Manufacturing Technology

SHORT TYPE QUESTIONS

Q.WRITEDOWN SIGNIFICANCE OF GROUNDING OPERATION.

Grinding is commonly used on cast iron and various types of steel. These materials lend themselves to **grinding** because they can be held by the magnetic chuck commonly used on **grinding** machines and do not melt into the wheel, clogging it and preventing it from cutting.

Q. WRITE DOWN MANUFACTURING PROCESS OF GRINDING WHEEL ?

Grinding wheels are made of natural or synthetic **abrasive** minerals bonded together in a matrix to form a **wheel**. ... Sandstone, an organic **abrasive made** of quartz grains held together in a natural cement, was probably the earliest **abrasive**; it was used to smooth and sharpen the flint on axes.
Q.CRITERIA FOR SELECTION OF GRINDING WHEEL ?

The proper selection of grinding wheels is very important for getting good results (i.e. obtaining better finish and at the same time having more life of the wheel). In order to meet all these requirements, the various elements that influence the process must be considered.

Selection mainly depends upon the following factors:

Constant factors include:

(i) Work material. It should be remembered that for grinding a soft material, hard wheel should be used and vice versa,

(ii) Amount and rate of stock removal,

(iii) Area of contact between work and wheel.

(iv) Condition of grinding machine. A softer grade of wheel is used on robust and heavy machine,

(v) Finish and accuracy required on the job.

Variable factors include:

(i) Wheel speed,

(ii) Work speed,

(iii) Condition of grinding machine (state of the wheel spindle bea

Q.**WRITEDOWN SPECIFICATION OF GRINDING WHEEL ?**

Specification of grinding wheels

A grinding wheel is specified by the standard wheel markings like diameter of the wheel, bore diameter of the wheel, thickness of the wheel type (Shape) of the wheel.

Example

32 A 46 H8V
250X20X32-
Straight wheel

Standard Grinding Wheel Marking System

Position 0	Position 1	Position 2	Position 3	Position 4	Position 5	Position 6
Manufac-turer's symbol for abrasive (Optional)	Type of abra-sive grit size	Grain size	Grade	Structure (Optional)	Type of bond	Manufac-turer's own mark (Optional)
51	A	46	H	5	V	8

