Hand taps and dies

Objectives : At the end of this lesson you shall be able to
- **state the uses of threading hand taps**
- **state the features of hand taps**
- **distinguish between different taps in a set**
- **name the different types of tap wrenches**
- **state the uses of different types of wrenches.**

Use of Hand Taps

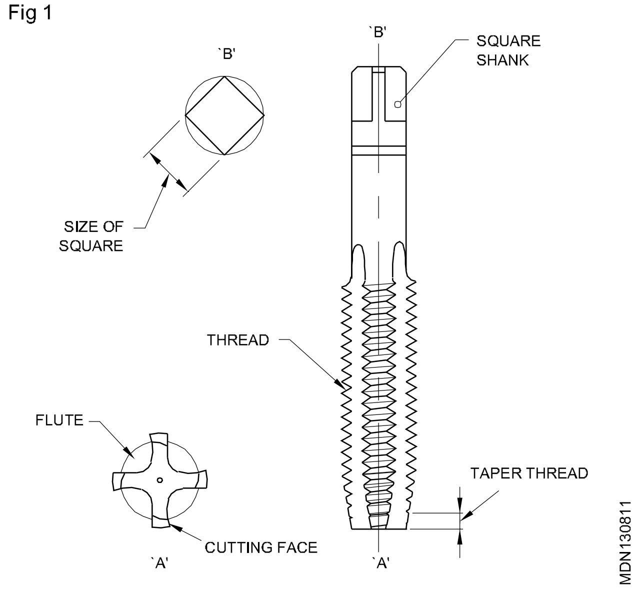
Hand taps are used for internal threading of components.

Features (Fig 1)

They are made from high carbon steel of high speed steel handened and ground

Threads are cut on the surface and are accurately finished.

Fig 1



To form the cutting edges, the flutes are cut across the thread.

For holding and turning the taps while cutting threads the ends of the shanks are squared.

The ends of the taps are chamfered (taper lead) for assisting aligning and starting of the thread.

The size of the taps and the type of the thread are usually marked on the shank.

In certain cases the pitch of the thread will also be marked.

Markings are also made to indicate the type of tap i.e first, second final or plug tap.

Types of Taps in a set

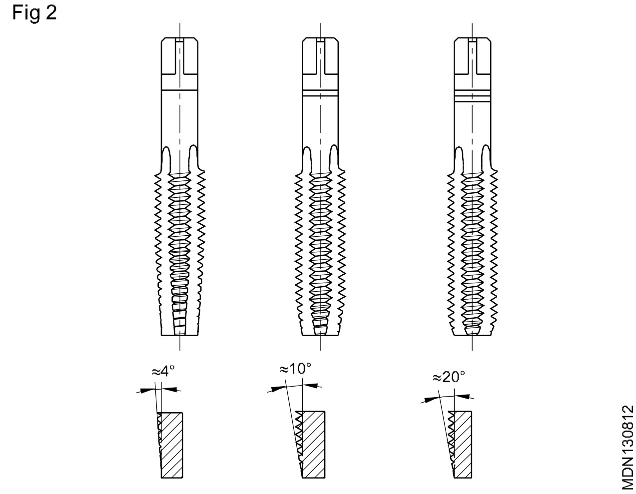
Hand taps for a particular thread are available as a set consisting of three pieces. (Fig 2)

These are

first tap or taper tap

second tap or intermediate tap

Fig 2



plug or bottoming tap

These taps are identical in all features except in the taper lead.

The taper tap is to start the thread. It is possible to form full threads by the taper tap in through holes which are not deep.

The bottoming tap (plug) is used to finish the threads of a blind hole to the correct depth.

for identifying the type of taps quickly - the taps are either numbered as 1,2 and 3 or rings are marked on the shank.

The taper tap has one ring the intermediate tap has two rings and the bottoming tap has three rings (Fig 2)

Tap Wrenches

Tap Wrenches are used to align and drive the hand taps correctly into the hole to be threaded.

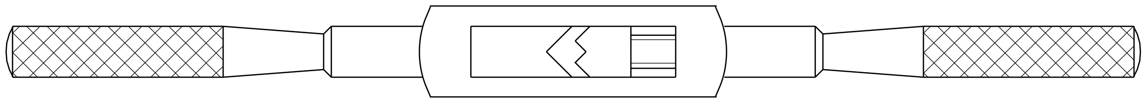
Tap Wrenches are of different types.

