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Design and Fabrication of Angular Drilling Machine

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ABSTRACT: Now a day, machines are widely controlled by embedded system. To meet the need of exploding population economic and effective control of machines is necessary. Our project even is rotated to easily drill at any direction. So that job setting operation is not complicated as well as reduces the setting time for the operation. It also takes into consideration the most effective method of controlling the drilling machine by manually. Materials like wood, plastic and light metals can be drilled with this. The work piece is fixed on the work table, which is provided with a moving arrangement. The drilling machine is one of the most important machine tools in a workshop. In a drilling machine holes may be drilled quickly and at a low cost. The hole is generated by the rotating edge of a cutting tool known as the drill, which exerts large force on the work clamped on the table. As the machine tool exerts vertical pressure to original a hole it loosely called a “drill press”. Drilling is the operation of producing circular hole in the work-piece by using a rotating cutter called drill, the most common type of drill is the twist drill. The machine tool used for drilling is called drilling machine. The drilling operation can also be accomplished in a lathe, in which the drill is held in the tailstock and the work is held and rotated by a chuck. This angular drilling is performed for Different Angle Drilling in the working job. Indexing Plate and Up/down mechanism is available in this Angular Drilling Machine.

KEYWORDS: Bevel gear, Lead screw, Drill chuck with drift key, drill bit.

I. INTRODUCTION

Drilling machine is one of the most important machine tools in a workshop. It was designed to produce a cylindrical hole of required diameter and depth on metal work pieces. Though holes can be made by different machine tools in a shop, drilling machine is designed specifically to perform the operation of drilling and similar operations. Drilling can be done easily at a low cost in a shorter period of time in a drilling machine. Drilling can be called as the operation of producing a cylindrical hole of required diameter and depth by removing metal by the rotating edges of a drill. The cutting tool known as drill is fitted into the spindle of the drilling machine. A mark of indentation is made at the required location with a centre punch. The rotating drill is pressed at the location and is fed into the work. The hole can be made upto a required depth.

A. Drilling Machine Construction

The basic parts of a drilling machine are a base, column, drill head and spindle. The base made of cast iron may rest on a bench, pedestal or floor depending upon the design. Larger and heavy duty machines are grounded on the floor. The column is mounted vertically upon the base. It is accurately machined and the table can be moved up and down on it. The drill spindle, an electric motor and the mechanism meant for driving the spindle at different speeds are mounted on the top of the column. Power is transmitted from the electric motor to the spindle.

B. Drilling Machine Working Principle

The working operation of this angular drilling machine is initially started from the universal motor through A.C. Power source. In this, there is one power sources, received from the power supply. After that the indexing mechanism

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is controlled, to fix the desired angle. A lock nut is attached to the indexing plate to avoid and deviation of angle during drilling. According to the requirement of drilling it will tilt very precisely. The rotary motion of the indexing plate is given to the bevel gear. This rotary motion is given to the shaft and used to rotate the Drill head. The depth of cut will be adjusted by the screw in the drill head structure. The speed of motor is controlled using Regulator. After that motor is started the desire angle and desire speed is fixed then drilling process performed. With the help our project we can achieve the angular drill hole very precisely. Thus our project can perform very tiny angular hole and variations can be achieved.

II. MATERIALS AND METHODS

Our project even be rotate easily drill at any direction. So that job setting operation is not complicated as well as reduces the setting time for the operation. It also takes into consideration the most effective method of controlling the drilling machine by manually. Materials like wood, plastic and light metals can be drilled with this. The work piece is fixed on the work table, which is provided with a moving arrangement. As the machine tool exerts vertical pressure to original a hole it loosely called a “drill press”. This Angular Drilling is performed for Different Angle Drilling in the working job. Indexing Plate and Up/down mechanism is available in this angular Drilling Machine.