Grinding Wheel Marking

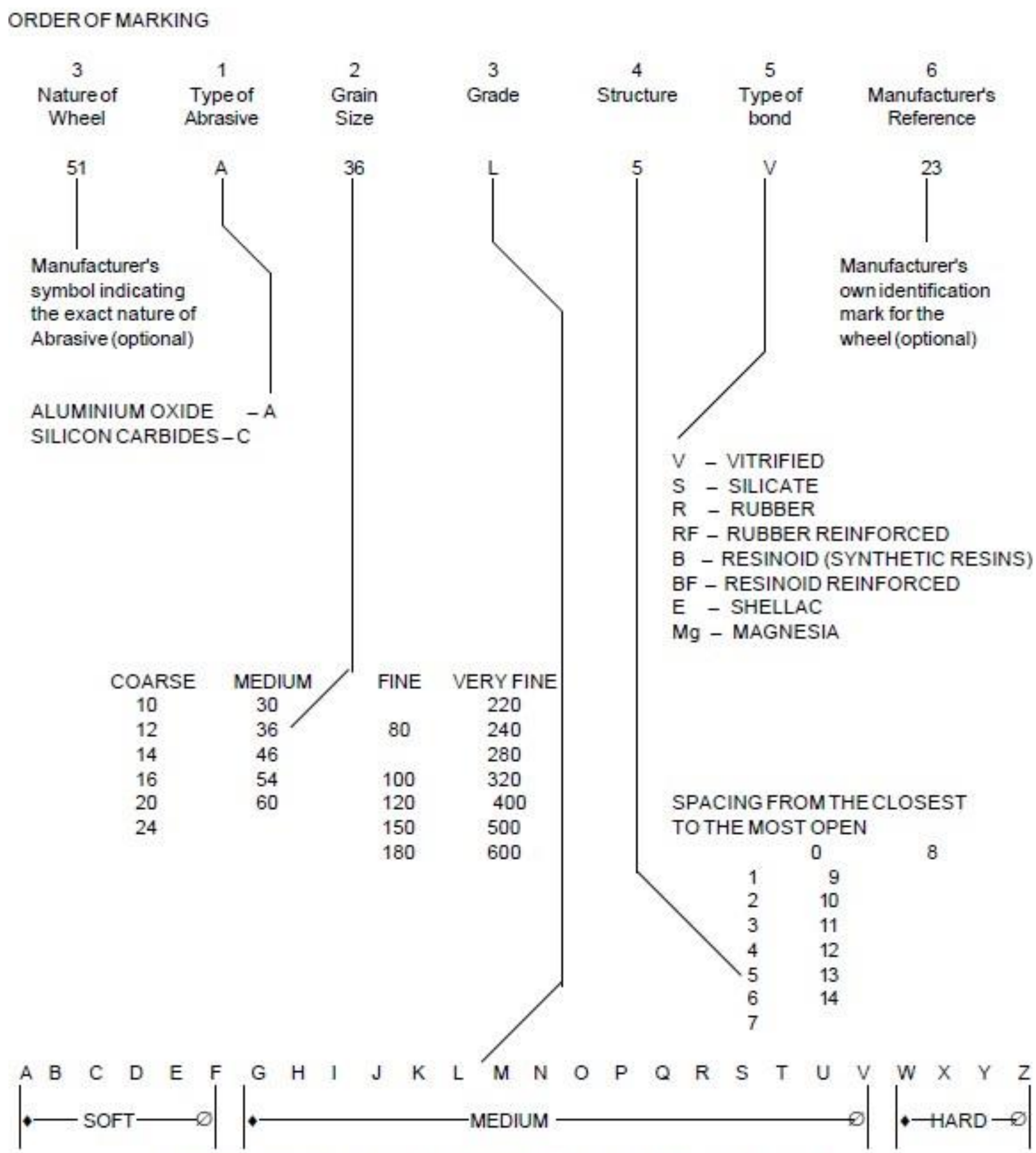

CHART ILLUSTRATING STANDARD MARKING SYSTEM IS : 551 – 1966

Q.WRITE WORKING PRINCIPLE OF CYLINDRICAL GRINDER ?

A **cylindrical grinder** is a specialized form of **grinder** meant for **work** on cylinders, rods, and other similar workpieces. The cylinder rests between two centers and rotates in one direction, while the **grinding** wheel or wheels approach and rotate in the opposite direction.

INTERNAL MACHING PROCESS

RADIAL DRILLING MACHINE-

Radial Drilling Machine is used to drill medium to large and heavy workpieces. This machine is used to drill holes in the given radial distance. It is mainly used when the component size is large in height.

Radial Drilling machine is mainly made for drilling holes in heavy jobs or workpieces. Since heavy jobs cannot move much, so the radial drilling machine is made in such a way that the tool of the machine can move any part of the heavy job without moving the job much.

Parts of a radial drilling machine:-

1) Base
It is the bottommost part of the radial drilling machine. It is made up of cast iron because cast iron has high compressive strength. The base is used to support the assembly of parts on it. It also absorbs the vibrations and shocks induced by the machine parts.

2) Column
The column is present at one end of the base. It is a vertical pillar which act as support for rotating the radial arm in 360 degrees.

3) Table
It is mounted above the column. It is provided with T slots for mounting the workpiece directly on its face. It is usually round or rectangle in shape.

4) Radial Arm
This is the part which is connected to the column. This part can rotate 360 degrees around the column. The face of the radial arm is accurately machined and drill head slides over it. This arm goes up and down in the column. In big machines, hydraulics are used to move the arm up and down.

5) Drill Head
Drill Head is mounted on the radial arm and drives the drill spindle.
It encloses all the mechanism for driving the drill at a different speed and feeds.

6) Spindle
It is the part of the drilling machine that holds the tool of drilling machine and is responsible for its rotation.

7) Motor
The motor is present at the top of drill head which drives the horizontal spindle.

8) Chuck
Chick is present at the bottom of the spindle. It is used to hold the drill bit in its place.

9) Tool or Drill Bit

Drill Bit is used to drill the holes in the workpiece. It is the part that rotates and enters into the workpiece making a hole.

Construction of Radial Drilling Machine :-

The bottommost part of the radial drilling machine.It is generally made of cast iron as cast iron has high compressive strength. On top of base the column is present. It is cylindrical in shape. The radial arm moves up and down in the column and it can also rotate in the column.

The table is placed above the base where the workpiece can be held for the drilling process.

The radial arm has a drill head. Different parts like spindle, chuck and motor for rotation of drill bit is present in this drill head. Motor is present above the head which rotates the spindle.

The spindle is attached to the drill head and chuck is present below the spindle. In the chuck, the drill bit is fixed which is used to make hole in the workpiece by rotating it and feeding it into the workpiece.

Working of Radial Drilling Machine

At starting when the power supply is given, the spindle rotates which is driven by the motor. As the radial arm can move up and down in the column, so radial arm is adjusted according to the operation and the height of the workpiece.
The spindle is connected to the chuck and the drill bit is placed in the jaws of the chuck. The head of the drilling machine is also adjusted so that the tool is in the right position to make the hole in the workpiece. After that a suitable feed is given and then the drill bit drives into the workpiece with ease.

The drive mechanism used in a drilling machine is **Rack and Pinion Mechanism**.

In Rack and Pinion Mechanism, gears are used to convert rotation into linear motion. When the hand wheel is rotated, then the Pinion which is attached to the rack also rotates which converts rotation into linear motion and hence the drill bit moves towards the workpiece.
PILLAR DRILLING MACHINE-

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Design and Development of Fixture for Pillar Drilling Machine

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Abstract : Fixture currently employed for drilling holes is very conventional and pristine. Problems occurring in current fixtures

are: Fixture setup is done manually, due to this cycle time is more.