Double ended adjustable wrench, T handle tap wrench and solid type tap wrench.

Double ended adjustable tap Wrench or Bar Type Tap Wrench (Fig 3)

This is the most commonly used type of tap wrench. It is available in various sizes. These tap wrenches are more suitable for large diameter taps and can be used in open places where there is no obstruction to turn the tap. It is important to select the correct size of wrench.

Fig 3

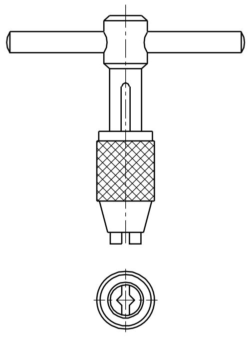


T- Handle Tap Wrench (Fig 4)

These are small adjustable chucks with two jaws and a handle to turn the wrench.

This tap wrench is useful to work in restricted places and is turned with one hand only.

Fig 4



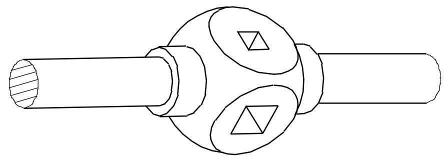
This is not suitable for holding large diameter taps.

Solid Type Tap Wrench (Fig 5)

These Wrenches are not adjustable

They can take only certain sizes of taps. This eliminates the use of wrong length of the tap wrenches and thus prevents damage to the taps.

Fig 5



Tap drill size

Objectives: At the end of this lesson you shall be able to
- **state what is tap drill size**
- **choose the tap drill sizes for different threads from tables**
- **calculate the tap drill sizes for ISO metric and ISO inch.**

What is a tap drill Size?

Before a tap is used for cutting internal threads, a hole is to be drilled. The diameter of the hole should be such that it should have sufficient material in the hole for the tap to cut the thread.

Tap Drill Sizes for Different Threads

ISO Metric Thread

Tapping drill size

for M10 x 1.5 thread

Minor diameter = Major diameter – 2 x depth

depth of thread = 0.6134 x pitch of a screw

2 depth of thread = 0.6134 x 2 x pitch

=1.226 x 1.5 mm = 1.839 mm

Minor dia (D1)=10 mm – 1.839 mm

=8.161mm or 8.2 mm

This tap drill will produce 100% thread because this is equal to the minor diameter of the thread. For most fastening purposes a 100% formed thread is not required.

A standard nut with 60% thread is strong enough to be tightened until the bolt breaks without stripping the thread. Further it also requires a greater force for turning the tap if a higher percentage formation of thread is required.

Considering this aspect, a more practical approach for determining the tap drill sizes is

Tap drill size = Major diameter – pitch
= 10 mm - 1.5 mm
= 8.5 mm.

Compare this with the table of tap drill sizes for ISO metric threads.

ISO Inch (Unified) threads Formula

$$\text{Tap Drill size} = \text{Major diameter} - \frac{1}{\text{Number of thread per inch}}$$

For calculating the tap drill size for 5/8" UNC thread

Tap drill size = 5/8" – 1/11"
= 0.625" – 0.091"
= 0.534"
The next drill size is 17/32" (0.531 inches)

Compare this with the table of drill sizes for unified inch threads.

What will be the tapping size for the following threads?

(a) M 20
(b) UNC 3/8

Refer to chart for determining the pitches of the thread.

