Design and fabrication of 360 degree flexible drilling machines

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***Abstract*: Drill machines have been the heart of every industry. Drilling holes in parts, sheets and structures is a regular industrial work. Perfect and well aligned drilling needs fixed and strong drills. So here we propose a 360 degree flexible drill that can be mounted on a table or wall and can be used to drill holes horizontally, vertically or even upside down. So this makes it possible for easy drilling in even complicated parts and surfaces. Thus we use rotating hinges and connectors with motor mount and supporting structure to design and fabricate a mini 360 degree drill for easy drilling operations.**

***Index Terms*: Strap drill, Taguchi optimization, S/N ratios , orthogonal array , pneumatic cylinder**

I. INTRODUCTION

Drilling is the method of making holes in a workpiece with metal cutting tools. Drilling is associated with machining operations such as trepanning, counter boring, reaming and boring. A main rotating movement is common to all these processes combined with a linear feed. There is a clear distinction between short hole and deep hole drilling. The drilling process can in some respects be compared with turning and milling, but the demands on chip breaking and the evacuation of chips is critical in drilling. Machining is restricted by the hole dimensions, the greater the hole depth, the more demanding it is to control the process and to remove the chips. Short holes occur frequently on many components and high material removal rate is a growing priority along with quality and reliability.

Solid drilling is the most common drilling method, where the hole is drilled in solid material to a predetermined diameter and in a single operation.

Trepanning is principally used for larger hole diameters since this method is not so power-consuming as solid drilling. The trepanning newer machines the wheel diameter, only a ring at the periphery. Instead of all the material being removed in the form of chips, a core is left round the center of the hole.

Counter boring is the enlargement of an existing hole with a specifically designed tool. This machines away a substantial amount of material at the periphery of the hole.

Reaming is the finishing of an existing hole. This method involves small working allowances to achieve a high surface finish and close tolerances.

The cutting speed, or surface speed (vc) in for drilling is determined by the periphery speed and can be calculated from the spindle speed (n) which is expressed in number of revolutions per minute. During one revolution, the periphery of the drill will describe a circle with a circumference of π x Dc, where Dc is the tool diameter. The cutting speed also varies depending upon which cutting edge across the drill-face is being considered.

A machining challenge for drilling tools is that from the periphery to the center of the drill, the cutting speed declines in value, to be zero at the center. Recommended cutting speeds are for the highest speed at the periphery.

The feed per revolution (fn) in mm/rev expresses the axial movement of the tool during one revolution and is used to calculate the penetration rate and to express the feed capability of the drill.

II. LITERATURE SURVEY

Around 35,000 BCE, Homo sapiens discovered the benefits of the application of rotary tools. This would have rudimentarily consisted of a pointed rock being spun between the hands to bore a hole through another material. This led to the hand drill, a smooth stick that was sometimes attached to flint point, and was rubbed between the palms. This was used by many ancient civilizations around the world, including the Mayans. The earliest perforated artifacts such as bone, ivory, shells and antlers found, are from the Upper Paleolithic Era.

Bow drill (strap-drills) are the first machine drills, as they convert a back-and forth motion to a rotary motion, and they can be traced back to around 10,000 years ago. It was discovered that tying a cord around a stick, and then attaching the ends of the string to the ends of a stick (a bow), allowed a user to drill quicker and more efficiently. Mainly used to create fire, bow-drills were also used in ancient woodwork, stonework and dentistry.

Archeologist discovered a Neolithic graveyard in Mehrgrath, Pakistan dates from the time of the Harappans, around 7,500-9,000 years ago, containing 9 adult bodies with a total of 11 teeth that had been drilled. There are hieroglyphs depicting Egyptian carpenters and bead makers in a tomb at Thebes using bow-drills. The earliest evidence of these tools being used in Egypt dates back to around 2500 BCE. The usage of the bow-drills were widely spread through Europe, Africa, Asia and North America, during ancient times and is still used today. Over the years, many slight variations of bow and strap drills have developed for the various uses of either boring through materials or lighting fires.

Micromachining operations play an important role in precision production industries. Out of the various machining processes, micro-drilling is used to produce micro holes in fuel injectors, printed circuit board, aerospace materials etc. So in order to achieve the optimum working conditions various research were conducted by different researchers from across the globe. This report reviews some of the journals published by them regarding optimization processes.