Product quality is not obtained as per specification. • Labor fatigue increases. • More exasperating to operator to load and unload. This problem is needed to be solved to meet the current trends of designing and manufacturing. Solution to this problem requires fixture to be designed using 3- 2-1 locating principle and having indexing mechanisms, first in modeling software (Solid Works) and thereby fabricating the actual fixture for pillar drill machine.

Keywords: Drilling Fixture, Indexing Mechanism, Fixture, Pillar Drilling, Translator motion of Fixture.

I. INTRODUCTION

A. Problem Summary And Introduction

1) Basic Concept of Fixture for Drilling Operation: A fixture is a mechanical component used to locate, clamp and sustain a workpiece during machining, assembly or inspection. The primary function of a fixture is to hold the workpiece sturdy such

that it provides position accuracy and work piece stability. Fixtures must accurately locate a work piece in a given orientation

with respect to cutting tool or measuring device, as for instance in drilling. Such locations must be invariant g. Such location

must be invariant in the sense that the devices must clamp and lock the work piece in that location for the drilling operation.

There are many standard work holding devices such as jaw chucks, collets, machine vises, drill chucks, etc. which are widely used in workshops and are usually kept in stock for general applications. Importance of fixtures: - Designing and fabricating a

fixture contributes considerably to overall manufacturing cost and also consumes time. But it will eliminate individual marking,

positioning and frequent checking before machining operation starts, thus resulting in significant saving in set-up time. Other

advantages of fixtures in drilling are: 1. More productivity 2. Repeatable clamp location 3. Eliminates human error 4.

Ergonomic efficiency 5. Improved part stability 6. Flexibility.

B. Aim and objectives of the project

1) To design and develop a fixture for a roller.

2) The aim is to develop a fixture such that it would hold the work piece and position it according to the pattern of holes to be

drilled on work piece. There would be no need to mark and drill holes, rather the indexing mechanism installed in the fixture

would allow the operator to drill holes without marking.

3) To increase the productivity in the process of drilling holes on the roller.

4) The design and working of fixture is to be made simple so that the time taken for job completion is reduced and also less skilled

labor can be employed to perform the job. The indexing mechanism would reduce processing time drastically and thereby

reduce processing cost. This way the productivity would increase without much change in the processes.

C. Problem Specifications

The problems that occurs without the fixture are:

Large workpiece (<1500mm length) cannot be rotated with ease and accuracy on the pillar drilling machine bed. 2. Each time for

drilling holes on roller marking is mandatory. 3. Marking of holes and the drilling them takes considerable amount of manufacturing

time.

To solve the above-mentioned problems, we plan to develop a fixture which would hold the workpiece effectively as well as

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The need for marking the holes would go completely because of the introduction of indexing mechanism. 2. This would reduce the

processing time drastically and thereby reduce the processing cost compared to manual marking. 3. The fatigue would also reduce drastically and this would make the worker more energetic and active during the work. 4. Also, the remaining time of the worker could be utilized in other effective way. 5. Accuracy would be far better compared to manual rotation of workpiece.

II. DESIGN AND ANALYSIS

A. Design

At first, the prototype was designed in Solid WORKS considering the design parameters and constraints. Each part of the model was created and then assembled, Fig a. shows the final assembly of the prototype. The different components used in this fixture is listed

below:

1) Gearbox
2) Flange
3) Clamps
4) Lead screw
5) Bearing block
6) Roller wheels
7) Roller (workpiece)

Fig b. shows that, how the workpiece will be clamped on the fixture. The clamps will be able to restrain the motion of workpiece in Y-direction during the drilling operation. The flange, which can be seen in fig c. connects the workpiece shaft to the gearbox. The gearbox gives rotary motion to the workpiece while the lead screw gives translatory motion the fixture bed, refer fig d. Indexing Mechanism: -The need to mark holes would be completely removed as the worm assembly and indexing screw would index all holes peripherally and also tangentially respectively. The worm ratio is 18:1 which means 18 turns of worm gear would result into one rotation of shaft. Indexing screw has pitch of 12mm. Roller Type A and Type C will have same indexing mechanism and type

WORKING PRINCIPLE The rotating edge of the **drill** exerts a large force on the **work** piece and the hole is generated. The removal of metal in a **drilling operation** is by shearing and extrusion. ... Sensitive **drill** presses are manufactured in **bench** or floor models, i.e., the base of **machine** may be mounted on a **bench** or floor.

