

**Work Shop Practices (ME110)**  
**L-T-P (0-0-3)**

**Session -3 (December, 2020)**

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# Presentation Layout

- Course structure
- Introduction of Fitting
- Classification of tools and its uses
- Various operations/processes
- Reference books and further reading materials

# What will you learn in this section?

- **Various cutting tools used in fitting shop.**
- **Description of various work holding devices used in fitting shop.**
- **Different marking and measuring tools used in fitting shop.**
- **Working principle of radial drilling machine and its operation.**

# Introduction of Fitting

**The fitting is the process of assembling various parts manufactured in the machine shop. These operations are usually carried on bench by person called fitter. Hence various tools and equipment's are required to perform operations to finish the work to the desired shape and size in assembling the unit.**

- **Fitting involves marking, cutting, striking, holding and fitting of metal pieces together to produce a finished product.**
- **Making of fitting piece is the essential operation in bench work.**

# Fitting tools

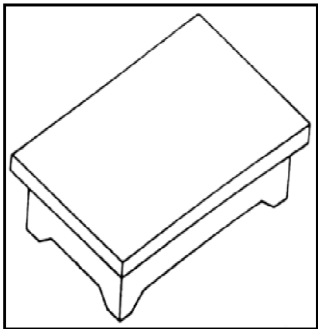
**Fitting tools are used to produce components to an exact size. The types of fitting tools are as follows.**

- 1. Marking tools**
- 2. Measuring tools**
- 3. Holding tools**
- 4. Cutting tools**
- 5. Striking tools**
- 6. Miscellaneous tools**

# Marking tools

Marking is the process of layout of sizes on the work piece. The following fitting tools are used in marking out operations.

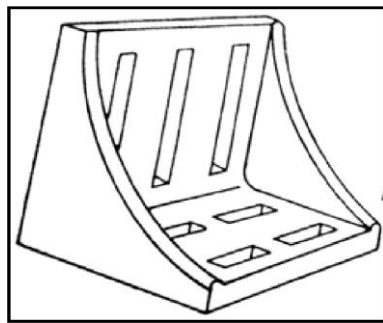
- Surface plate is used for testing the flatness and marking-out the work. It is made of grey cast iron of solid design.
- Try square consist of a blade and a stock in one piece at right angle to each other. It is made of steel and is used to test trueness of mutually perpendicular surfaces and for making straight lines.
- Angle plate is made of grey cast iron and used for used in conjunction with the surface plate for supporting work in the perpendicular position.
- V block is made of hardened steel and used for roundly shaped work pieces which are to be marked or drilled.
- Punches are made of tool steel and used for locating the centre on the work piece in permanent manner.
- Scriber is used for making straight lines on metal surface with the aid of steel rule, try square and templates. It is made of tool steel with hardened and tampered points and knurled on the body to provide grip.



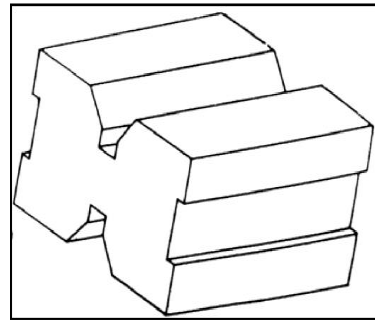
Surface Plate



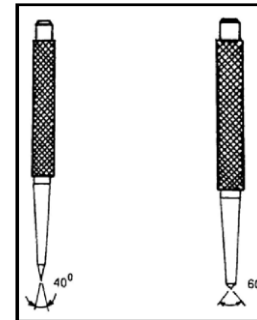
Try - Square



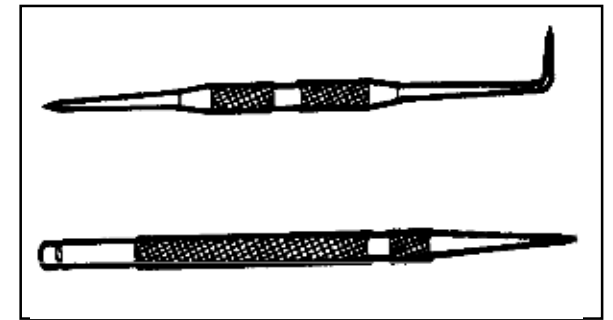
Angle plate



V - Block



Punches

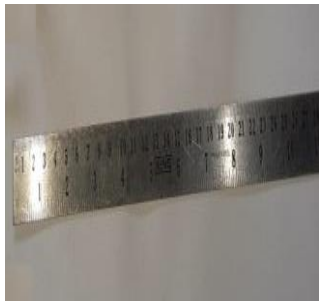


Scribers

# Measuring tools

**The fitting measuring tools are as follows:**

- **Steel rules** are used for measuring lengths in millimeters and also used to transfer the measurements from steel rule to calipers.
- **Outside and inside calipers** are used for measuring and transferring the dimensions as per need. Also very useful for comparing the sizes with existing standards.
- **Vernier calipers** are used to measure length, thickness, depth along with the inside and outside diameters with high precision and accuracy upto 0.02 mm.
- **Micrometer** is a precision tool and used to measure internal or external dimensions such as diameters and thickness upto 0.01 mm accuracy.
- **Depth gauge** is used to measure the blind holes, slots, recesses and height of projections.
- **Gauge blocks** are used to check the accuracy of gauges to set comparators, sine bars and to make machine tool setups.