Yogendra Tyagi, Vadansh Chaturvedi and Jyoti Vimal [1] have conducted an experiment on the drilling of mild steel, and applied the Taguchi methods for determining the optimum parameters condition for the machining process using the Taguchi methods and analysis of variance. The work piece used is mild steel (100mm×76mm×12mm) and the tool used is HSS with a point angle of 118° and a diameter of 10 mm. Taguchi L9 orthogonal arrays are used here in order to plan the experiment. The input parameters are fed rate, depth of cut and spindle speed whereas the output responses are surface roughness and metal removal rate (MRR). In case of signal to noise ratio calculation, larger the better characteristics is used for calculation of the S/N ratio for the metal removal rate and nominal and small the better characteristics are used for the calculation of the S/N ratio for surface roughness. After the analysis of the data obtained it is found that MRR is affected mostly by feed. Confirmation experiment was conducted using the data obtained from S/N ratio graphs and it confirmed by the results of Taguchi methodology. In case of surface roughness analysis same procedure was followed where the significant parameter was found to be the spindle speed. Here too the confirmation experiment was conducted and this confirms the successful implementation of Taguchi methods.

Timur Canel,A. Ugur Kaya, Bekir Celik [3] studied the laser drilling on PVC material in order to increase the quality of the cavity. A Taguchi optimization method was used to obtain the optimum parameters. The material used in the experimental setup is PVC samples with dimensions of 5mm×85mm×4.5mm. The Surelite Continuum Laser is used to form the cavities. The input parameters are wavelength, fluence and frequency and the output response are aspect ratio, circulate and heat affected zone. A Taguchi L9 orthogonal array is used to find the signal to noise ratio. Smaller the better characteristic is used for HAZ, larger the better characteristic is used for aspect ratio and nominal the better characteristic is used for circularity. Variance analysis is performed using the calculated S/N ratio to conclude optimum stage. It is found that most effective parameter for aspect ratio is frequency, second is wavelength and last is fluence. For circularity it is found that the most effective parameter is wavelength, fluence and frequency. For HAZ it is found that the most effective parameter is wavelength, second is frequency and last is fluence. The experimental results are compatible with the Taguchi method with a 93 % rate.

Thiren G. Pokar,Prof. V. D. Patel [5] used gray based Taguchi method to determine the optimum micro drilling process parameters.

B. Shivapragash, K. Chandrasekaran, C. Parthasarathy, M. Samuel [6] have tried to optimize the drilling process involving metal matrix composites (MMC) in order to minimize the damage done to it during the process by using Taguchi and gray rational analysis. The work piece used is Al-TiBr2 (MMCs), with dimension of 100mm × 170mm × 15mm.The tool material is HSS with a diameter of 0.6 mm. The input parameters are spindle speed, depth of cut and feed rate, whereas the output parameter is MRR and surface roughness. For finding out the optimal combination of cutting parameters the results are converted into S/N ratios and higher the better type characteristics is used for MMR, and smaller the better characteristics is used for surface roughness.

Wen Jialing and Wen Pengfei [8] used an orthogonal experimental design in order to find out the optimum process parameters for injection molding of the Aspheric plastic lens, to reduce volumetric shrinkage and volumetric shrinkage variation. Six input parameters were taken, each with 5 levels(Fill Time/sec, holding pressure/Mpa, holding pressure/times, cooling time/s, melt temperature/°C, mold temperature/°C.L25(56) orthogonal array is used to plan the above experiment. The parameters affecting both volumetric shrinkage and volumetric shrinkage variation are identified in order.

III. WORKING PRINCIPLE

This drilling machine possesses a radial arm, which along with the drilling head can swing and move vertically up and down as can be seen in Fig 3.1. The radial, vertical and horizontal arm movement of the drilling head enables locating the drill spindle at any point within a very large space required by large and odd shaped jobs. The tubular column on that the radial arm which moves up and down manually or it can powered movement, then the drilling head here this is called drilling head, which holds the drill spindle here in which the drill is mounted and is subjected to rotation. The main movements of the machine are:

- 360 degrees rotation of arm joint.
- Up & down movement of the horizontal arm in vertical arm.
- Linear slide movement of horizontal arm

