WORK HOLDING ACCURACY AND APPLICATION OF BENCH LATHE IN INDUSTRY

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ABSTRACT

The lathe, probably one of the earliest machine tools, is one of the most versatile and widely used machine tool, so also known as mother machine tool [1]. It is the most essential machine tool in an engineering workshop for performing various operations on workpieces as required by the machinist. In this research paper, we have explained the working parts such as Spindle, Tailstock, Carriage, Chuck and Jaws of lathe machine as well as our study on concept of workholding accuracy and applications of lath machine in industry.

Key Words: *Lathe, Carriage, Chuck, Tools, Spindle, Jaws, Work-Holding*

I.INTRODUCTION

Lathe machine is a general-purpose machine tool, which is used for machining different round objects. We can do different operation on the job by lathe machine. It is commonly used in the mechanical field. It makes the work easier and simplify. Mostly the simple jaws we can make on lathe machine tool. It is easy to install and easy to work on it.

II.METHODOLOGY

Lathes have existed in one form or another since the time of Egypt.Consider the similarity with the potter's wheel: the thrown vesselhas been around for thousands of years, so it's only naturalthat lathes, which work on the same principle, but with athe workpiece moves against the stationary cutting tool, wouldto followThe simplest lathes allowed workers to shootDIY materials. There were more lathes for metal and woodtechnologically advanced throughout time, after allturning into machines with built-in heads. Each headwas mounted on cross slides that ran the length of the lathebed and were used to turn the workpiece.Basic lathes were used for precision machining of metals untilthe introduction of the lathe engine, which used anautomated feed to the cutting tool. Already then every turnerwas different but the process was the same. Engine lathescontributed to the birth of the industrial revolution, which saw the introduction of steam-powered lathes capable of up torotational speed and torque, allowing you to spin harderparts. Lathes turned into heavy machiningcars. A lathe, like a milling machine,simplified the processing process, because there were more of themadvanced. With the introduction of computer numbersControl in the second half of the 20th century, a significant leap forward (CNC) has been made. Operators canprogram a set of instructions for each machine that uses CNC lathes. This allowed for exact repetitionthese instructions, resulting in more accuratecomponents and reducing the number of workersis necessary for each machining tool to operate in the same mannertime Modern technologies allow more accurate work with CNCprogramming with an ever-increasing number of axes.

III.MODELING AND DISCUSSION

1.COMPONENTS

Necessary components of a lathe are a bed, a headstock,tailstock, spindles, carriage, chuck, tool holder and motor.

2.1 Bed

The bed consists of two heavy metal slides that movealong and have paths or "V's" created on themrigidly held by the transverse girths. This is the basis of the lathe andone of the criteria that determines the size of the work. That meansthe maximum diameter limit is determined by the distancebetween the main spindle and the bed. It has three main uses:

 It is sufficiently rigid and has a high damping capacity

 It prevents cutting forces from occurringdeflection

 It supports the lathe headstock, tailstock,carriage and other components

2.2 Grandmother

The main action takes place on the headstock.Here the power of the engine is transferredblank. Drive mechanism and electrical mechanismthe lathe is located in the main warehouse which appearslocated on the left side of the lathe bed. The work is carried out inplace at the nose of the spindle, which has an external threadand an internal Morse taper to hold the center of the lathe. Thisrotates at different speeds thanks to a cone pulley or all-wheel drive. The hole runs the entire length of the spindle contain long bar work. Feed rod, lead screw andall threading mechanisms are powered by the spindlethrough the Main Warehouse. Below the headstock is a separate speed switchgearbox that reduces the speed so that the variable feed rate forthreading and automatic lateral movement of the carriage can bereachedMost turning work is done with feedrod, while threading operations are performed withlead screw.

2.3 Spindle

The machine spindle provides relative motionbetween the cutting tool and the workpiece being heldrequired to perform the material removal operation. Uturning, is the physical connection between the machinestructure and workpiece, while in processes such as milling,drilling or grinding, it connects the structure and the cutting tool.The spindle is supported by two bearings separateddifferent spans.[5] A cylindrical blank is contained in thispart of a lathe. Various nozzles andaccessories can be added to the spindles, includingwhich rotates the main spindle which holds the workpiece. Primarythe spindle is generally hollow and threaded on the outsidefit these fittings. Centers, cartridges and faceplatesall useful bits for the main spindle. It can beused to position and hold the workpiece in place.

