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Design of Gears for Drilling Machine

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Abstract— The drilling machine is most essential machine required in almost all the industries. The drilling machines having different types as per operations to be carried out. The growth of manufacturing sector depends largely on its productivity & quality. Productivity depends upon many factors, one of the major factors being manufacturing efficiency with which the operation/activities are carried out in the organization. Productivity can be improved by reducing the total machining time, combining the operations etc. In furniture industries needs the multiple drilling bits to complete operations on one workpiece. They need the multi drilling machines to increase the productivity, accuracy and quality. The best way to improve the production rate (productivity) along with quality is by use of special purpose machine. The tool set is design to hold the 5-6 number of tools. To drive that tool set we need to design a gear box i.e. gear. In this paper mostly focused on the gear design.

Keywords—Drilling machine; multi-drilling; gear design.

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1 INTRODUCTION

The Drilling operations are carried out in most of the industry using different drilling machine as per requirement. 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/wooden 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 up to a required depth.

1.1 Drilling Machines

Drilling machine is one of the most important machine tools in a workshop. Drilling can be called as the operation of producing a cylindrical hole of required diameter and depth by removing metal/wooden 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 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.

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1.2 Components of Drilling Machine

Spindle:-
The spindle holds the drill or cutting tools and revolves in a fixed position in a sleeve.
Sleeve:-
The sleeve or quill assembly does not revolve but may slide in its bearing in a direction parallel to its axis. When the sleeve carrying the spindle with a cutting tool is lowered, the cutting tool is fed into the work and when it's moved upward, the cutting tool is withdrawn from the work. Feed pressure applied to the sleeve by hand or power causes the revolving drill to cut its way into the work a fraction of an mm per revolution.
Column:-
The column is cylindrical in shape and built rugged and solid. The column supports the head and the sleeve to quill assembly.
Head:-
The head of the drilling machine is composed of the sleeve, a spindle, an electric motor and feed mechanism. The head is bolted to the column.
Worktable:-
The worktable is supported on an arm mounted to the column. The worktable can be adjusted vertically to accommodate different heights of work or it can be swung completely out of the way. It may be tilted up to 90 degree in either direction, to allow long pieces to be end or angle drilled.
Base:-
The base of the drilling machine supports the entire

machine and when bolted to the floor, provides for vibration-free operation and best machining accuracy. The top of the base is similar to the worktable and may be equipped with t-slot for mounting work too large for the table.

G. Klene1 [1], Design a Multi-drilling machines to find the minimum number of supports and gears. And also find the optimized configuration of multi-spindle drilling gears and an automated system based on pattern identification. The automated configuration of multi-drilling gears include two steps: generalized pre-placement of drills and an iterative process. It observed that the automated design is very fast compared to the design of the human experts.

A. S. Udgave [2], Design and development of multi-spindle drilling head attachment to increase the performance and usefulness of existing drilling machine. Two spindles driven by a single power head to drill a two holes simultaneously they used an adjustable multi-spindle drilling head planetary gear train. They make a calculations required to design a shaft, pulley shaft, bush bearing, welded joint.

M. Narasimha [3], To drill a three T-slots in single cycle, they make an attachment of adjustable multi-spindle design. The components were designed and generated a 3-D CAD model of machine by using that design data. Design calculations includes design of clamping bolts, design of circular T-Bolts, spindle design and helical gear design.

Prof. Ms. A. A. Shingavi [4], By combining three spindle together it make a multi-spindle drilling machine. In the multi-spindle drilling attachment multiple spindle driven simultaneously by carry drill chucks. The chucks can receive twist drills, reamers, countersink drills or spot facing cutters to perform the desired operation. They design a multi-spindle drilling head, 6 holes of different diameter can be drill at a time. Also they give a adjustment to separate the three arbour shaft from main shaft, it helps us to drill a three work piece at a time as requirement.

Zulkifli Tahir [5], the three axis PCB drilling machine is designed to reduce the drilling cost. This drilling machine is used in small or medium scale industry.