TABLE FOR TAP DRILL SIZES - ISO METRIC

PITCH / NOMINAL DIA	0.25	0.3	0.35	0.4	0.45	0.5	0.6	0.7	0.75	0.8	1	1.25	1.5	1.75		2.5	3	3.5	4	4.5	5	5.55
1	0.85																					
1.1	0.95																					
1.2	0.96																					
1.4		1.10																				
1.6			1.25																			
1.8			1.45																			
2				1.60																		
2.2			2.15		1.75																	
2.5			2.65		2.05																	
3			3.15			2.50																
3.5							2.90															
4						3.50		3.30														
4.5						4.00			3.70													
5						4.50				4.20												
5.5						5.00																
6									5.20		5.00											
7									6.20		6.00											
8									7.20		7.00	6.80										
9									8.20		8.00	7.80										
10									9.20		9.00	8.80	8.50									
11									10.20		10.00		9.50									
12											11.00	10.80	10.50	10.20								
14											13.00	12.80	12.50		12.00							
15											14.00		13.50									
16											15.00		14.50		14.00							
17											16.00		15.50									
18											17.00		16.50		16.00	15.50						
20											19.00		18.50		18.00	17.50						
22											21.00		20.50		20.00	19.50						
24											23.00		22.50		22.00		21.00					
25											24.00		23.50		23.00							
26													24.50									
27											26.00		25.50		25.00		24.00					
28											27.00		26.50		26.00							
30											29.00		28.50		28.00		27.00	26.50				
32													30.50		30.00							
33													31.50		31.00		30.00	29.50				
35													33.50									
36													34.50		34.00		33.00		32.00			
38													36.50									
39													37.50		37.00		36.00		35.00			
40													38.50		38.00		37.00					
42													40.50		40.00		39.00		38.00	37.50		
45													43.50		43.00		42.00		41.00	40.50		
48													46.50		46.00		45.00		44.00		43.00	
50													48.50		48.00		47.00					
52													50.50		50.00		49.00		48.00		47.00	
56																						50.50

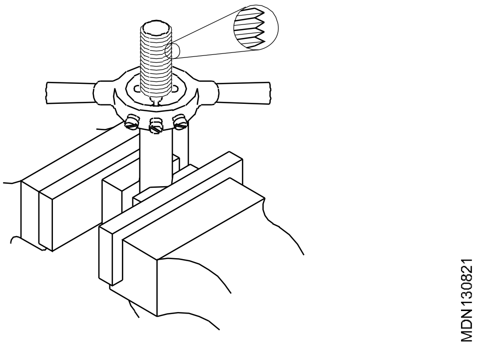
Die and die stock

Objectives: At the end of this lesson you shall be able to
- **name the different types of dies**
- **state the features of each type of die**
- **state the use of each type of die**
- **name the type of diestock for each type of die.**

Uses of Dies

Threading dies are used to cut external threads on cylindrical workpieces. (Fig 1)

Fig 1



Types of Dies

The following are the different types of dies.

Circular Split Die (Button die)

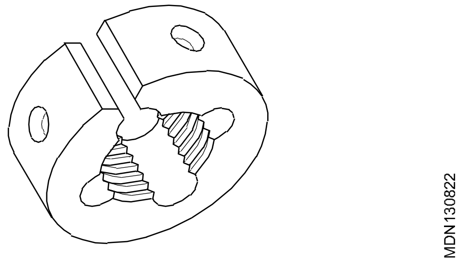
Half Die

Adjustable Screw Plate Die

Circular Split Die/Button Die (Fig 2)

This has a slot cut to permit slight variation in size.

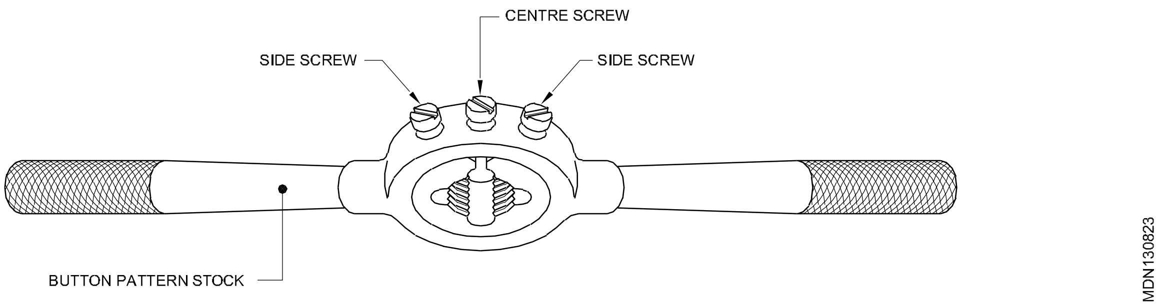
Fig 2



When held in the diestock, variation in the size can be made by using the adjusting screws. This permits increasing or decreasing of the depth of cut. When the side screws are tightened the die will close slightly.(Fig 3)

For adjusting the depth of the cut, the centre screw is advanced and locked in the groove. This type of die stock is called button pattern stock.