Steel Rule



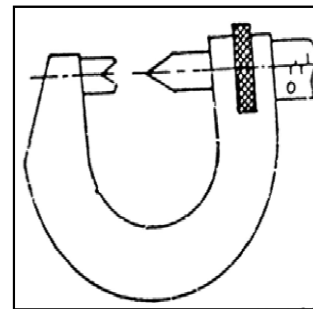
Outside caliper



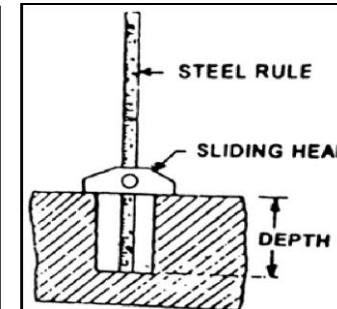
inside caliper



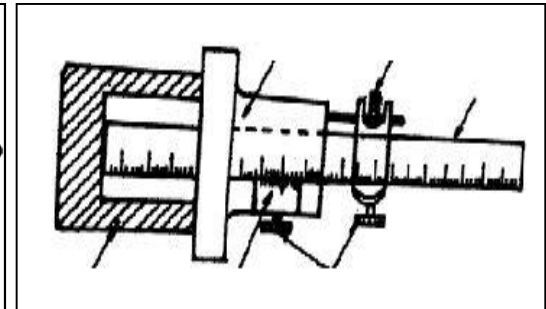
Vernier caliper



Micrometer



Depth gauge

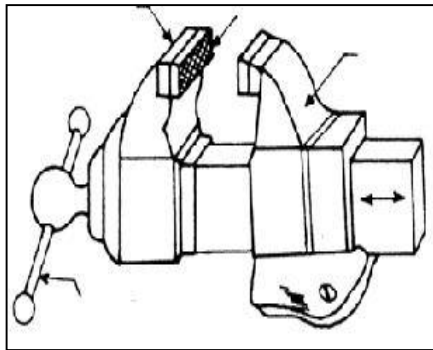


Gauge block

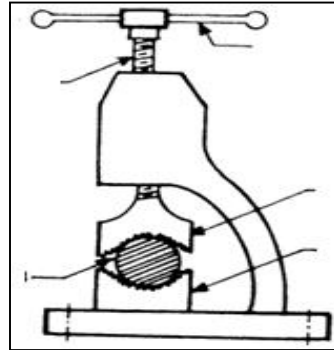
# Holding tools

Large number of cutting forces are involved in fitting operations therefore holding the job is an important aspect of all metal cutting operations. The holding tools are as follows:

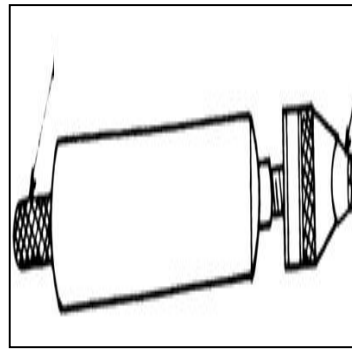
- **Bench vice** is the most common tool and used for holding the work piece. It consist of one fixed jaw, one sliding jaw, one handle and collar arrangement.
- **Pipe vice** is generally used in plumbing work and it grips the circular objects like tubes and pipes at four points on its surfaces.
- **Pin vice** is used for holding small parts such as wires ,nails and pins.
- **Hand vice** is used to grip small objects like screw, rivets and keys when it is inconvenient to hold by the bench vice.
- **Tool maker's vice** is used for holding small jobs which requires fitting or drilling and it is made of mild steel.



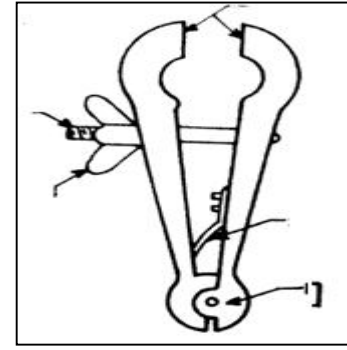
**Bench vice**



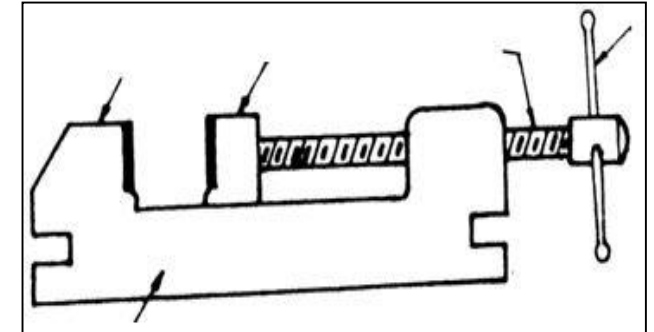
**Pipe vice**



**Pin vice**



**Hand vice**



**Tool Maker's Vice**



# Cutting tools

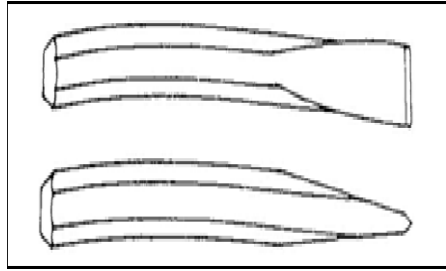
These tools are used to remove excess metal from the job to obtain desired geometry. Various cutting tools used in fitting are as follows:

1. Chisels 2. Files 3. Hacksaws 4. Scrapers 5. Drill bits 6. Reamers 7. Taps 8. Dies and sockets

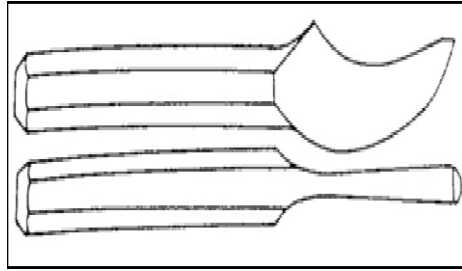
1. **Cold chisels:** They are widely used to remove excess material from the large surface of the work piece but the surface finish and accuracy are usually poor. The body of a chisel mainly consist of head, shank and cutting edge. There are mainly five types of chisels used in fitting and they are specified by the shapes of their cutting edges.

- Flat chisel is mainly used for chipping of large surfaces, cutting of sheets and for doing part off metal after chain drilling. Flat chisels varies in length from 100mm to 400mm and in width from 16mm to 32mm.
- Half round chisel is particularly used for cutting oil ways , curved grooves in bearings ,bosses and pulleys.
- Cross cut chisel is also known as cape chisel and specially used for cutting grooves ,channels and keys ways in shafts and pulleys. This chisel varies from 100 mm to 400 mm in length and 4 mm to 12 mm in width.
- Diamond point chisel is used for cutting V- grooves, cleaning corners and squaring small holes. It has a cutting edge in the shape of a diamond.
- Side chisel is used for chipping and removing the surplus metal in rectangular slots.