2.4 Rear headstock

The tailstock is located above the bed on the right side.The tailstock is a non-rotating spindle that moves downbed and concentric with the main spindle of the lathe. Thethe tailstock is usually used to support the ends of the long onesworkpiece, but it can also be equipped with a drill chuckto carry out drilling and other work on making holes.

2.5 Carriage

When processing is finished, the carriage is used forsupport, guide and feed the tool according to the job. It is located in itcomplicated rest over. It is responsible for holding, moving andcutting tool control. During operations providesrigid support for the tool. For this, the apron mechanism is usedpower transmission from the rod feed to the cutting tool forlongitudinal cross-feeding. With the help of a travel screw andhalf-nut mechanism, it facilitates threading

2.6 Tool Post

The cutting tool is held in place by a tool post that is firmlysecured in the T-slots of the compound rest. Tool posts canhave a variety of designs, but the following are the mostcommon:

 Quick Release Tool Post: This tool post is becomingincreasingly popular. In the ready-to-use holders, aninfinite number of tools are pre-programmed. Toolheight may be quickly and easily modified using afastener, and it can be pre-set for each tool that has been removed from the lathe.

 Index Tool Post: This tool post allows for four tools to bemounted on the turret at the same time. Each tool issafeguarded separately, allowing you to utilise anywherefrom one to four tools at the same time. The turret'soutstanding indexing system allows it to be placed in 24locations, each at 15 degrees, allowing the widest rangeof machining processes. With a millionth of an edgerepeatability, it is possible to index from one cutting toolto another in less than one second.

 Pillar Type Tool Post: The Pillar Type Tool Post, alsoknown as the American Pillar, is commonly used forlight-duty lathes. Shaking the boat part in its roundseating adjusts the tool height quickly and easily.Unfortunately,this type of tool post lacks the inflexibilityrequired for the tool's mission. The useful cutting anglesvary depending on how far the boat component isadvanced or changed.

 Clamp Type Tool Post: Clamp type tool post, also knownas English Clamp, is simple and effective, with theexception of some difficulty. The tedious process ofadding or subtracting stuffing and shims until the tool isat the exact height with the spindle axis is the only wayto keep the tool's height. This must remain consistent asthe tool adjusts. Furthermore, only one tool is acceptedat a time, and fast tool change is not possible whilemachining a small batch of complicated components.

 Turret (4-Way) Tool Post: This form of tool post savestool changing when constructing a mechanism, with eachtool swinging into place as needed. The number of toolsin this array is limited to four, and vertical changes aremade by inserting packing beneath the tool. The tool'sshank size is too small.

 Super Six Index Turret: When multi-process worknecessitates the use of more than one tool, the indexturret tool post is designed to make machining easier andmore efficient on Engine Lathes. For outside and insidemachining processes, the rotary index turret can beequipped with up to six tools. Every tool has its ownheight adjustment in this unit, and tool changes take lessthan a second.

2.7 Chuck

Chucks are accessories that are used to hold a workpiece or cut down tool on a machine tool. The chuck isactually essential to a lathe's functioning as it fixtures theportion to the spindle axis of the work-holding machine [6]. Itis connected to main spindle of the headstock. Lathe chucksare used to clamp a workpiece accurately on a lathe forturning operations or on an indexing fixture for millingactivities. A screw or pinion opens or closes the jaws of amanual lathe chuck. The jaws of a power lathe chuck areclosed by hydraulics, pneumatics, or electricity. They aredesigned for mass production and have a high graspingaccuracy.

Different types of chuck used in the lathe machine are:

1. Three jaw chuck

2. Four jaw chuck

3. Magnetic Chuck

4. Collet Chuck

5. Combination Chuck

6. Air/ Hydraulic Operated

7. Drill Chuck

 Self-CenteringChucks : Since all jaws work in unisonand automatically centre the item, self-centeringscroll chucks are suitable for holding cylindrical orconcentric work. The scroll's jaws are opened andclosed by a wrench that rotates on a pinion. As astationary fixture, 2-jaw self-centering are employed for rectangular shaped pieces. The most versatileand ideal for handling spherical items are 3-jaw selfcentering jaws (bars, rings and pipes.) For squarepieces, 4-jaw self-centering is used. For thin-walleditems, 6-jaw self-centering is used. More grippingpoints ensure that clamping forces are distributedevenly and that distortion is avoided.

 Independent Jaw Chucks: Jaws in independentchucks are designed to move separately rather thantogether. Ideal for eccentric operations or holdingoddly shaped workpieces. They require more time toset up than self-centering chucks.