Fig 3



Half Die (Fig 4)

Half dies are stronger in construction.

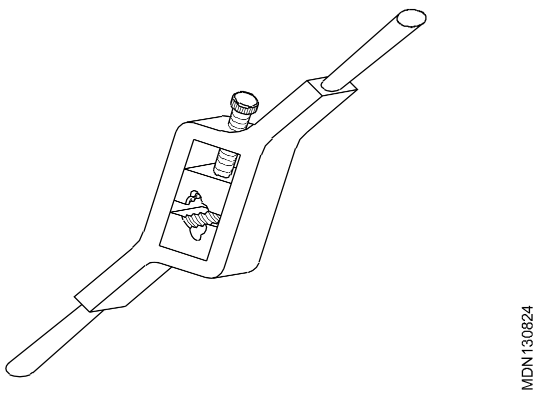
Adjustments can be made easily to increase or decrease the depth of cut.

These dies are available in matching pairs and should be used together.

By adjusting the screw of the diestock, the die pieces can be brought closer together or can be moved apart.

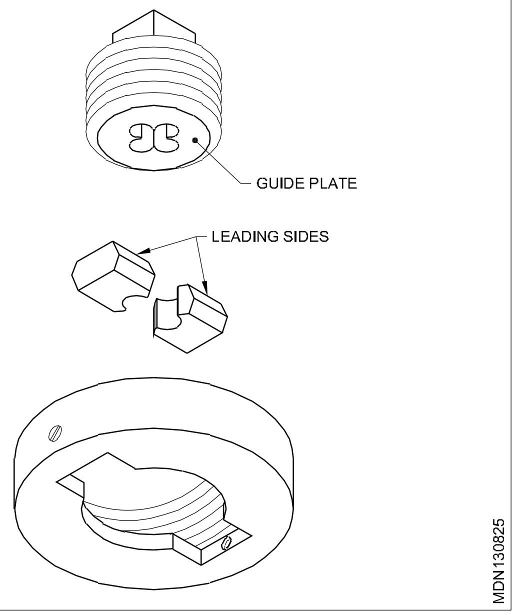
They need a special die holder.

Fig 4



Adjustable Screw Plate Die (Fig 5)

Fig 5



This is another type of a two piece die similar to the half die.

This provides greater adjustment than the split die.

The two die halves are held securely in a collar by means of a threaded plate (guide plate) which also acts as a guide while threading.

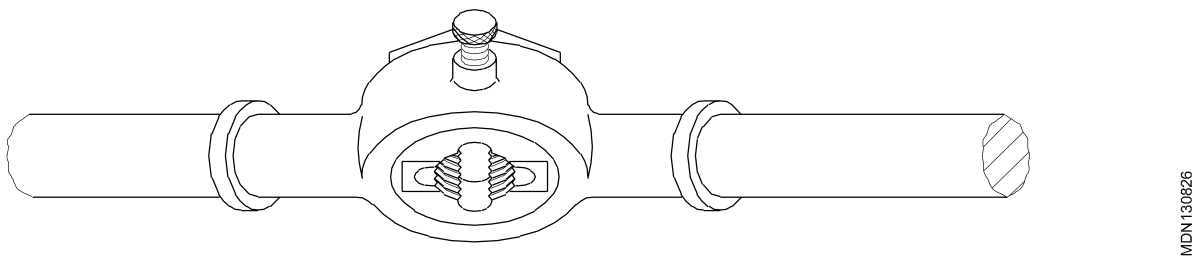
When the guide plate is tightened after placing the die pieces in the collar, the die pieces are correctly located and rigidly held. (Fig 5)

The die pieces can be adjusted, using the adjusting screws on the collar. This type of die stock used is called quick cut diestock. (Fig 6)

The bottom of the die halves is tapered to provide the lead for starting the thread. On one side of each die head, the serial number is stamped.

Both pieces should have the same serial numbers.