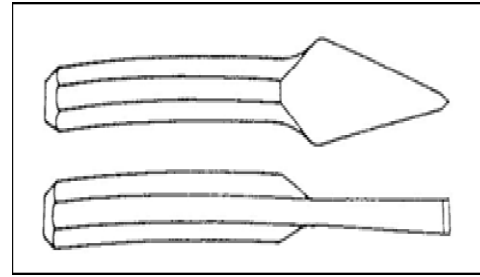
# Cutting tools continued..



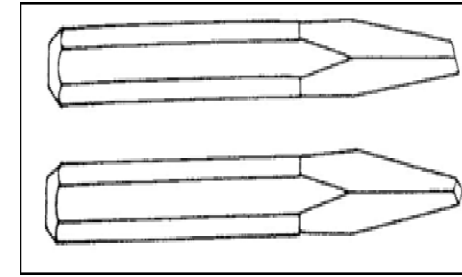
**Flat chisel**



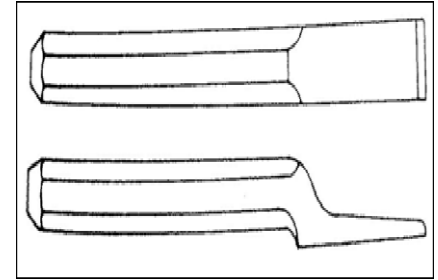
**Half round chisel**



**Cross cut chisel**

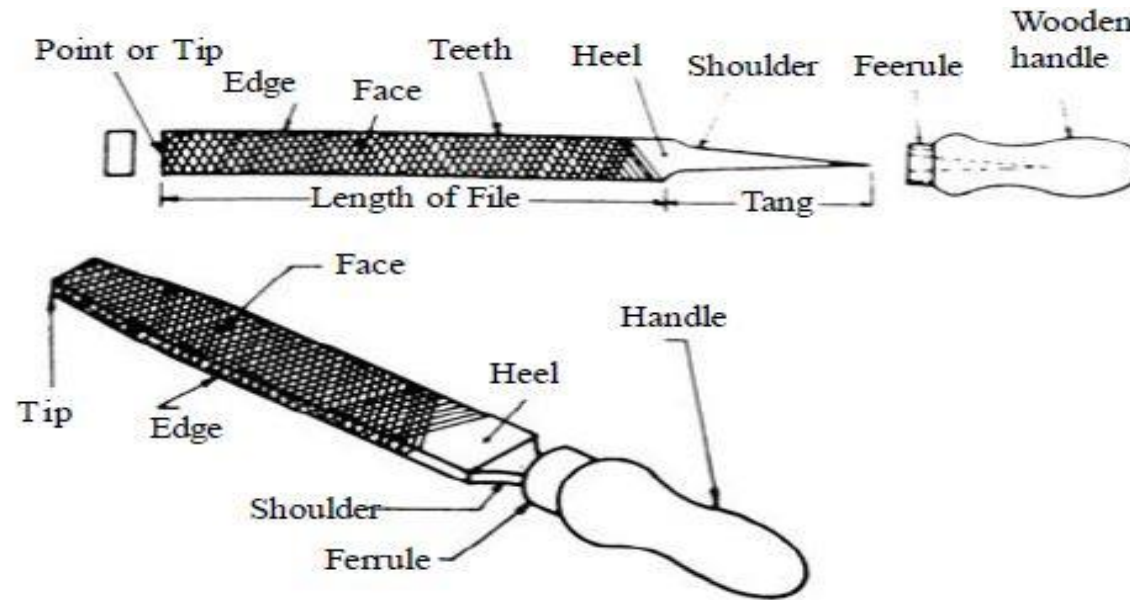


**Diamond point chisel**



**Side chisel**

**2. Files:** They are used to produce smooth surface on the metal piece. These cutting tools have multiple teeth and they act as cutting edges with the cutting accuracy in between 0.2 mm to 0.5 mm. The different parts of a file are shown below:

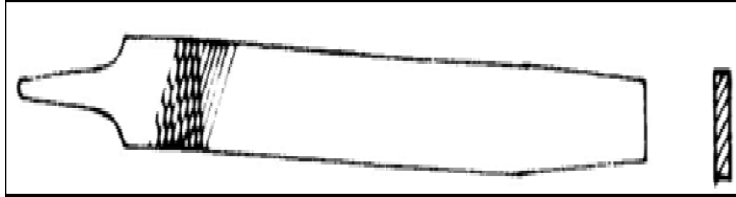


# Cutting tools continued..

The most commonly used files are:

- Flat file is used for heavy filing and parallel to about two third of length, then tapers in both width and thickness.
- Square file is used for filing square and rectangular holes and for finishing the bottom narrow slots.
- Hand file has rectangular cross section with parallel edges throughout and used for filing flat surfaces where flat file is not suitable. The thickness of this file is tapered towards point.
- Round files are used for filing circular holes, curved surfaces and finishing fillets. These files are tapered and round in cross section.
- Half round file is used for round cuts and filing curved surfaces. The tapered double-cut cross section of this file is not a half circle but only one third of a circle.
- Knife edged file is used to file narrow slots, grooves and sharp corners. Its width and thickness are tapered towards a point in the form of knife.
- Triangular file is used for filing grooves, slots , holes and sharp corners. The cross section is like equilateral triangle.

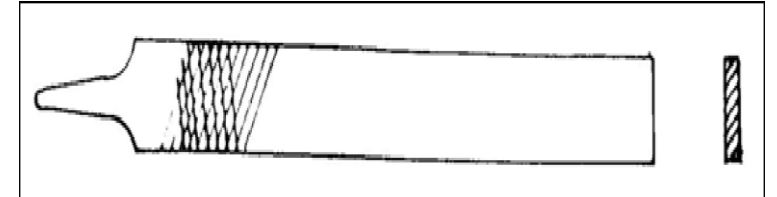
# Cutting tools continued..