Engineering Tutorials

Principle and Working of DRILLING MACHINE

October 21, 2009

By admin

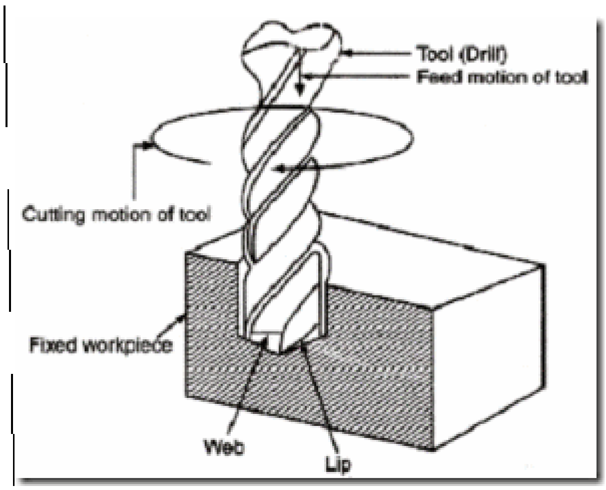
DRILLING MACHINE

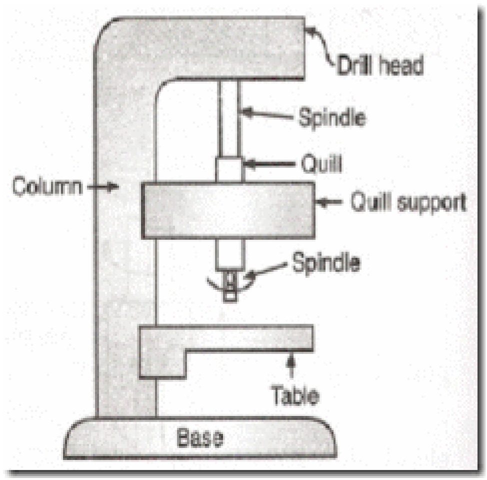
Introduction: The drilling machine or drill press is one of the most common and useful machine employed in industry for producing forming and finishing holes in a workpiece. The unit essentially consists of:

1. A spindle which turns the tool (called drill) which can be advanced in the workpiece either automatically or by hand.

2. A work table which holds the workpiece rigidly in position.

Working principle: The rotating edge of the drill exerts a large force on the workpiece and the hole is generated. The removal of metal in a drilling operation is by shearing and extrusion.





Working Principle of Drill machine Sensitive Drill Machine/Drill Press

Types of Drilling Machines: A wide variety of drilling machines are available ranging from the simple portable to highly complex automatic and numerically controlled machines are as follows:

1. Portable drilling machine: It is a small light weight, compact and self contained unit that can drill holes upto 12.5 rnrn diameter. The machine is driven by a small electric motor operating at high speed. The machine is capable of drilling holes in the workpieces in any position.

2. Sensitive drill machine/press: This is a light weight, high speed machine designed for drilling small holes in light jobs. Generally the machine has the capacity to rotate drills of 1.5 to 15.5 rnrn at high speed of 20,000 rev/min.

Construction: The machine has only a hand feed mechanism for feeding the tool into the workpiece. This enables the operator to feel how the drill is cutting and accordingly he can control the down feed pressure. Sensitive drill presses are manufactured in bench or floor models, *i.e.,* the base of machine may be mounted on a bench or floor.

The main operating parts of a sensitive machine/drill press are Base, Column, Table, and Drill Head.

1. **Base**: The base is a heavy casting that supports the machine structure; it provides rigid mounting for the column and stability for the machine. The base is usually provided with holes and slots which help to Bolt the base to a table or bench and allow the work-holding device or the workpiece to be fastened to the base.

2. **Column**: The column is a vertical post that Column holds the worktable and the head containing the driving mechanism. The column may be of round or box section.

3. **Table**: The table, either rectangular or round. Drill machine/press in shape supports the workpiece and is carried by the vertical column. The surface of the table is 90-degree to the column and it can be raised, lowered and swiveled around it. The table can be clamp/hold the required the workpiece. Slots are provided in most tables to allow the jigs, fixtures or large workpieces to be securely fixed directly to the table.

4. **Drilling Head**: The drilling head, mounted close to the top of the column, houses the driving arrangement and variable speed pulleys. These units transmit rotary motion at different speeds to the drill spindle. The hand feed lever is used to control the vertical movement of the spindle sleeve and the cutting tool.

The system is called the sensitive drilling machine/press as the operator is able to sense the progress of drill with hand-faced.

Boring

In machining, **boring** is the process of enlarging a hole that has already been drilled (or cast) by means of a single-point cutting tool (or of a boring head containing several such tools), such as in boring a gun barrel or an engine cylinder. Boring is used to achieve greater accuracy of the diameter of a hole, and can be used to cut a tapered hole. Boring can be viewed as the internal-diameter counterpart to turning, which cuts external diameters.

There are various types of boring. The boring bar may be supported on both ends (which only works if the existing hole is a through hole), or it may be supported at one end (which works for both, through holes and blind holes). **Lineboring** (line boring, line-boring) implies the former. **Backboring** (back boring, back-boring) is the process of reaching through an existing hole and then boring on the "back" side of the workpiece (relative to the machine headstock).

Because of the limitations on tooling design imposed by the fact that the workpiece mostly surrounds the tool, boring is inherently somewhat more challenging than turning, in terms of decreased toolholding rigidity, increased clearance angle requirements (limiting the amount of support that can be given to the cutting edge), and difficulty of inspection of the resulting surface (size, form, surface roughness). These are the reasons why boring is viewed as an area of machining practice in its own right, separate from turning, with its own tips, tricks, challenges, and body of expertise, despite the fact that they are in some ways identical.