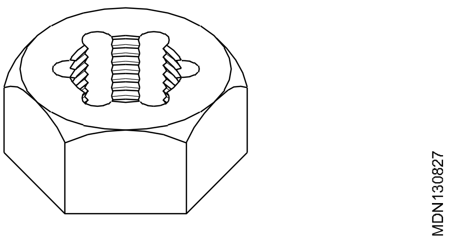
Fig 6



Die Nut (Solid Die) (Fig 7)

The die nut is used for chasing or reconditioning the damaged threads.

Fig 7



The die nut is turned with a spanner.

The die nuts are available for different standards and sizes of threads.

Die nuts are not to be used for cutting new threads.

Hand Reamers

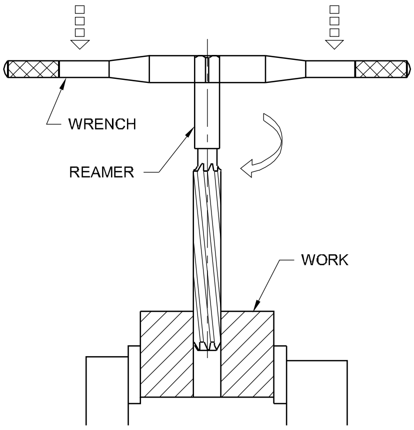
Objectives : At the end of this lesson you shall be able to
- **state the uses of reamers**
- **state the advantages of reaming**
- **distinguish between hand and machine reaming**
- **name the elements of a reamer.**

What is reamer?

A reamer is a multi-point cutting tool used for enlarging and finishing previously drilled holes to accurate sizes. (Fig 1)

Advantages of 'reaming'

Fig 1



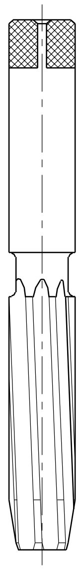
Reaming produces high quality surface finish and dimensional accuracy to close limits.

Also small holes which cannot be finished by other processes can be finished.

Classification of reamers

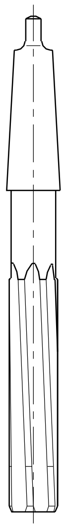
Reamers are classified as hand reamers and machine reamers. (Fig 2 and 3)

Fig 2



HAND REAMER

Fig 3



MACHINE REAMER

Reaming by using a hand reamer is done manually for which great skill is needed.

Hand reamers have straight shanks with 'square' at the end for holding with tap wrenches. (Fig 2)

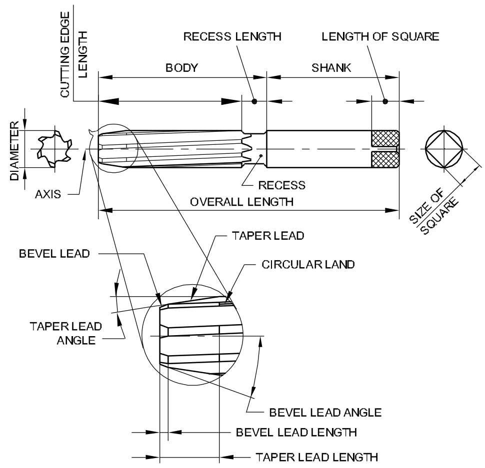
Machine reamers are fitted on spindles of machine tools by means of a floating chuck and are rotated for reaming.

Machine reamers are provided with Morse taper shanks for holding on machine spindles.(Fig 3)

Parts of a hand reamer

The parts of a hand reamer are shown in Fig 4

Fig 4



Hole size for reaming

Objectives : At the end of this lesson you shall be able to
- **determine the hole size for reaming.**

For reaming with a hand or machine reamer the hole drilled should be smaller than the reamer size.

The drilled hole should have sufficient metal for finishing with the reamer. Excessive metal will impose a strain on the cutting edge of the reamer and damage it.

Calculating drill size for reamer

A method generally practised in workshops is by applying the following formula.

Drill size = Reamed size - (undersize+oversize) of drilled hole.

Finished size

Finished size is the diameter of the reamer.

Undersize

Undersize is the recommended reduction in size for different ranges of drill diameter. (see Table)

TABLE -1

Undersizes for reaming

Diameter of ready reamed hole (mm)	Undersizes of rough bored hole (mm)
under 5	0.1...0.2
5....20	0.2...0.3
21....50	0.3....0.5
over 50	0.5....1

Oversize of drilled hole

It is generally considered that a twist drill will make a hole larger than its diameter. The oversize for calculation purposes is taken as 0.05 mm, for all diameters of drills.