**Flat file**



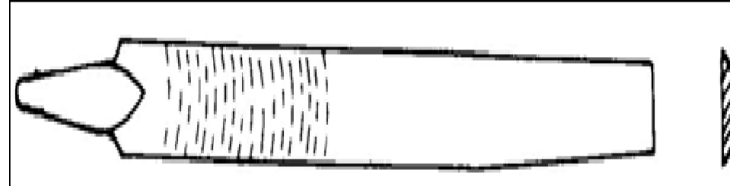
**Square file**



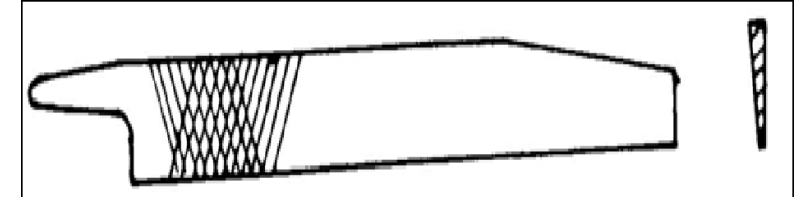
**Hand file**



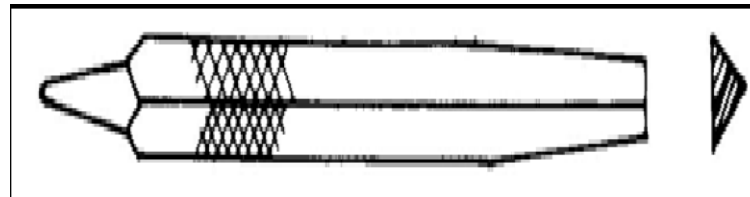
**Round file**



**Half round file**



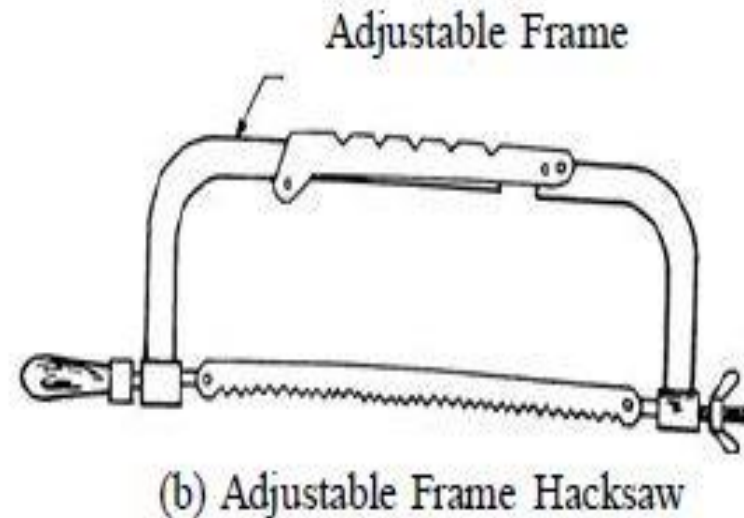
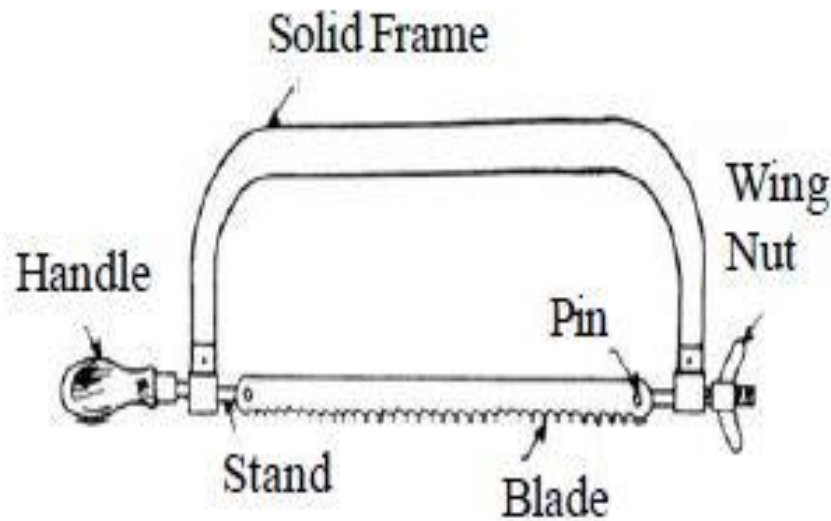
**Knife edged file**



**Triangular file**

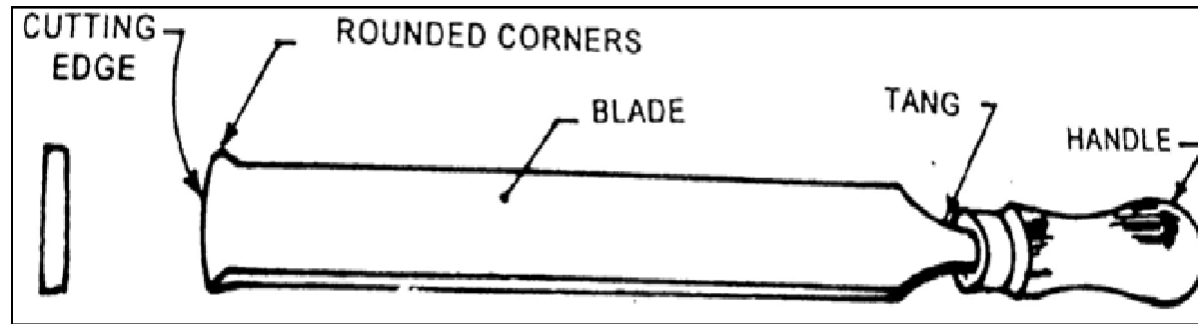
# Cutting tools continued..