III. LITERATURE REVIEW

In order to model surface roughness, several methods had been used in previous research. A project to use multiple heads to create contour drills and angular holes was taken up by **A.S.Udgave**, (2008). Multiple-spindle drilling machines are used for mass production, a great time saver where many pieces of jobs having many holes are to be drilled. Multi-spindle head machines are used in mechanical industry in order to increase the productivity of machining systems. This machine has two spindles driven by a single motor and all the spindles are fed in to the work piece simultaneously. Feeding motions are obtained either by raising the work table or by lowering the drills head. As the name indicates multiple spindle drilling machines have two spindles driven by a single power head, and these two spindles holding the drill bits are fed into the work piece simultaneously. The spindles are so constructed that their centre distance can be adjusted in any position within the drill head depending on the job requirement. The positions of those parallel shafts holding the drills are adjusted depending upon the locations of the holes to be made on the job. **Hazim El-Mounayri, Zakir Dugla, and Haiyan Deng** (2009) developed a model in End Milling by using worm gear. From the studies, data collected from CNC cutting experiments using Design of Experiments approach. Then the data obtained were used for calibration and validation. The inputs to the model consist of Feed, Speed and Depth of cut. The model is validated through a comparison of the experimental values with their predicted counterparts. A good agreement is found from this research. The proved technique opens the door for a new, simple and efficient approach

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that could be applied to the calibration of other empirical models of machining. **Hun-Keun Chang** (2006) established a method to rotate the drill head using robotics. In their research, roughness of machined surface was assumed to be generated by the relative motion between tool and work piece and the geometric factors of a tool. A simple linear model was developed to predict drill head rotation. Surface roughness was predicted from the displacement signal of spindle motion. Prediction model had prediction accuracy of about 95%. Based on the literature review, the most parameters that widely considered when investigating the operation of a machine are feed rate, spindle speed and depth of cut. Most of the researches didn't consider the uncontrolled parameters, such as tool geometry, tool wear, chip loads, and chip formations, or the material properties of both tool and work piece.

3.3.1 BEVEL GEARS

Bevel gears are gears where the axes of the two shafts intersect and the tooth-bearing faces of the gears themselves are conically shaped. Bevel gears are most often mounted on shafts that are 90 degrees apart, but can be designed to work at other angles as well.

The pitch surface of bevel gears is a cone. The most familiar kinds of bevel gears have pitch angles of less than 90 degrees and therefore are cone-shaped. This type of bevel gear is called external because the gear teeth point outward. The pitch surfaces of meshed external bevel gears are coaxial with the gear shafts; the apexes of the two surfaces are at the point of intersection of the shaft axes.

Bevel gears that have pitch angles of greater than ninety degrees have teeth that point inward and are called internal bevel gears. Bevel gears that have pitch angles of exactly 90 degrees have teeth that point outward parallel with the axis and resemble the points on a crown. That's why this type of bevel gear is called a crown gear.



Fig: Bevel gear

3.3.2 LEADSCREW

Linear motion can be achieved by means other than through the use of lead screws. Chain and cable drives along with belt and pulley drives do not require pumps and support hardware as do hydraulic and pneumatic systems. They can carry very small to very heavy loads at great speeds when needed. However, these systems are not as accurate or as repeatable as lead screws, and they generally require a greater number of components, are more complicated to install, and require more maintenance during operation. In addition, recirculating or running chains, cables, or belts can be a safety hazard.

Lead screw drive systems are selected for linear motion over the other possible choices when the requirements are for:

- Accuracy in Positioning
- Load Capacity
- Repeatability

Lead screw assemblies usually consist of the screw and nut assembly supported in bearings and driven with a motor. This sub-assembly is attached to the load to be moved. Because of their compactness and simplicity, lead screw assemblies lend themselves to virtually any kind of drive mechanism. Since the drive method can be directly connected to the lead screw, the motion is much easier to control precisely.

If the environment is extreme or if there are special considerations as a result of the application, the choice of lead screw assembly can be severely limited. Examples of special environments might be a vacuum, very high or very low temperatures, extreme temperature variations, environments which require special lubricants or no lubricant at all, and environments that are particularly dirty.