For light metals the undersize will be 50% larger.

Example

A hole is to be reamed on mild steel with a 10mm reamer. What will be the diameter of the drill for drilling the hole before reaming?

Drill size = Reamed size - (undersize + oversize) (finished size) = 10mm

Undersize as per table = 0.2 mm

Oversize = 0.05 mm, finished size = 0.05+0.2=0.25mm

Drill size = 10mm-0.25mm

= 9.75mm

Determing the drill hole sizes for the following reamers.

i) 15mm ii) 44mm

iii) 4mm iV) 19mm

Answer

i) ------------------------

ii) ------------------------

iii) -------------------------

iv) ---------------------------

If the reamed hole is undersize, the cause is that the reamer is worn out.

Always inspect the condition of the reamer before commending reaming.

For obtaining good suface finish, use a coolant while reaming. Remove metal chips from the reamer frequently advance the reamer slowly into the work.

DEFECTS IN REAMING - CAUSES AND REMEDIES

Reamer hole undersize

If a worn out reamer is used, it may result in the reamed hole being undersize. Do not use such reamers.

Always inspect the condition of the reamer before using.

Surface finish rough

The causes may be anyone of the following ara combination there of.

- incorrect application
- Swarf accumulated in reamer flutes
- in adequate flow of coolant
- feed rate too fast

While reaming apply a steady and slow feed rate.

Ensure a copious supply of the lubricant.

Do not turn the reamer in the reverse direction.

Lapping

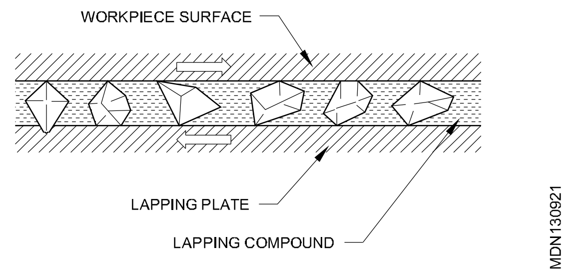
Objectives : At the end of this lesson you shall be able to
- **state the purpose of lapping**
- **state the features of a flat lapping plate**
- **state the use of changing a flat lapping plate**
- **state the method of charging a cast iron plate**

Lapping is a precision finishing operation carried out using line abrasive materials.

Purpose: This process

- improves geometrical accuracy
- refines surface finish
- assists in achieving a high degree of dimensional accuracy.
- improves the quality of fit between the mating components.

Fig 1



Lapping process: in the lapping process small amounts of material are removed by rubbing the work against a lap charged with a lapping compound. (Fig 1)

The lapping compound consists of the abrasive particles. Suspended in a vehicle such as oil, paraffin, grease etc.

The lapping compound which is introduced between the workpiece and the lap chips away the material from the workpiece. Light pressure is applied when both are moved against each other. The lapping can be carried out manually or by machine.

Hand lapping of flat surfaces: Flat surfaces are hand lapped using lapping plates made out of close grained cast iron. (Fig 2) The surface of the plate should be in a true plane for accurate results in lapping.

The lapping plate generally used in tool rooms will have narrow grooves out on its surface both lengthwise and crosswise forming a series of squares.

These grooves are usually about 12mm apart.

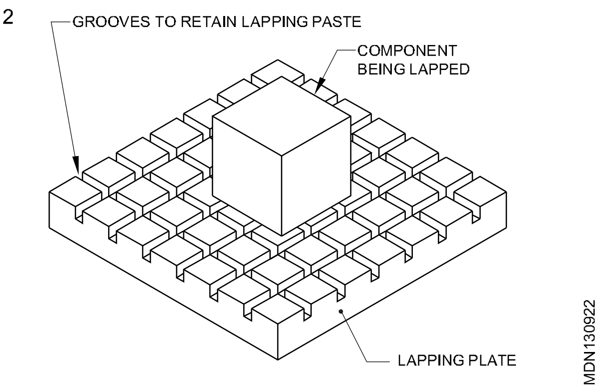
While lapping the lapping compound collects in the serrations and rolls in and out as the work a moved.

Before commencing lapping of the component, The cast iron plate should be CHARGED with abrasive particles.