**3. Hacksaw:** It is a hand cutting tool and used for making recesses by cutting unwanted metal in fitting. It is also used for cutting slots and contours. A blade is fixed in hacksaw frame and the frame may be of solid or adjustable type. In solid frame the length of blade can not be changed while in adjustable frame it can be adjusted. The blade must be fitted in such a way so that the teeth point away from the handle to provide cut in the forward stroke. The different parts of the hacksaw are shown below:



# Cutting tools continued..

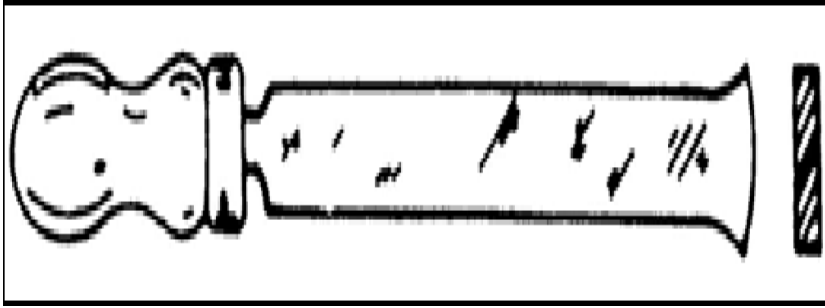
**4. Scrappers:** They are made from a good quality forged steel with a thinner cutting edge. When obtaining the smooth and fine surfaces are difficult from files and chisels, then scrappers are used to shave off thin slices from metal surface.



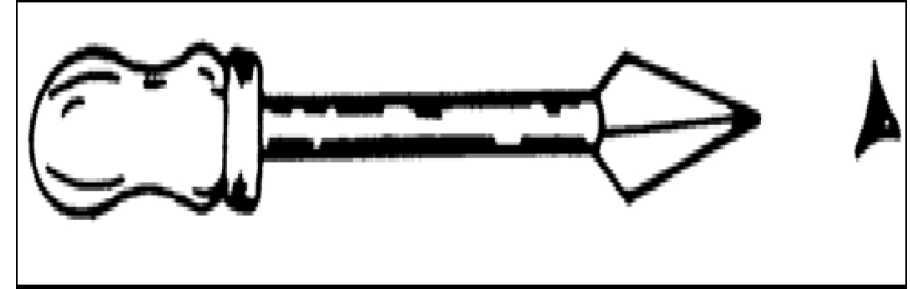
scrapers are classified into three types as follows:

- **Flat Scraper** is used for scrapping plane surfaces or slots exactly at the desired spot. The cutting edge at the ends of the blade is curved.
- **Triangular Scraper** has three cutting edges and is made from old triangular files used to scrap round or curved surfaces and to remove sharp corners.
- **Half round Scraper** is used for finishing curved surfaces and chamfering holes and removing burrs.

# Cutting tools continued..



**Flat Scraper**

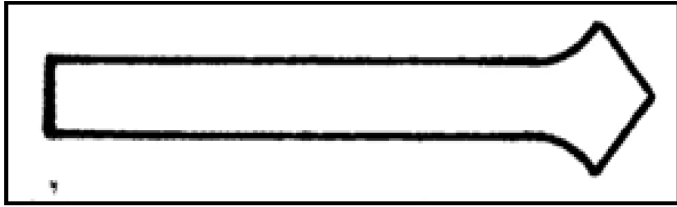


**Triangular Scraper**

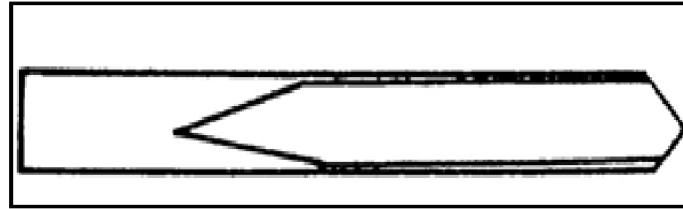
**5. Drill bits:** For making through holes in a metal piece, a drill bit is used in fitting. It has two cutting edges set an angle with axis and usually does not produce accurate hole . There are mainly three types of drill bits as below:

- Flat drill is made of high carbon steel and has two cutting edges. It is used for producing holes in softer materials like wood and plastic.
- Straight fluted drill has two cutting edges and two straight flutes used for drilling brass and non-ferrous metals.
- Twist drill is made of high speed steel and has two cutting edges with two helical grooves. These grooves admit coolant and allows the chips to escape during the drilling.

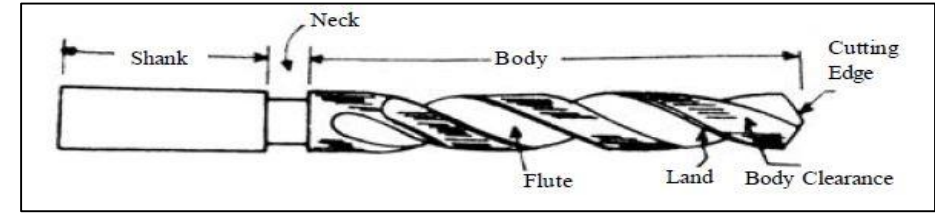
# Cutting tools continued..



Flat drill



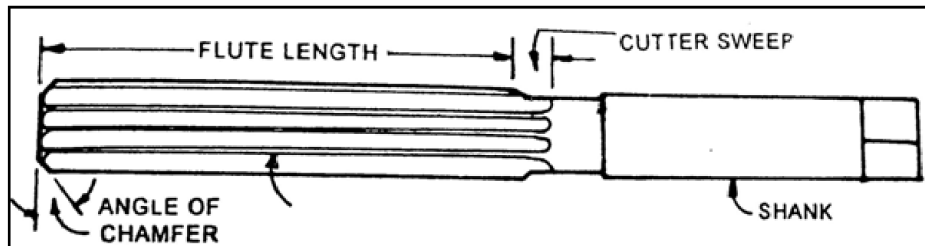
Straight fluted drill



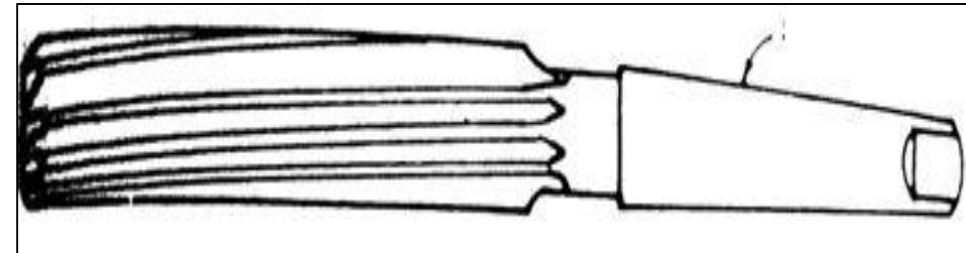
Twist drill

**6. Reamers:** They are used for producing an accurate and smoother hole. It is a post drilling operation to remove very small amount of metal to make is smooth. They are of two types:

- **Hand reamer** is available with straight or helical flutes and turned by hand only. The shank has a square tang so that a tap wrench can be used to turn the reamer in to work.
- **Machine reamer** is available with straight shanks which is held and driven by drill chuck. This reamer has a tapered shank which fits directly in the internal taper of the machine spindle.