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3.3.3 ADJUSTABLE DRILL UNIVERSAL MOTOR

The AC/DC universal motor is found in portable tools such as electric drills, saws, sanders, etc., and in home appliances such as vacuum cleaners, electric mixers, blenders, etc., where high speed, power and small size are an advantage. However, it is closer in concept to the DC motor than to the AC motor and, therefore, has some inherent disadvantages, which could be avoided in purely AC induction motors; chiefly, the need for commutation and brushes. The universal motor is basically a series DC motor which is specially designed to operate on AC as well as on DC. A standard DC series motor has very poor characteristics when operated on AC, mainly due to two reasons:

- The high reactance of both the armature and field windings limits AC current to a much lower value than DC current (for the same line voltage).
- If solid steel is used for the stator frame, AC flux will produce large eddy currents in the frame with consequent heating. To insure satisfactory operation of the universal motor from an AC power source, some modifications are necessary.

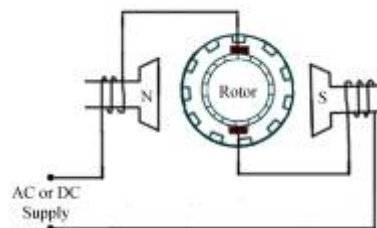


Figure 3.4 Universal Motor

3.3.4 SPEED REGULATOR

It is a device used to control the speed of rotation of motor. It consists of a series of coils to control the speed. The reactance of the series field and armature windings must be reduced as much as practicable. The reactance of the series field winding can be somewhat reduced by using fewer turns of heavier wire. However, it would not be practical to eliminate the reactance voltage drop due to the series field since that would also eliminate the magnetic field. The reactance voltage drop due to the armature winding can be practically eliminated by use of a compensating winding. The controlling winding is connected in series with the armature winding and arranged such that the ampere-turns of the compensating winding oppose and neutralize the ampere-turns of the armature.

Due to the inductive reactance of these windings the AC starting current will always be less than the DC starting current. Consequently, the starting torque on AC power will be lower than the starting torque for power supplied.

3.3.5 INDEXING MECHANISM

Two basic precision mechanisms were developed to meet the requirements for accurate spacing: the rotary or circular milling table and the dividing/indexing head.

These mechanisms are called indexing devices. The rotary head and dividing head are used to index (locate) one surface or angular dimension in an exact relationship with another. These mechanisms have accessories that permit them to serve also as work holding devices.

3.3.6 INDEXING PLATE

The rotary table permits a workpiece to be moved in a circular path. This accessory consists of a base and a rotary table. The base of a simple direct setting rotary table is graduated through 360° in increments of 1-minute. The rotary table is provided with a T-slotted face plate and possibly a chuck. Irregularly shaped work may be strapped to the table, held in a fixture or chuck.

A precision type of rotary table is geared and moved by a handwheel. The micrometer collar on the lead screw mechanism reads in degrees, minutes, and seconds. Some rotary tables are geared to the machine table and provide continuous motion.

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Drill bits are cutting tools used to create cylindrical holes. Bits are held in a tool called a drill, which rotates them and provides torque and axial force to create the hole. Specialized bits are also available for non-cylindrical-shaped holes.

The shank is the part of the drill bit grasped by the chuck of a drill. The cutting edges of the drill bit are at one end, and the shank is at the other. Drill bits come in standard sizes, described in the drill bit sizes article. A comprehensive drill bit and tap size chart lists metric and imperial sized drill bits alongside the required screw tap sizes.

The term drill may refer to either a drilling machine or a drill bit for use in a drilling machine. In this article, for clarity, drill bit or bit is used throughout to refer to a bit for use in a drilling machine, and drill refers always to a drilling machine.



Fig: Drill bit

3.3.8 DRILL CHUCK



Fig: Drill chuck

A drill chuck is a specialized three-jaw chuck used to hold drill bits or related tools. The image shows the traditional keyed style of drill chuck with its key. The arbor is shown separately to the right. These chucks require a key to provide the necessary torque to tighten and loosen the jaws. The rotary action of the key turns the outer body which acts on an internal screw; this in turn moves the threaded jaws in or out along a tapered surface. The taper allows the jaws to encompass various sizes of drill shanks. The end view shows the three small jaws that slide within the body. Some high precision chucks use ball thrust bearings to reduce friction in the closing mechanism and maximizing drilling torque. These chucks are sometimes referred to as “super chucks”.