The first boring machine tool was invented by John Wilkinson in 1775.[1]

Boring and turning have abrasive counterparts in internal and external cylindrical grinding. Each process is chosen based on the requirements and parameter values of a particular application.

There are three main **types** — table, planer and floor. The table **type** is the most common and, as it is the most versatile, it is also known as the universal **type**. A horizontal **boring machine** has its work spindle parallel to the ground and work table.

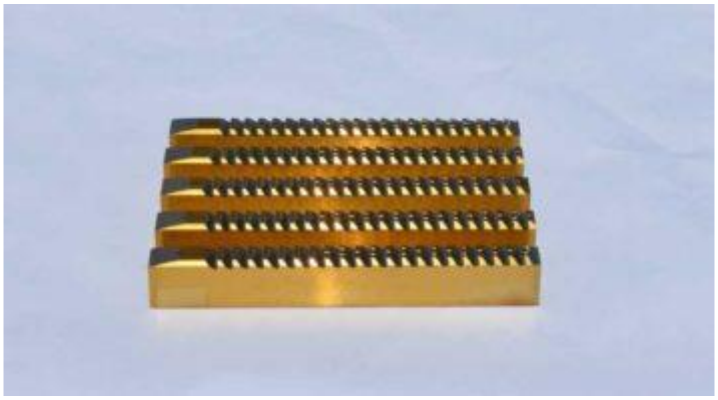
Differences between drilling and boring

Drilling	Boring

Drilling operation is performed to originate a hole.	Boring operation is performed to enlarge the hole diameter.
Drilling is the first phase for hole machining. However, sometime centering is done prior to drilling.	Boring is carried out after drilling. Boring cannot be performed if there is no drilled hole or hollow part.
Drill is meant for efficient plunging into the workpiece. So axial length of the hole can be increased by drilling operation.	Plunging is not possible by boring tool. So length of the hole cannot be increased by boring.
Hole diameter is limited to the drill diameter, in fact, they are exactly same.	Boring is performed to increase the hole diameter only.
Cutting tool used in drilling operation is called Drill.	Cutting tool used in boring operation is called Boring Bar or tool.
Drill is a multi-point cutter. That means drill has two or more cutting edges that can simultaneously remove material.	Boring bar is a single point cutter, so it has only one main cutting edge that removes material from workpiece.
Chip evacuation is the major problem in drilling. So it cannot be plunged continuously for longer length.	Chip evacuation is not an issue in boring. So it can be fed continuously without any risk of chip clogging.
A taper hole cannot be created by drilling operation. It only makes straight cylindrical holes.	Since boring operation is similar to internal turning, taper holes can be easily created by boring.

What is Broaching?

July 31, 2019 |



Broaching is a machining process that uses a toothed tool to remove material in a consistent and accurate way. There are two types of broaching services, linear and rotary, which are used to produce different kinds of machining finishes, but in either case, production broaching is typically only used for precision applications and high-quantity production.

What is a Broach?

Broaching relies on a toothed tool called a broach. One of the most essential traits of a broach is the rise per tooth, which indicates the amount of material each tooth removes every pass. These teeth are then broken down into sections along the body of the tool: the roughing, semi-finishing and finishing sections.

Also, Broaches can typically be placed into two categories: (1) surface or (2) internal. Surface broaches comprise a variety of broach designs.

- Slab
- Slot
- Contour
- Pot
- Straddle

Internal broaches are another style of the broach. These also come in a variety of styles.

- Solid
- Shell
- Modular
- Keyway
- Concentricity
- Cut-and-recut

Regardless of the style of the broach, both surface and internal models are typically made from alloy steel or high-speed steel. If using high-speed steel, the bits are usually coated with TiN. Also, while cast iron is an exception, tungsten carbide is not used for the teeth of most broaches because it will not stand up to the use.

What is the Broaching Process?

The broaching process varies depending on whether surface or internal broaching is being used. Surface broaching is the most straightforward operation because one surface acts on the other. For example, either the broaching tool remains stationary, and the workpiece is moved against it, or the workpiece is stationary, and the broach is moved against it.

Internal broaching is not so simple. For the use of an internal broach, the workpiece must be secured in place with a work holder, which also acts as the mount for the broaching machine. Then, using the elevator on the machine, the broach is lowered into the workpiece. Then, the machine’s puller grabs ahold of the broach pilot, and then when the elevator releases the follower, the puller pulls the broach entirely through the piece. Finally, the workpiece is removed, and the broach reengages with the elevator.

What are the Uses of Broaching?

There are a plethora of uses for broaches. In fact, you have likely seen types of broaching in hand tools, appliances, plumbing, automotive design, farming equipment and a variety of other military and industrial applications. However, the primary use of broaching is in the production of high-volume parts that require accurate, repetitive and complex cuts. While the broaching process can be used for a variety of applications, the best materials to use are those with a hardness rating of between 26 and 28 Rockwell C. However, many production companies have seen success by using materials up to a hardness rating of 32 Rockwell C.

How to Care for Your Broaches?