 Three Jaw Chuck: The three jaw chuck is the mostfrequent method of holding a workpiece on a lathe.It's simple and quick to use. However, it can onlyhold workpieces that are round, triangular, orhexagonal. Though it is quite exact, it is rarely asaccurate as a four jaw chuck, yet it is adequate formany projects. To hold a workpiece, both the threejaw and four jaw chucks would almost invariably beattached to the spindle in the headstock. However,they can be utilised to hold a tool or even be attached to the tailstock in select situations. It ispossible to create three-jaw chucks with reversiblejaws. Three jaw chuck have advantage of selfcentering and limitation is that it not recommendedfor high-speed load condition.[3]

Fig -9: 3-Jaw Self Centering Chuck

 Four Jaw Chuck: For Non-Self Centering Four JawChuck, each of the chuck stepped jaws are controlledby a separate screw giving them independentmovement. This feature allows the four-jawindependent chuck to secure any form. Using two tofour of the various jaws, this type of chuck mayfasten circular, rectangular, square, irregular, andother shapes. Self-Centering Four Jaw Chucks arenever utilised in metalworking as in woodworking. A four-jaw chuck with self-centering jaws can holdboth round and square pieces. For a carpenter, thiscovers significantly more jobs than for ametalworker. A self-centering four jaw chuck losesthe advantages of a four jaw chuck to the metalworker – great accuracy and the ability to handleodd shapes. However, the craftsman is uninterested in these. However, he finds it incredibly useful to beable to grip round and square forms simply andswiftly. Four Jaw Chucks are critical units of thehigh-speed horizontal lathe, while the interferencefit between the chuck and spindle is one of mostimportant factors influencing the performance of thehigh-speed horizontal lathe. It is very important tomonitor the chucking condition of the power chucksfor safety consideration in Lathes, especially highspeed lathes. They can be used to hold irregularlyshaped parts. Multiple gripping method is one of theadvantages of four jaw chuck.[3]

Fig -10: 4-Jaw Independent Jaw Chuck

 Magnetic Chuck: The magnetic chuck is used to holdvery thin parts in place. These thin pieces are madeof a magnetic substance that can't be grasped in astandard chuck. Due to the pressure of typical chuckjaws, there is a risk of the work piece bending, buckling, twisting, or deforming in any way.Magnetic lathes are employed in these situations.The radiated magnetic flux is obtained by the chuckfrom these magnets. This magnetism helps the chuckkeep the work item in place.

 Collet Chuck: Collet chucks are commonly used infactories and industries to hold bar stock where itmust be quickly fixed and properly centred. A colletis a bushing that resembles a lean cylinder and hascarved slots running the length of its edge. Thecollet's internal bore can be hexagonal, cylindrical,square, or any other shape. The shape of theworkpiece passing through it determines its shape.The collet has a tapered outside surface. Thistapered surface fits into the taper hole on thechuck's body, and the threaded tail end interlockswith a key.

 Combination Chuck: A combination chuck can beused as a self-centering and independent chuck atthe same time. This aspect of this chuck contributesto the benefits of both types of chucks. The jaws areoperated by separate screws. The scroll discs controlall the jaws independently. The bottom frame iscarved with teeth that interlock with the scroll. Thescrews, like the jaws, move in a radial manner. Thismovement occurs when a pinion turns the scroll.

 Air/Hydraulic Chuck: Most of the time, air chucks orhydraulic chucks are useful in mass productionprocesses. To operate an air or hydraulic used chuck,a hydraulic or air cylinder is required. This chuck's holding calibre is quick and effective. This cylinder isattached to the rear end of the headstock spindleand rotates. Fluid pressure is transferred to thecylinder by operating a valve with a lever, causingthe piston to drop within the cylinder. The piston'smotion is transmitted to the jaws via a connectingrod and links, which securely grip the workpiece.

 Drill Chuck: Drill chucks are spindle-mountedmechanisms used to hold a drill or other cutting tool.They are available in keyed, keyless, and hybridsystems, which allow for quick drill bit changes. DrillChucks are frequently connected to a machine'sspindle via a removable Drill Chuck Arbor. Thearbour is essentially a steel shaft with two ends, onemachined to fit into a machine's spindle and theother to fit into the rear of a drill chuck. Jaws arecommonly used in chucks to hold the tool orworkpiece. Jaws (also known as dogs) are typicallyarranged in a radially symmetrical pattern, similar tothe points of a star.