IV. MACHINING AND DESIGN PARAMETERS

4.1.1. Cutting Speed (v)

It's the peripheral speed of the drill. The cutting speed depends upon the properties of the material being drilled, drill material, drill diameter, rate of speed, coolant used etc...

$$v = \pi * D * N \text{ where}$$

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D = diameter of the drill in mm

N = Speed of rotation in rpm

4.1.2. Feed Rate (f)

It's the movement of drill along the axis (mm/min).

4.1.3. Depth of Cut (d)

The distance from the machined surface to the drill axis.

$$d = D / 2 \quad \text{mm}$$

As the depth of hole increases, the chip ejection becomes more difficult and the fresh cutting fluid is not able to cutting zone. Hence for machining the lengthy hole special type of drill called 'gun drill' is used.

4.1.4. Material Removal Rate

It's the volume of material removed by the drill per unit time

$$\text{MRR} = (\pi D^2 / 4) * f * N \quad \text{mm}^3 / \text{min}$$

4.1.5. Machining Time (T)

It depends upon the length (l) of the hole to be drilled, to the Speed (N) and feed (f) of the drill.

$$t = L / f \quad \text{min}$$

4.2 Recommended Tool Speeds for High Speed Tooling

Higher quality tooling can often allow you to run faster RPM rates and/or more aggressive feed and thrust rates but typically require higher HP for the process as well.

A typical drill press often has an RPM limitation of between 2000-3600 RPM. If the speed specifies a higher RPM than your machine is capable of, it should not cause a problem to run at a lower RPM. For instance, many people drill 1/16" holes at less than 10,000 RPM with no problems.

The process of drilling holes in metal or similar materials without coolant is possible but not suggested. In most metals, the RPM rate can be decreased to 25% of what is calculated. In stainless steel, the RPM rate must be decreased significantly more as stainless steel does not dissipate heat easily and will almost immediately ruin the tip of your tool. It is often helpful to take a heavier cut in stainless than a lighter one to keep the tip of the tool in "cool" material rather than near the surface that was recently heated up by the last pass of the tool tip.

4.3 Kinematic System and Principle of Working

Kinematic system in any machine tool is comprised of chain(s) of several mechanisms to enable transform and transmit motion(s) from the power source(s) to the cutting tool and the workpiece for the desired machining action. The kinematic structure varies from machine tool to machine tool requiring different type and number of tool-work motions. Even for the same type of machine tool, say column drilling machine, the designer may take different kinematic structure depending upon productivity, process capability, durability, compactness, overall cost etc targeted.

1. Cutting motion:

The cutting motion in drilling machines is attained by rotating the drill at different speeds (rpm.). Like centre lathes, milling machines etc, drilling machines also need to have a reasonably large number of spindle speeds to cover the useful ranges of work material, tool material, drill diameter, machining and machine tool conditions. It is that the drill gets its rotary motion from the motor through the speed gear box (SGB) and a pair of bevel gears.

2. Feed motion

In drilling machines, generally both the cutting motion and feed motion are imparted to the drill. Like cutting velocity or speed, the feed (rate) also needs varying (within a range) depending upon the tool-work materials and other conditions and requirements.

The drill receives its feed motion from the output shaft through the feed gear box (FGB), and the clutch. The feed rate can be changed to any of the 6 rates by shifting the gears in the FGB. And the automatic feed direction can be reversed, when required, by operating the speed reversal mechanism, RM-s as shown. The slow rotation of the pinion causes the axial motion of the drill by moving the rack provided on the wheel.

3. Tool work

The taper shank drills are fitted into the taper hole of the spindle either directly or through taper socket(s). Small straight shank drills are fitted through a drill chuck having taper shank. The work piece is kept rigidly fixed on

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the bed (of the table). Small jobs are generally held in vice and large or odd shaped jobs are directly mounted on the bed by clamping tools using the T-slots made in the top and side surfaces of the bed.