Hand reamer



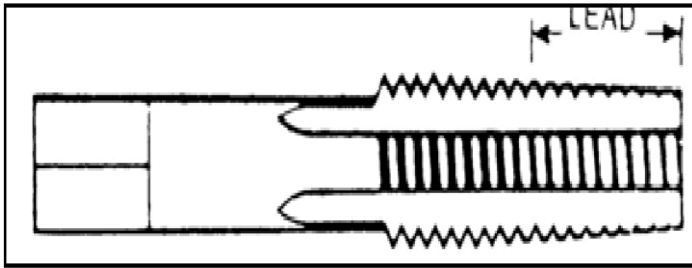
Machine reamer



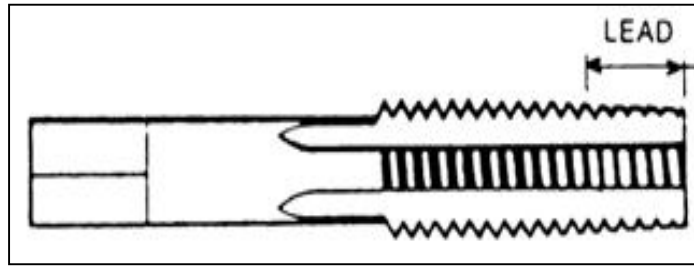
# Cutting tools continued..

**7. Taps:** This tool is used to produce internal threads in a drilled hole. Tapping tool is like a screw which has threads similar to a bolt and three or four flutes are cut across the threads. The lower part of a tapping tool is tapered so that it allows to attack on the walls of a drilled hole to produce threads. Taps are usually made in the set of three:

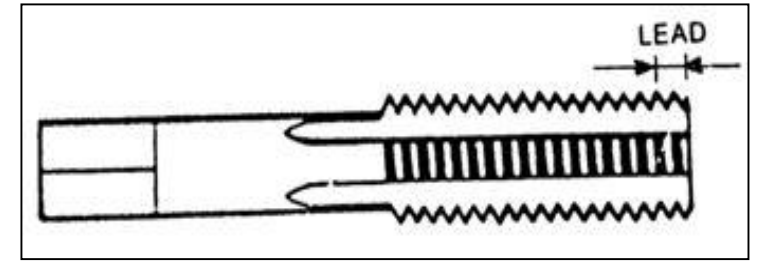
- **Taper Tap** is used to start the thread in a hole and has initial six threads tapered on it.
- **Second tap** is used to cut the threads as far as possible .It is tapered back from the edge about three or four threads used after taper tap.
- **Bottom Tap** has full threads for the whole of its length. This is used to finish the work prepared by the other two taps.



**Taper Tap**



**Second tap**

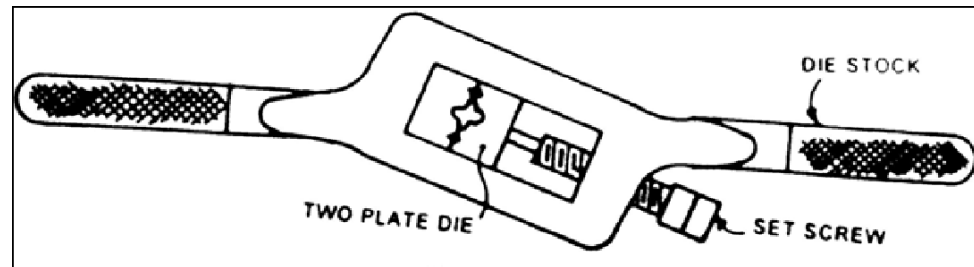


**Bottom Tap**

# Cutting tools continued..

**6. Dies and sockets:** Dies are made of hardened tool steel and used to make external threads on a round rod or bolts. It has a hole containing threads and flutes . Dies are of two types:

- **Solid Die** has fixed dimension and cannot be adjusted for smaller or large diameter. It is used for recutting damaged threads and may be driven by suitable wrench .
- **Adjustable Die** can be set to cut larger and smaller diameters. It has a split through one side and a slight adjustment is possible with the help of set screw.

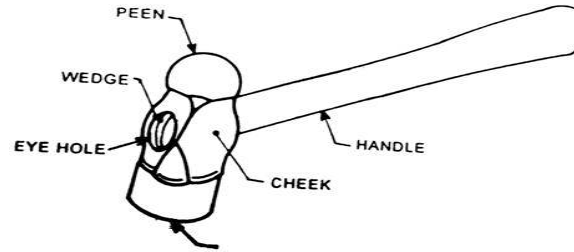


Two - Plate Die

**Sockets** are used for the drills whose taper is larger than spindle hole taper. It is much larger than sleeve. Its taper shank conforms to the spindle hole taper and fits in to it.

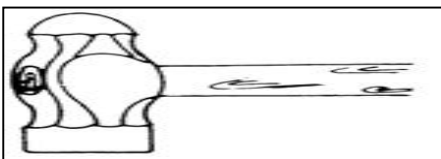
# Striking tools

Different types of hand hammers are called striking tools used to strike the job in fitting. They are made of forged steel of various sizes and used for several purposes like punching, chipping, marking, bending and riveting.

