine pitch is again recommended, the idea is two or more teeth should remain in contact with workpiece, at a time, to prevent stripping of the teeth.

For band saws the pitch should be very fine is 0.75 mm for hack saw or power saw the recommended value of pitch is 1.5 mm. Coarse band saw and power saw may have a pitch as high as 12 mm. In case of circular saws value of pitch may very from 5 mm for small saws to 50 mm for larger diameter saws. The large diameter saws with large pitch value are used for cutting of softer materials.

**Cutting Speed of a Saw**

Cutting speed for sawing is determined by the same considerations as for any other machining operation. Normally power driven hack saws are equipped with 3 or 5 speeds in their working mechanism. The speed of a saw is expressed as number of strokes per minute with high carbon steel blade, the higher speed should be used in cutting mild steel and other soft materials with HSS blade all materials can be processed at appreciable higher speeds. The cutting speed can also expressed as meter per second (mps). In this expression length of a blade also matters a log along with number of strokes per unit time.

**Feed Rate of the Blade**

Feed rate in case of sawing is the movement of the saw into the workpiece at right angle to the direction of cutting. It is expressed in mm/sec or mm/stroke. Feed rate determines the depth of cut taken by each other, it should be so adjusted that the force exerted by the workpiece on the saw in the opposite direction of feed is as
high as the blade would permit without any damage to it. Higher the feed rate higher will be the force exerted by the workpiece on the blade.

Feed rate is a big problem in case manual sawing, it is not possible to maintain a definite and uniform feed rate, so manual sawing is considered inferior from feed point of view.

### 7.4 SPECIFICATIONS OF A SAW BLADE

A saw blade is normally specified by following parameters.

**Length of the Blade**

This is active length used in actual cutting of workpiece.

**Width of the Blade**

This is a dimension measured perpendicular to its length. It is important for strength considerations of the blade.

**Thickness of the Blade**

How much the blade is thick? It decides width of the cut and bearing capability of the blade when higher feed rates are to be maintained. Higher cutting speeds are also possible with thicker blades.

**Number of Teeth per Unit Length (Pitch)**

It is expressed as number teeth per centimeter or per inches. Pitch decides the fineness of cut which have already been discussed.

### 7.5 MACHINE SIZE AND SPECIFICATIONS

Different types of sawing motions are required for cutting action. Depending upon the cutting actions three types of sawing machines are there. Reciprocating or power hack sawing, circular sawing and bend sawing. The size of a machine is usually designated by the maximum size of the bar stock of any geometry (workpiece) that can be accommodate for processing other parameters that specify a machine are detailed below.

**Length of Blade**

Minimum length and maximum length of the blade that can be accommodated on a machine.

**Maximum Length of Stroke**

Stoke length of the blade can be set to any value but maximum upto active length of the blade.

**Number of Strokes per Minute**

Different discrete values of number of strokes per minute are available in a machine in a range. As we know that number of strokes per minutes and stroke length together decides the cutting speed of the work.

**Power of Motor**

A sawing machine is also identified by its power of the motor used to provide different movements to all of its motive parts as prime mover. Motor should be enough powerful to provide desired movements to all the motive parts simultaneously. Power of motor is normally expressed in H.P. or K.W. (horsepower or kilowatts).
Type of Drive and Lift

The other important parameter used to specify a machine is type of drive. That means how the power is transferred to various motive parts from prime mover. Type of power transmission may be belt drive, gear drive, etc. Type of lift should also be specified for a machine which may be manual hydraulic pneumatic, etc.

7.6 GENERAL BLADE FAILURE AND THEIR REMEDIES

Power hack saw blade may fail due to many reasons. Failure means breakage of blade before its wear and tear or excessive wear, more than expectations, during on operation. Some of the common blade failure and their causes with remedies are explained below.

(a) Erratic cutting or no cutting from beginning of the operation. During loading of the blade to the saw teeth may point in wrong direction. It should be reversed teeth pointing towards the crank.

(b) Selection of a wrong blade leads to its poor performance like poor life of blade, excessive wear, poor quality of cut. The blade should be selected by considering size, number of teeth, suitable material (its properties) in accordance to the workpiece.

(c) Unexpected breakage of the blade. It may be due loose mounting of blade, workpiece or both. Clamping should be checked.

(d) Unexpected breakage may also be due to improper tension in blade. Proper tightening without buckling of blade should be ensured.

(e) For longer life of the blade, it should not be left under tension while not in use.

(f) Start of cut should be done slowly so that blade can be accommodate into the groove of the cut made on the workpiece. This will avoid risk of slip and breakage.

(g) If a blade breaks during the process, the unfinished cut should not be processed using a new blade. The main reason for that is new blade is always considered thicker than the used/old blade.