When you receive a new broach, it is likely good for at least 8,000 cuts. However, if the broach is cared for and regularly sharpened, you can increase that original estimate to nearly 60,000 or more cuts. Broaches are expensive parts, with some costing roughly $2,000 or more, and while the estimated 8,000 cuts might be OK for smaller operations, not every company can afford to replace these tools so frequently.

Therefore, after cutting 3,000 parts, it might be worth sending your broaches out to be sharpened and reconditioned to prolong the broaches usefulness and reduce overall production costs. If you have noticed that there is an increase in force required to cut your parts, then your broach may need some sharpening.

Broaching Methods

Following are the classification of broaching methods:

1. Pull Broaching
2. Push Broaching
3. Surface Broaching
4. Continuous Broaching

Pull Broaching

In the pull broaching the work is held fixed and the broach is pulled through the work. Usually, broaches are very long and are held in a special head. Pull broaching method is used for internal broaching but it also used for some surface broaching.

Push Broaching

In the push broaching the work is fixed and the broach is pushed through the work. Hand and hydraulic arbor presses are commonly used for push broaching. This method is used for sizing holes and cutting keyways.

Surface Broaching

In surface broaching either the work or the broaching tool moves across the other. This method has become an important means of surface finishing. Many irregular or intricate shapes can be broached by surface broaching, but the tools must be specially designed for each job.

Continuous Broaching

In continuous broaching the work is moved continuously and the broach us held stationary. The movement of work may be either straight horizontal or circular. The continuous broaching method is mostly used for broaching a number of similar works at the same time.

Advantages and Limitations of Broaching

Following are the features and advantages of the broaching.

1. The rate of production is very high.
2. Skill is required from the operator to perform a broaching operation. In most cases, the operator merely loads and unloads the work-piece.
3. High accuracy and a high class of surface finish are possible. A tolerance of ±0.0075mm and a surface finish about 0.8 microns (1 micron=0.001mm) can be easily obtained in broaching.
4. Both roughing finishing cuts are completed in one pass of the tool.
5. The broaching process is used for internal and external surface finishing.
6. Any form or shape that can be reproduced on a broaching can be machined.
7. Cutting fluid may be readily applied where it is most effective because a broach tends to draw the fluid into the cut.

For specific reasons, however, limit the utilisation of the broaching process. They are:

1. High tool cost. A broach normally makes only one job and is expensive to make and sharpen.
2. Very large work-piece cannot be broached.
3. The surface to be broached cannot have an obstruction.
4. Broaching cannot be used to remove a large amount of stock.
5. Parts to be broached must be capable of being rigidly supported and must be able to withstand the force that set up during cutting.
    6. **Surface finish,** also known as **surface texture** or **surface topography,** is the nature of a surface as defined by the three characteristics of lay, surface roughness, and waviness.[1] It comprises the small, local deviations of a surface from the perfectly flat ideal (a true plane).
    7. Surface texture is one of the important factors that control friction and transfer layer formation during sliding. Considerable efforts have been made to study the influence of surface texture on friction and wear during sliding conditions. Surface textures can be isotropic or anisotropic. Sometimes, stick-slip friction phenomena can be observed during sliding, depending on surface texture.
    8. Each manufacturing process (such as the many kinds of machining) produces a surface texture. The process is usually optimized to ensure that the resulting texture is usable. If necessary, an additional process will be added to modify the initial texture. The latter process may be grinding (abrasive cutting), polishing, lapping, abrasive blasting, honing, electrical discharge machining (EDM), milling, lithography, industrial etching/chemical milling, laser texturing, or other processes.

9. **Lapping** is a machining process in which two surfaces are rubbed together with an abrasive between them, by hand movement or using a machine.
10. This can take two forms. The first type of lapping (traditionally called grinding), involves rubbing a brittle material such as glass against a surface such as iron or glass itself (also known as the "lap" or grinding tool) with an abrasive such as aluminum oxide, jeweller's rouge, optician's rouge, emery, silicon carbide, diamond, etc., between them. This produces microscopic conchoidal fractures as the abrasive rolls about between the two surfaces and removes material from both.
11. The other form of lapping involves a softer material such as pitch or a ceramic for the lap, which is "charged" with the abrasive. The lap is then used to cut a harder material—the workpiece. The abrasive embeds within the softer material, which holds it and permits it to score across and cut the harder material. Taken to a finer limit, this will produce a polished surface such as with a polishing cloth on an automobile, or a polishing cloth or polishing pitch upon glass or steel.
12. Taken to the ultimate limit, with the aid of accurate interferometry and specialized polishing machines or skilled hand polishing, lensmakers can produce surfaces that are flat to better than 30 nanometers. This is one twentieth of the wavelength of light from the commonly used 632.8 nm helium neon laser light source. Surfaces this flat can be molecularly bonded (optically contacted) by bringing them together under the right conditions. (This is not the same as the wringing effect of Johansson blocks, although it is similar).

Cutting Tool Applications, Chapter 18: Lapping and Honing

Lapping is a final abrasive finishing operation that produces extreme dimensional accuracy, corrects minor imperfections, refines surface finish and produces close fit between mating surfaces. Honing is a low-velocity abrading process.