V. WORKING PROCESS

- The working operation of this angular drilling machine is initially started from the universal motor through A.C. Power source.
- In this, there is one power sources, received from the power supply.
- After that the indexing mechanism is controlled , to fix the desired angle.
- A lock nut is attached to the indexing plate to avoid and deviation of angle during drilling.
- According to the requirement of drilling it will tilt very precisely.
- The rotary motion of the indexing plate is given to the bevel gear.
- This rotary motion is given to the shaft and used to rotate the Drill head.
- The depth of cut will be adjusted by the screw in the drill head structure.
- The speed of motor is controlled using Regulator.
- After that motor is started the desire angle and desire speed is fixed then drilling process performed.
- With the help our project we can achieve the angular drill hole very precisely.
- Thus our project can perform very tiny angular hole and variations can be achieved.



FIG: Simple model of angular drilling machine

VI. DESIGN AND SPECIFICATION

6.1 Design of Bevel Gear:

DESIGN CALCULATION OF BEVEL GEARS:

- Number of the teeth on the driver = 18
- Number of the teeth on the driven = 9
- Gear ratio = $Z_2/Z_1 = i$ $i = 9/18 = 0.5$
- $d_1 = m \times z_1$ $m = d_1/z_1$ $m = 51/18$
- $m = 2.833$ so, standard module = 3mm
- Dia. of driver gear, $d_1 = 51\text{mm}$
- dia. of driven gear, $d_2 = 31\text{mm}$
- pressure angle assume initially, = 20 degree
- pitch angle $\delta_2 = \tan^{-1}(0.5) = 26.56$ degree
- pitch angle $\delta_1 = 90 - \delta_2 = 90 - 26.56 = 63.43$ degree
- cone distance, $R = 0.5 \times 3 \times 18 + 9 = 40.5\text{mm}$
- Transverse module, $M_t = R / 0.5 \times (Z_1 + Z_2) = 40.5 / 0.5 \times (18 + 9) = 3\text{mm}$
- Addendum, $h_a = 3\text{mm}$
- Dedendum, $h_f = 1.2 \times m_t = 1.2 \times 3 = 3.6\text{mm}$
- Clearance, $c = 0.2 \times m_t = 0.2 \times 3 = 0.6$
- Addendum angle, $\theta_{a1} = \tan^{-1} \frac{m}{R} = \tan^{-1} \frac{3}{40.5} = 0.07\text{deg}$

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- Dedendum angle, $\theta_f = \tan \theta f_1 = \tan \theta f_2 = m_t \times (f_o + c) / R = 0.11 \text{ deg}$
- Height factor, $f_0 = 1$
- Tip angle $\delta a = \delta + \theta a = 63.43 + 0.074 = 63.5 \text{ degree}$

6.4 Specification of Universal Motor

- Type of motor : Sewing machine motor
- Speed of The motor : Max. Speed up to 6000 RPM
- Voltage : 220 V
- Supply : AC or DC Supply
- Current : 0.6 A
- Power : 120 W
- Frequency : 50-60 Hz
- Controller : Foot Control Pedal

6.4 Leadscrew Specification

- Pitch of thread = 0.6mm
- Diameter of the thread = 25mm
- Type of thread = SQUARE THREAD

6.5 Specification of Drill Chuck

- Size of the chuck : Max. upto 10mm
- Type of chuck : 3 Jaw Chuck
- Type of key : Drift Key

VII.CONCLUSION

- This project is an efficient operation and competitive cost. Since a number of operation and angular hole can be performed in a simple unit.
- It is efficient and economical. Considering its uses and cost of project, it becomes relatively cheap when compared to other units.

7.1 Advantages

- This system determines the accurate position .
- This system reduces the manufacturing lead time.
- This system eliminates the geometrical error of the drill hole.
- Highly accurate and more efficient.
- Compact and quick response

7.2 Application

- To put angular and straight holes with high precession on engine heads and blocks and cylindrical shell
- Used in general furniture making angle

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