2.8 Jaws

Permanent Jaws for retaining a workpiece in a lathe chuckare known as hard lathe chuck jaws. They're composed ofcase-hardened steel and include a serrated clamping surfaceto keep the piece secure during machining. It's ideal for partsthat haven't been finished yet. Lathe Chuck jaws that are soft(machinable) are used to hold a workpiece while it is beingturned on a lathe. They're constructed of soft materials likealuminium or mild steel and can be machined to precisedimensions for precisely aligning the workpiece during anoperation. They can be trimmed to match the diameter of acertain item, increasing the contact surface area. Use on finelymachined items to get the best results.Two sets of jaws are usually included in a three-jawchuck. The internal jaws are one set. These can be utilised toretain the work item on its outside surface using the longedges. They can also use the stepped faces on the interior ofthe workpiece to hold it. The external jaws are the other set.Only the internal stepped edges are ground on these, andthey are intended to be used to hold the workpiece, hence theworkpiece is always held on an external surface when usingthese. These are normally hardened and ground, and must beutilised as is.

When employing soft jaws, the location of the jaws isnever important because the edge that will hold theworkpiece can be produced anywhere on the jaw. The maincriterion is that it is preferable to utilise, as little metal aspossible while still completing the task.The teeth and alignment slots are the mostsignificant parts of the soft jaws. It should be feasible to makeparts that fit on these as long as they work. When these components wear out, they are unbolted and replaced withnew components.

Fig -9: 3-Jaw Workholding

Fig -10: Inverted 3-Jaws Workholding

When twisting the soft jaws to hold a part on itsexterior, the jaws must be forced out at the same time.Holding a circular portion that contacts the rear of the jaws isone way to accomplish this. Even if the cut isn't preciselyround, it'll be concentric when the jaws are tightened on around object. Similarly, the jaws must be driven out whenholding the workpiece on an inside edge.

3. ACCURACY OF WORK HOLDING IN A THREE –

JAW CHUCK

When holding a round bar, the axis of the bar must beconcentric with the axis of the spindle for a three-jaw chuckto be accurate.

There are two types of errors that could occur here:

- When a piece of ground round stock is clamped in athree jaw chuck and tested with it is frequentlyfound to be a few hundredths off. In a lot ofcircumstances, this is perfectly okay. This inaccuracyvaries depending on the wear of the chuck's scrolls,therefore it could be different for workpieces ofdifferent diameters.

- If a workpiece is held in a three chuck that is offcentre, any surfaces turned on it in one pass, that is,without removing it from the chuck, will beconcentric relative to each other and to the spindle'saxis of rotation. This means a workpiece can haveany number of round surfaces as long as they are allconcentric. Turning between centres is madepossible by this feature. However, if the workpiece isheld in a chuck for some reason, it is not possible toturn the surface that is being held. As a result, itusually indicates that the part can be created butmust subsequently be disassembled. The workpiecebe large enough to be turned down to therequired size. As a result, we won't be able to useany existing surface on the final workpiece becauseit will be eccentric to any.

4. APPLICATIONS

On an industrial scale, large lathes turn out a huge number ofparts, such as automobile driveshafts, table legs, and so on. Agigantic metal cone or disc can be turned with large-scalelathe equipment, whereas a metal chess piece can be carvedout with small-scale devices.On a larger scale, lathes can be rather massive, but a toolroomlathe is typically a smaller machine tool. Because of itsversatility, a metal lathe is the workhorse of many smallmachine shops and tool-and-die shops. A lathe is useful tomany professionals and amateurs outside of the machineshop.Today, every industrial metalworking lathe is completelyautomated, with multiple-bit-holding heads. This means thata single lathe can handle a variety of tasks: rough bits forgrinding out material, finer bits for refining pieces, and evensanding and polishing bits. A trained operator can use a CNClathe to programme a metalworking lathe to take a singleworkpiece from raw material to completed product with nohuman intervention after the programme is started.

RESULT AND DISCUSSION

The lathe machine has proved to be one the most versatileand helping piece of machine tool in a tool room workshopand has variety of applications for making possibleoperations required to make a workpiece its desired shapeand size. We have studied various parts of the workshoplathe giving information about the bed, the tailstock, thetoolpost and its types, the headstock, the carriage, chucksand their types, jaws and their types. Also we have workedon workholding accuracy of a 3 jaw chuck that explains thetypes of errors the jaws show while holding a concentricworkpiece. Also, we have explained the day-to-dayapplications of a workshop lathe in small scale and largescale industries.

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