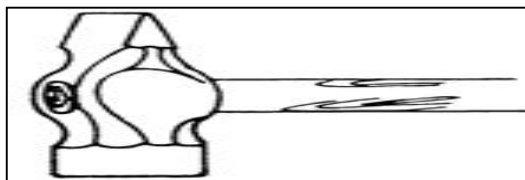


**Hand hammers are classified according to the shape of their peen as follows.**

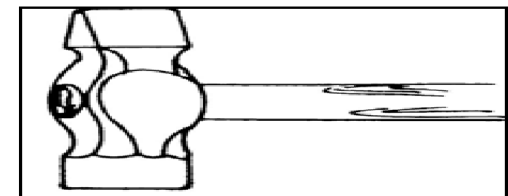
- **Ball peen hammer is used for chipping and riveting and has a flat striking face with ball peen shape which is hardened and polished.**
- **Cross peen hammer is used for bending, stretching and hammering into shoulders. It has wedged shape peen across the eye.**
- **Straight peen hammer is used for stretching and peening the metal. It is similar to cross peen hammer except that the peen in this case is parallel to eye.**



**Ball peen hammer**



**Cross peen hammer**



**Straight peen hammer**

# Miscellaneous tools

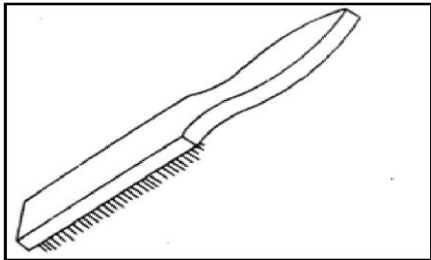
In addition to the previously mentioned tools, the following tools are widely used in fitting.

**File Card** is a type of short wire brush and used to remove small chips called pins. During the filing operation the small chips of metal are deposited between the teeth of file. As a result they produce scratches on work piece and reduces the cutting ability. File card is used to clean the file and removes the chips.

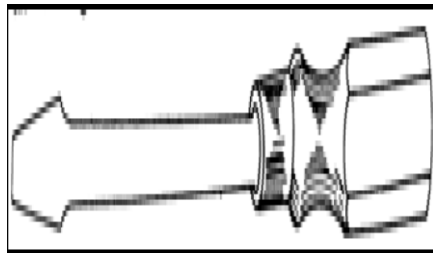
**Screw Driver** is used for tightening and loosening the screws.

**Spanners** are used for tightening or loosening nuts and bolts and also known as wrenches. Single end, double end, adjustable and box type spanners are widely used in fitting.

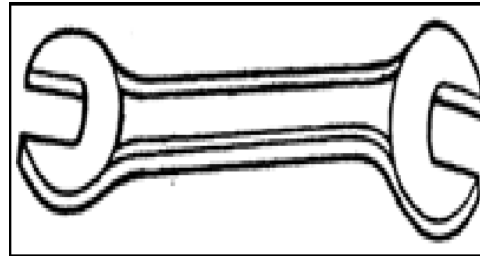
**Pliers** are used for bending and cutting the wires and also used for holding small jobs which are difficult to held by hand. Cutting pliers and nose pliers are widely used in fitting.



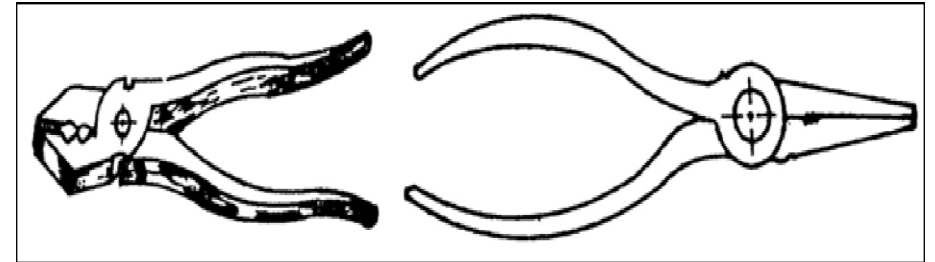
**File Card**



**Screw Driver**



**Spanners**



**Cutting plier**

**Nose plier**

# Drilling machines

The method of making holes by using a “drill” is known as drilling operation. In this process a metal piece is rigidly held and holes are generated by driving a rotating drill. To accomplish this task, drilling machine and drill tools are required. Other operations like reaming, boring, lapping etc. can also be performed by using a drilling machine. There are mainly five types of drilling machines used in fitting as below:

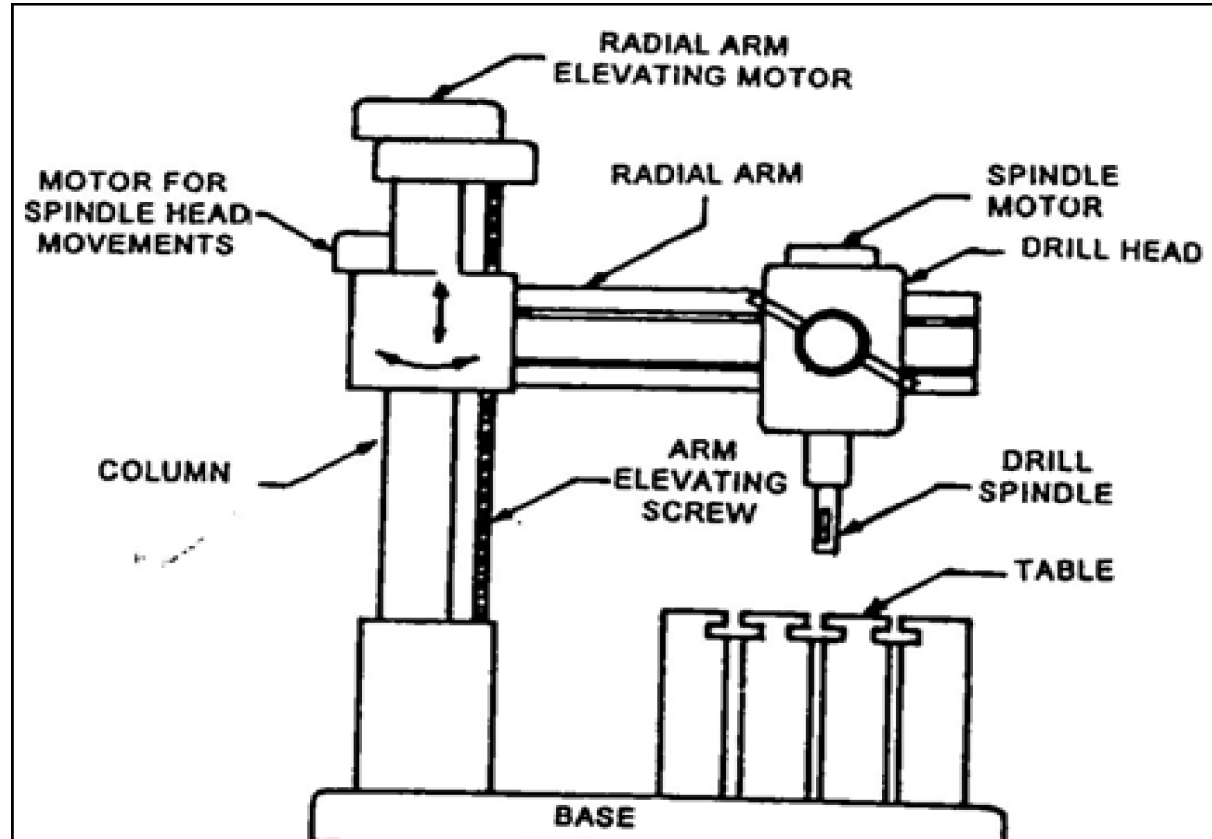
- **Portable drilling machine**
- **Radial drilling machine**
- **Sensitive drilling machine**
- **Upright drilling machine**
- **Gang drilling machine**