Lapping processes

The principal use of the lapping process is to obtain surfaces that are truly flat and smooth. Lapping is also used to finish round work, such as precision plug gages, to tolerances of 0.0005 in. to 0.00002 in.

Work that is to be lapped should be previously finished close to the final size. While rough lapping can remove considerable metal, it is customary to leave only 0.0005 in. to 0.005 in. of stock to be removed.

Lapping, though it is an abrasive process, differs from grinding or honing because it uses a ”loose" abrasive instead of bonded abrasives like grinding wheels.

These abrasives are often purchased “ready mixed” in a “vehicle” often made with an oil-soap or grease base. These vehicles hold the abrasive in suspension before and during use. The paste abrasives are generally used in hand-lapping operations. For machine lapping, light oil is mixed with dry abrasive so that it can be pumped onto the lapping surface during the lapping operation.

Lapping machines. These machines are fairly simple pieces of equipment consisting of a rotating table, called a lapping plate, and three or four conditioning rings. Standard machines have lapping plates from 12 in. to 48 in. in diameter. Large machines up to 144 in. are made. One- to 20-hp motors run these tables.

The lapping plate is most frequently made of high-quality soft cast iron, though some are made of copper or other soft metals. This plate must be kept perfectly flat. The work is held in the conditioning rings. These rings rotate. This rotation performs two jobs. First, it ”conditions” the plate — meaning that it distributes the wear so that the lapping plate stays flat for a longer time. Second, it holds the workpiece in place. The speed at which the plate turns is determined by the job being done. In doing very critical parts, 10 to 15 rpm is used. When polishing is involved, up to 150 rpm is used.

Abrasive grit must be uniformly graded to be effective in lapping.

A pressure of about 3 pounds per square inch (psi) must be applied to the workpieces. Sometimes their own weight is sufficient. If not, a round, heavy pressure plate is placed in the conditioning ring. The larger machines use pneumatic or hydraulic lifts to place and remove the pressure plates.

The workpiece must be at least as hard as the lapping plate, or the abrasive will be charged into the work. It will take from 1 to 20 minutes to complete the machining cycle. Time depends on the amount of stock removed, the abrasive used and the quality required.

Grit and plate selection. Flatness, surface finish and a polished surface are not necessarily achieved at the same time or in equal quality. For example, silicon carbide compound will cut fast and give good surface finish, but will always leave a ”frosty” or matte, surface.

The grits used for lapping may occasionally be as coarse as 100 to 280 mesh. More often, the ”flour” sizes of 320 to 800 mesh are used. The grits, mixed in slurry, are flowed onto the plate to replace worn-out grits as the machining process continues.

The case for using diamond super abrasives rather than conventional abrasives such as aluminum oxide or silicon carbide can be summed up in three words. Diamonds are faster, cleaner and more cost-effective.

With diamond slurries, the lapping and polishing phases of a finishing operation can often be combined into one step. Also, less time is required for cleaning parts and processing waste. Throughput, along with overall productivity, is increased.

Lapping plates are manufactured from various materials and are available in standard sizes from 6 to 48 inches in diameter. Plates are supplied with square, spiral, and concentric and radial grooves.

Advantages and limitations

Any material, hard or soft, can be lapped, as well as any shape, as long as the surface is flat.

Advantages. There is no warping since the parts are not clamped and very little heat is generated. No burrs are created. In fact, the process removes light burrs. Any size, diameter, and thickness from a few thousandths thick up to any height the machine will handle can be lapped.

Limitations. Lapping is still something of an art. There are so many variables that starting a new job requires experience and skill. Even though there are general recommendations and assistance from manufacturers, and past experience is useful, trial and error may still be needed to get the optimal results.

Honing processes

As stated, honing is a low-velocity abrading process. Material removal is accomplished at lower cutting speeds than in grinding. Therefore, heat and pressures are minimized, resulting in excellent size and geometry control. The most common application of honing is on internal cylindrical surfaces.

Machining a hole to within less than 0.001 in. in diameter and maintaining true roundness and straightness with finishes less than 20(mu) in. is one of the more difficult jobs in manufacturing.

Finish boring or internal grinding may do the job, but spindle deflection, variation in hardness of the material, and difficulties in precise workholding make the work slow and the resuits uncertain. Honing, because it uses rectangular grinding stones instead of circular grinding wheels, can correct these irregularities.

Honing can consistently produce finishes as fine as 4μ in., and even finer finishes are possible. It can remove as little as 0.0001 in. of stock or as much as 0.125 in. of stock. However, usually only 0.002 in. to 0.020 in. stock is left on the diameter for honing.

Honing machines
For most work, honing machines are quite simple. The most-used honing machines are made for machining internal diameters from 0.060 in. to 6 in. However, large honing machines are made for diameters up to 48 in. Larger machines are sometimes made for special jobs.

The length of the hole that can be honed may be anything from 1/2 in. to 6 in. or 8 in. on smaller machines and up to 24 in. on larger machines. Special honing machines will handle hole lengths up to 144 in.