In this project pneumatic cylinder is employed for applying the brake. A button is placed whenever the brake is to be applied the button is pressed and that actuates the pneumatic cylinder. A wheel is coupled to a motor and placed on the base frame. When the motor is switched on the wheel rotates. For applying brake a pedal is provided by the wheel. The pneumatic cylinder actuates faster to and fro to press the brake pedal, thus braking is carried out efficiently. Solenoid valve supplies the air to the pneumatic cylinder from the air compressor. When the brake is applied in a regular time interval the braking will be efficient also the vehicle can be controlled also in the turning. Thus the anti lock braking system provides safer drive even on slippery surfaces and turning roads.A Drilling machine at a construction site with a concrete pump and a barely visible concrete mixer. The tops of foundation columns with re-enforcing iron rods sticking out are visible at the bottom of the photo.A **Drilling machine** is used for foundation construction in the building industry, or for drilling water or oil wells.

Fig 3.1.360 degree drilling machine

3.1. Parts

3.1.1.Base

The base is made up of the steel or iron. The main function of the base of the drill press is used to support the column and stabilize it.

With the help of the base or the foot, the drill press can be placed in the upward direction.

3.1.2.Column

The column of the drilling machine is used to tie the table. The work is held in place by the table during the drilling process.

This is a long rod in shape that stands vertically with the table. Both the column and the tables are placed at the 90 degrees with each other.

3.1.3.Work Table

You can adjust the work table up or down the column to reach the proper height. If required, it can also be swiveled around the column to the intended working position.

A whopping majority of worktables have slots, holes and other structures and other work holding accessories. Certain tables can also be rotated around the horizontal axis.

3.1.4.Head

The head part of the drilling machine houses the spindle as it is attached at the top region of the spindle.

It is responsible for the spindle movement because the spindle can only move upward or downward.

3.1.5.Spindle

The spindle is the most important part of the drilling machine that is used to hold the tool and is responsible for its rotation.

The spindle of the tool is held with the help of arm that is gripped with the column.

In order to keep the spindle in its place, the manufacturer has used a spindle return spring and the spindle moves up and down easily. The weight of the spindle is very useful in the performance of the drill press as counterbalances the spindle spring. At the bottom side of the spindle, chuck is placed and this chuck is used to hold the drill bit in place.

3.1.6.Angle plates

An angle plate is usually known to support the action by its edge.

These very accurately align the work in a perpendicular fashion to the surface of the table, and they usually have holes and slots to help in clamping it to the table and holding the workpiece together.

3.1.7.Drill jigs

Drill jigs are used for multi-tasking. That is when several holes need to be made in one particular place.

It has got quite a few functions. It clamps, works in a firm manner and locates it in the correct or favorable position required for drilling.

The last, but not the least important function of the drill jig is to guide the drill straight through with the help of ‘drill bushings’.

3.1.8.Power transmission

The power transmission in the drilling machine used to transmit the power for its working is known as the power transmission. This power is supplied from the electric motor. The process of transmission takes place with the help of the v-bolt and the pair of pulley stacks opposite to each other. The speed of the spindle is fixed or controlled with the help of the pulley stacks.

The above-provided figure shows the all the main parts of the drilling machine. All the important parts are highlight by labeling them. You can see the figure and get the idea of the parts of the drill press.

Using the drilling machine is very easy if you know all the parts of the tool and their functions. In a case, if your tool is not working properly and having some problem you can find out easily that which part of the tool is not working properly or creating problems. You can de-attach that part of the drill press and replace it with the new one. This is the best way to operate your drill press in a quick and a good way.

3.2. Types

Drilling machines are classified on the basis of:

- their constructional features, or
- the type of work they are required to do

3.3. Various types of drilling machines:

- Portable drilling machine
- Bench-type Drilling machine
- Sensitive drilling machine
- Bench mounting
- Floor mounting
- Upright drilling machine
- Round column section
- Box column section
- Radial drilling machine
- Plain
- Semi universal
- Universal
- Gang drilling machine
- Multiple-spindle Drilling machine
- Automatic drilling machine
- Deep hole Drilling machine
- Vertical
- Horizontal

3.4. Drilling Operation:

- Drilling
- Counter boring
- Boring
- Countersinking
- Spot facing
- Tapping

3.5. Work Holding Device:

- Vice
- Plane
- Universal
- T-Bolt
- Clamps
- Step block
- V-block
- Angle plate
- Drilljigs

3.6. Basic purposes of use of drilling machines

Drilling machines are generally or mainly used to originate through or blind straight cylindrical holes in solid rigid bodies and/or enlarge (coaxially) existing (premachined) holes:

- of different diameter ranging from about 1 mm to 40 mm
- of varying length depending upon the requirement and the diameter of the drill
- in different materials ,excepting very hard or very soft materials like rubber, polythene etc.