By studying all above literature, it is found that for increasing the accuracy, efficiency and productivity we need to design a drilling machine with multi-drilling head gear box. So we needed to design a gear in the gear box

2 DESIGN CALCULATIONS

SPUR GEAR DESIGN:
Material Name :- Cast iron (Grade 25)

Ultimate tensile stress (σu) :- 250 Mpa
Surface compressive stress (σc):- 588 Mpa
Bending Stress (σb) :- 58.8 MPa
Young's Modulus (E) :- 110000 MPa

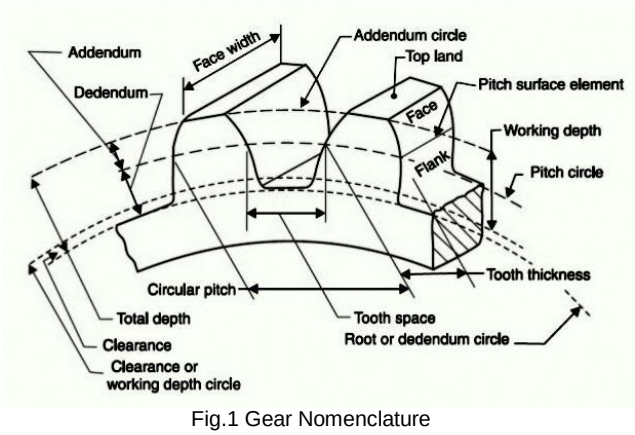

Fig.1 Gear Nomenclature

Motor Power:- 1 Hp = 745.699872 Watt No. of revolution (n) :- 1500 rpm
Gear Ratio (i) :- 1

The Value of ψ = 0.3 and ψm = 10 (intially) Mt = 4747.272828 Nmm

k * kd = 1.3 (Initially assume for Symmetric Scheme)
[Mt] = 6171.454676 Nmm

Based on surface compressive stress, the minimum center distance required for the gear drive as, (a)

$$a \geq (i+1)\sqrt[3]{\left(\frac{0.74}{[\sigma_c]}\right)^2 \frac{E[M_t]}{i\varphi}}$$

≥ 30.6068933 mm (for 20˚ pressure angle)

Module (m),

$$m \geq 1.26\sqrt[3]{\frac{[M_t]}{y[\sigma_b]\varphi_m Z}}$$

≥ 1.23663123 (for no. of teeth, Z = 26) Therefore, module (m)= 1.25 (form PSG)

No. of teeth's (z),

$$Z = \frac{2a}{m(i+1)}$$

= 24.48551464 ≈ 26
Corrected center distance (a) :- 32.5 mm

Gear Diameter (d) :- 32.5 mm

Face width (b) :- 9.75 mm

Pitch line velocity (v) :- 2.552544031 m/s

Load Correction factor (k) :- 1
Dynamic load factor (kd) :- 1
Corrected [Mt] = 4747.272828 Nmm

Corrected Surface compressive stress (σc) :-

$$\sigma_c = 0.74\left(\frac{i \pm 1}{a}\right)\sqrt{\frac{(i+1)}{ib}E[M_t]}$$

= 471.3130693 MPa

Corrected Bending Stress (σb) :-

$$\sigma_b = \frac{(i+1)[M_t]}{amby}$$

= 56.13688658 MPa

Height factor (fo) = 1 (for Standard gear tooth)

Radial clearance(c) = 0.25 (for full depth teeth)

Addendum = 1.25 mm

Deddendum = 1.5625 mm
Tip Diameter = 35 mm
Root Diameter = 29.375 mm
Tooth height = 2.8125 mm
Working Depth = 2.5 mm

Clearance = 0.3125 mm
Circular Pitch = 3.926990817 mm

3 RESULT

The above gear design is safe because the Surface compressive stress and Bending stress value after calculation is less than that of material selected for the gear.

4 CONCLUSION

The main objective of this paper was to discuss about how to design a spur gear. Which is required to drive a multiple drilling head of drilling machine. It helps to drive the all drilling head by connecting a single motor.

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