This is a process by which the abrasive particles are embedded on to the surfaces of the laps which are comparatively softer than the component being lapped.

For charging the cast iron lap apply a thin coating of the abrasive compound over the surface of the lapping plate.

Fig 2



Use a finished hard steel block and press the cutting particles into the lap. While doing so, rubbing should be kept to the minimum. When the entire surface of the lapping plate is charged, the surface will have a uniform grey appearance. If the surface is not fully charged, bright spots will be visible here and there.

Excessive application of the abrasive compound will result in the rolling action of the abrasive between the work and the plate developing in accuracies.

The surface of the flat lap should be finished true by scraping before charging. After charging the plate, wash of all the loose abrasives using kerosene.

Then place the worpiece on the plate and move along and across, covering the entire surface areas of the plate. When carrying out fine lapping, the surface should be kept moist with the help of kerosene.

Wet and dry lapping: Lapping ca be carried out either wet or dry.

In wet lapping there is surplus oil and abrasives on the surface of the lap. As the workpiece which is being lapped is moved on the lap, there is movement of the abrasive particles also.

In the dry method the lap is first charged by rubbing the abrasives on the surface of the lap. The surplus oil and abrasives are then washed off. The abrasives embedded on the surface of the lap will only be remaining. The embedded abrasives act like a fine oilstone when metal pins to be lapped are moved over the surface with light pressure. However, while lapping, the surface being lapped is kept moistened with kerosene or petrol. Surfaces finished by the dry method will have better finish and appearance. Some prefer to do rough lapping by wet method and finish by dry lapping.

Lap Materials and lapping compounds

Objectives : At the end of this lesson you shall be able to
- **name the different types of lap materials**
- **state the qualities of different lap materials**
- **name the different types of abrasive materials used for lapping**
- **distinguished between the application of different lapping abrasives**
- **state the function of lapping vehicles**
- **name the solvents used in lapping.**

The material used for making laps should be softer than the workpiece being lapped. This helps to charge the abrasives on the lap. If the lap is harder than the workpiece, the workpiece will get charged with the abrasives and cut the lap instead of the workpiece being lapped.

Laps are usually made of

- close grained iron
- copper
- brass or lead.

The best material used for making lap is cast iron, but this cannot be used for all applications.

When there is excessive lapping allowance, copper and brass laps are preferred as they can be charged more easily and cut more rapidly than cast iron.

Lead is an in expensive form of lap commonly used for holes. Lead is cast to the required size on steel arbar. These laps can be expanded when they are worn out. Charging the lap is much quicker.

Lapping abrasives:

Abrasives of different types are used for lapping.

The commonly used abrasives are:

- silicon carbide
- aliminium oxide
- boron carbide
- diamond.

Silicon carbide: This is an extremely hand abrasive. Its grit is sharp and brittle. While lapping the sharp cutting edges contiuously break down exposing new cutting edges. Due to this reason this is considered as very ideal for lapping hardened steel and cast iron, particularly where heavy stock removal is required.

Aluminium oxide: Aluminium oxide is sharp but tougher than silicon carbide. Aluminium oxide is used in un-fused and fused forms.

Un-fused alumina(aluminium oxide) removes stock effectively and is capable of obtaining high quality finish.

Fused alumina is used for lapping soft steels and nonferrous metals.

Boron Carbide: This is an expensive abrasive material which is next to diamond in harness. While it has excellent cutting properties, it is used because of the high cost only in special application like dies and gauges.

Diamond: This being the hardest of all materials. It is used for lapping tungsten carbide. Rotary diamond laps are also prepared for accurately finishing very small holes which cannot be ground.

Lapping vehicles: In the preparation of lapping compounds the abrasive particles are suspended in vehicles. This helps to prevent concentration of abrasives on the lapping surfaces and regulates the cutting action and lubricates the surfaces.

The commonly used vehicles are:

- water soluble cutting oils
- vegetable oils
- machine oils
- petroleum jelly or grease
- vehicles with oil or grease base used for lapping ferrous metals.

Metals like copper and its alloys and other non-ferrousmetals are lapped using slouable oil, bentomite etc.

In addition to the vehicles used in making the lapping compound, solvents like water, kerosene, etc are also used at the time of lapping.