IV. LIST OF MATERIALS

4.1. Parts

- Chassis
- Power Unit
- Rig Mast
- Kelly
- Drill Bit
- chunk
- chunk key

4.2. Types

Drilling machine drill bits

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4.4. Drilling Operation:

There are total 9 operations in drilling machine:

4.4.1. Core Drilling

When sand castings are made, cores are used to displace the metal where holes are desired. When cast the molten metal flows around the core. After the metal solidifies the casting is removed from the mould and the core disintegrates leaving the desired holes. the holes are usually quite rough and require heavy body drill to clean up the side wall of the whole.

4.4.2. Step Drilling

The above figure shown is also step drilling operation.More than one diameter can be ground on the drill body which saves an extra operation.

4.4.3. Boring

It is the process of enlarging a hole. It is done with the help of a single point cutting tool which is usually held by a boring bar.

4.4.4. Reaming

It is an operation of finishing a drilled hole. A finished hole has the specified diameter size, is perfectly round, the diameter is the same size from end to end, and it has it has a smoothly finished surface. A drill hole is seldom accurate enough in size or sufficiently smooth to be called a precision hole. When greater accuracy is required the whole must be drilled undersize by a certain amount and finished by the reaming

4.4.5. Counter Boring

It is the operation of boring a second hole, larger diameter than the first but concentric with it. When this operation is done on a drilling machine a tool known as counter bore is used. The small diameter on the end of the tool known as the pilot keeps the counter bore concentric with the original hole. Pilots are interchangeable with others of different size to fit the various sizes of holes.

4.4.6. Counter Sinking

It is the operation of producing an angular surface at the end of a hole. A countersink is used. Countersinks are made in many diameters size and several angles. The angle size depends upon the reason for countersinking. Flathead screws require a countersink with an 82 included angle, where a Centre hole is must be 60. Various types of rivet heads have included angles of from 90 145.

4.4.7. Spot Facing

It is the operation of machining a flat, circular surface around a whole to provide a seat for a Bolt head, nut or washer. It is usually performed on casting. A Counter bore may be used for spot facing. The Surface machined should be a square with the hole.

4.4.8. Tapping

Holes that are to be tapped (threaded) are first are drilled to a specified size. In order to tap holes on a standard drilling machine, a tapping attachment must be used. This attachment is held in the spindle of the drill press by a tapered Arbor, who drives the friction type mechanism. The tap holding chuck accurately centers the tap on the round part of the shank and floating jaws hold the tap on its square end in a firm, rigid grip, which prevents the tap from pulling out of the chuck when reversing.

4.4.9. Trepanning
It is a hole making operation where an annular groove is produced leaving a solid cylindrical core in the center. In Trepanning a cutter consisting of one or more cutting edges placed along the circumference of a circle is used to produce the annular groove. Trepanning is feasible if the hole has a diameter of more than 50 mm. Hole depth of 160 times the diameter can be obtained in Trepanning.

4.4.10.Advantages of Drilling Machine
This machine is needed to mark on the end of components of dresses especially for setting pocket, dart & so on.
It can make the hole permanently for a long.

4.4.11.Dis-advantage of Drilling Machine
The use of a machine is limited.

4.4.12.Application of Drilling Machine:
It is used to make a hole in the fabric for **button attaching** and to make a reference mark for attaching different small components on the garments.

4.5. Work Holding Device:

- Vice
- Plane
- Universal
- T-Bolt
- Clamps
- Step block
- V-block
- Angle plate
- Drill jigs

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- of varying length depending upon the requirement and the diameter of the drill
- in different materials, excepting very hard or very soft materials like rubber, polythene etc.

V. CONCLUSION

- The size of machine is smaller than the older machine so it is very simple to move from one place to another. So this machine can be easily transported. The overall space required is also minimum.
- With the help of this machine we can drill holes in any direction at a particular time.
- This machine is reduces the manufacturing cycle time, the re-clamping can be eliminated: once the work piece is clamped, there is no need for reclamping in a different direction, reduces the number of machines needed, elimination of human error.
- The machine is very simple to operate.

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