(h) To cut the thicker sections low speeds and very small feed rate should be maintained to avoid breakage of the blade.

Above precautions are applicable to all types of saw blades.

7.7 POWER HACK SAW

These machines are also known as heavy duty power hack saw or production hack saws. These are heavier in construction and are provided with some additional accessories. In these machines work table may hydraulically operate. The workpiece is rigidly clamped on the work table in vice built in there. A number of rods, bars or other sections can be grouped together and clamped to cut them simultaneously to the desired size. A special purpose fixture having a stop can be designed on the work table to maintain the dimensional accuracy of workpiece efficiently. This can avoid the repetitive measurement exercise during its operation.

In these machines, most of the operations like moving the stacked stock to required length each time, clamping of stacked material, raising of saw frame after cutting is over, circulation of cutting fluid, etc. are hydraulically controlled. Some of the power saws maintain these controlling operations very accurately as these are computer numerically controlled. A line diagram indicating construction of a reciprocating power saw (heavy duty) is shown in Figure 7.3.
**Working of Reciprocating Power Hack Saw**

The work table consists of a vice (clamp) on it. The vice is adjustable for cutting at right angles as well as at several other angles. At one end of the table a very short column is there. The saw frame is mounted on the column, the column also house the mechanism to transfer different reciprocating speeds to the frame holds the saw blade. Cutting action takes place only in the forward stroke which is also named as draw stroke. The frame lifts up slightly on the return stroke. Switches are also provided to turn on the power and clutch handle to start the sawing operation. Supply of cutting fluid cable maintained as per the requirement. The machine is equipped with the facility that reciprocating stops automatically as soon as the cut is complete.

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### 7.8 BAND SAW MACHINES

Band saw consist of endless saw blade sued to a greater extent for cut off and straight sawing operations for metals since they enable the width of the kerf to be substantially reduced. They are used in special power band sawing machines. A continuous saw blade runs over the rims of two wheels on the machine. Normally two types of band saw machines are used. These are vertical band saw and horizontal band saw.

#### 7.8.1 Vertical Band Saw Machine

Line diagram of main parts of a vertical band saw machine is shown in Figure 7.4. Different parts are described below.
**Column**

It is heavy vertical cast iron hallow structure. It consists of prime mover, driving mechanism and control in itself. Its top part is made projected outward to accommodate the upper wheel to support and drive the saw blade.

**Bed**

It is made integral part of column, a heavy cast iron structures main supporting member of the machine and its all fixtures. It should be perfectly flat in incorporate high degree of accuracy to work.

**Table**

Work table supports the workpiece directly, it can be titled to an angle and mounted on trumious to enable its inclination to either side. Table is made of cast iron and carries a long slot at its centre through which saw blade can pans.

**Wheels**

Two revolving wheels are provided mounted on two different shafts to move endless saw blade called band. Centre distance between the wheels can be adjusted to adjust the tension in the band.

**Guides**

Guides are provided to keep the band straight while it penetrates into the work.

**Blade**

Blade of band saw is called band. Different types of bands can be therefore different purposes. Saw band for metal cutting, file band for filing and polishing band for polishing and finishing of surface. Details of teeth of saw band have already been discussed.

### 7.8.2 Horizontal Band Saw

It is also named as cut off band saw machine. Its line diagram indicating construction of working is shown in Figure 7.5. It also carries two revolving wheels which have their axis in a horizontal plane. A endless band saw is loaded over the two wheels. A tension control mechanism is there by varying centre distance between the wheels slightly. Two guides are available on the path of the band to avoid abnormal bending and breakage.

![Figure 7.5: Horizontal Band Saw](image-url)
This saw is used to cut workpiece along a vertical plane. The frame of the machine is normally hinged so that it can be swung in a vertical plane to raise it after the completion of cutting. Cutting takes place due to continuous feed given to band into the workpiece, and band runs continuously in the same direction as there is not any requirement of return stroke like power hack saw. This also can operate at higher speed as compared to power hack saw. Some of the important matters explained below should be taken in care during the use of horizontal band saw.

(a) Correct adjustment of tension before start of its use.
(b) All protecting guard should be operational at their proper place to avoid risk of any accident.
(c) Selection appropriate feed rate, speed corresponding to type of saw and workpiece material.
(d) Proper coolant should be used to overcome the problem of overheating. It is also required to maintain long life of band and good quality of operation.

7.9 SUMMARY

Metal sawing is one of the inevitable operations of metal shaping. Metal sawing cuts the metal into two or more pieces as per the requirement with exact dimensional accuracy. It is categorized into different categories depending upon the profile of saw tooth. Different machine tools are available to run the saw in a predetermined manner. Classification of various sawing machines, different types of saw tooth are described in this unit. Failure of a saw blade due to some error in its operation along with the suggested solutions are also available in the description.