**Among above five drilling machines, we will discuss about Radial drilling machine which is widely used for heavy drilling operations in fitting.**

**Radial drilling machine :** This machine is used where higher degree of accuracy is required. The arm of radial drilling machine can be swing around the column to any position and angle, so it become easy to move drill rather than work in heavy operations. The machine consist of base, column, radial arm, drill head and driving mechanism. The provision of wide range of spindle speeds and its automatic feed mechanism makes this machine

# Drilling machines continued..

more suitable for drilling large castings. The radial arm and the spindle can be adjusted without disturbing the work setting. The detailed description about all parts of this machine is shown below:



**Radial drilling machine**

# Drill fittings

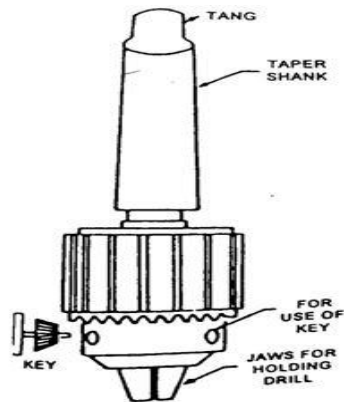
**Drill Fittings:** Following drill fittings are used to hold the drill in machine.

**Drill Chuck:** It holds straight shank drills of different sizes and drill chucks have standard taper shanks. Drill chuck key is used for tightening the drill in the jaws of chuck.

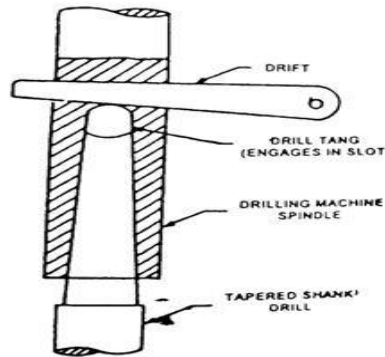
**Machine spindle:** Standard taper drills are directly fitted in the spindle. The drill may be removed by driving the drift.

**Sleeve:** It is used to hold the taper shank drills whose taper is less than taper hole of the spindle.

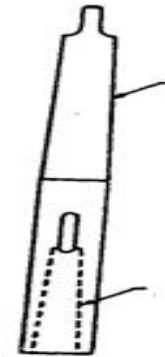
**Socket :** It is longer than sleeve and used for the drilling whose taper is larger than spindle hole.



**Drill Chuck**



**Machine spindle**



**Sleeve**



**Socket**

# Drilling operations

The following operations are generally performed on drilling machine.

**Drilling:** Process of making cylindrical holes by using a drill.

**Reaming:** Process of finding accuracy and smoothness in a drilled hole by using reamer.

**Boring:** Process of enlarging the drilled hole to meet the required size by using a single point cutting tool.

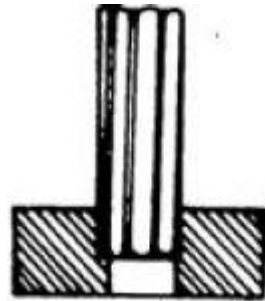
**Counter boring:** Process of enlarging the drilled hole up to a certain depth to maintain alignment and true concentricity of the counter bored hole. The tool is provided with a pilot at its bottom.

**Counter Sinking:** Process of enlarging the end of a drilled hole to give a conical shape for a short distance. This is done for providing a seat to the counter sunk heads of screws.

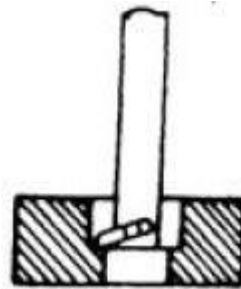
**Tapping:** Process of cutting internal threads by using a cutting tool called tap.



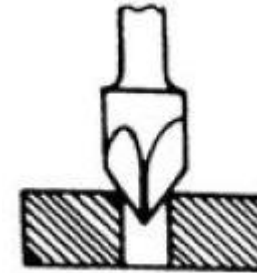
Drilling



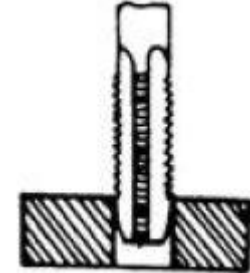
Reaming



Boring



Counter Sinking



Tapping



## **Texts:**

[1] Department of Mechanical Engineering, IIT Guwahati, Workshop Practice Manual, Vidya Mandir, Guwahati, 2018.

## **References:**

[1] S. K. H. Choudhury, A. K. H. Choudhury and N. Roy, Elements of Workshop Technology, Volume I: Manufacturing Processes, Media Promoters, 2008.

[2] H. Gerling, All About Machine Tools, 2nd Edition, New Age International, 2006.

[3] W. A. J. Chapman, Workshop Technology, 4th Edition, Viva Books, 1998.

[4] HMT, Mechatronics, McGraw Hill Education, New Delhi, 2017.

**Thank you**