Horizontal spindle machines. Horizontal-spindle honing machines, for hand-held work with bores up to 6 in., are among the most widely used. The machine rotates the hone at from 100 to 250 fpm.

The machine operator moves the work back and forth (strokes it) over the rotating hone. The operator must ”float” the work — that is, not press it against the hone or the hole will be slightly oval. Sometimes the workpiece must be rotated.

Horizontal-spindle honing machines are also made with ”power stroking.” In these, the work is held in a self-aligning fixture and the speed and length of the stroke are regulated by controls on the machine.

As a hone is being used, it is expanded by hydraulic or mechanical means until the desired hole diameter is achieved. Various mechanical and electrical devices can be attached to the honing machine to control the rate of expansion, and stop it when final size is reached.

On the simplest hand-held machines, the operator may check the bore size with an air gage, continue honing, and recheck and so on until the size is correct.

Vertical spindle machines. Vertical-spindle honing machines are used especially for larger, heavier work. These all have power stroking at speeds from 20 to 120 fpm. The length of the stroke is also machine controlled by stops set up by the operator.

Vertical honing machines are also made with multiple spindles so that several holes may be machined at once, as in automobile cylinders.

Hone body: The hone body is made in several styles using a single stone for small holes, and two to eight stones as sizes get larger. The stones come in a wide variety of sizes and shapes. Frequently, there are hardened metal guides between the stones to help start the hone cutting in a straight line.

Cutting fluid: A fluid must be used with honing. This has several purposes: to clean the small chips from the stones and the workpiece, to cool the work and the hone and to lubricate the cutting action.

A fine mesh filtering system must be used, since recirculated metal can spoil the finish.

Abrasive tool selection
The abrasive honing stone must be selected for the proper abrasive type, bond hardness and grit size to deliver the fastest stock removal and desired surface finish. This selection is simple if done in the following three steps:

Step one: Select the abrasive type with respect to the material composition of the bore. There are four different types of abrasives: aluminum oxide, silicon carbide, diamond and CBN. (All four of these were discussed in the previous chapter.) Each type has its own individual characteristics that make it best for honing certain materials. Some simplified guidelines for their use are:

Diamond and CBN are considered super abrasives because they are much harder than conventional abrasives. They cut easily and dull slowly, therefore allowing them to hone certain materials much faster and more efficiently than conventional abrasives. However, as shown above, super abrasives are not suited to boning all materials. For instance, diamond does not hone steel very well, and CBN may not be as economical as using aluminum oxide to hone soft steel.

Step two: Use the stone hardness suggested in the manufacturer's catalog. If the stone does not cut, select the next softer stone; if the stone wears too fast, select the next harder stone. Stone hardness does not refer to the hardness of the abrasive grain, but to the strength of the bonding material holding the abrasive grains together, as discussed in the previous chapter.

Diamond and CBN abrasive grains dull so slowly that standard ceramic or resin bonds may not be strong enough when honing rough out-of-round bores in hard materials, or when CBN is used to hone soft steel. Metal bonds are best suited for these applications because the grains are held in a sintered metal matrix that is much stronger than standard bonds. As with choosing abrasive type, stone bond hardness must be matched to the application to maximize life and stock removal rates.

Step three: Select the largest abrasive grit size that will still produce the desired surface finish. Surface finish is a function of the height of microscopic peaks and valleys on the bore surface and honing can produce almost any degree of roughness or smoothness through the use of different abrasive grit sizes.

Honing oil can improve stock removal rates by helping the cutting action of the abrasive grains. It prevents pickup (spot welding of tool to bore) and loading (chips coating the stone). Honing oil does this, not by acting as a coolant, but through chemical activity.

Cylinder block honing

Bores sometime require a preliminary rough honing operation to remove stock, followed by finish honing to get the desired surface finish. A characteristic feature of a honed surface finish is crosshatch, which makes an excellent oil retention and bearing surface. The crosshatch pattern is generated in the bore surface as the workpiece is stroked back and forth over the rotating honing tool.

Advantages and limitations

Honing has developed into a productive manufacturing process, with particular advantages and disadvantages:

Advantages: The workpiece need not be rotated by power, there are no chucks, faceplates, or rotating tables needed, so there are no chucking or locating errors. The hone is driven from a central shaft, so bending of the shaft cannot cause tapered holes as it does when boring. The result is a truly round hole, with no taper or high or low spots, provided that the previous operations left enough stock so that the hone can clean up all the irregularities.

Honing uses a large contact area at slow speed compared with grinding or fine boring, which use a small contact area at high speed. Because of the combined rotating and reciprocating motion used, a crosshatched pattern is created which is excellent for holding lubrication. Diameters with 0.001 to 0.0001 inch and closer accuracies can be honed by using diamond stones similar to diamond wheels.

Limitations: Honing is though of as a slow process. However, new machines and stones have shortened hone times considerably. Horizontal honing may create oval holes unless the work is rotated or supported. If the workpiece is thin, even hand pressure may cause a slightly oval hole.