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DESIGN AND FABRICATION OF MULTIPLE SPINDLE DRILLING ATTACHMENT

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Abstract: Manufacturing productivity is critical to the success of the Indian manufacturing industry. Drilling machines are usually used for drilling holes, but they may also do additional activities like as tapping, spot facing, reaming, countersinking, and counter boring, to mention a few. While the multiple spindle drilling attachment conducts fundamental drilling operations, there are some particular duties that are more correctly and readily accomplished. This connection is primarily based on a planetary gear system configuration. Drilling Attachment with Multiple Spindles The primary role is to do many drilling operations at the same time. It offers several advantages, including increased output, decreased operating time, lower labor costs, increased productivity, and many more. Reduce the number of operations cycles as well. If general-purpose machines are used for production, this is not feasible. The design and manufacturing process of the multiple spindle drilling attachment will improve the drilling machine's performance and productivity. In order to optimize the component's cycle time, this article focuses on improving the design and manufacturing process of the multiple spindle drilling attachment.

Keywords: Planetary gear system, Manufacturing, Multi-spindle Drilling Attachment, Gear.

I. INTRODUCTION

The aforementioned issue, where a traditional drilling machine is utilized to execute three operations at once, maybe perfectly solved with the Multi- spindle drilling attachment. This attachment allows for the simultaneous completion of several operations, such as drilling, reaming, countersinking, and spot-facing. The MT-2 taper arbor fits directly into the drilling machine sleeve, making it simple to place the multi-spindle drilling attachment on the drilling machine. If additional stability is needed, a support sleeve may be fastened to the top casing plate. Three spindles that hold three drill chucks are operated concurrently in the multi-spindle drilling attachment. To accomplish the required operation, the drill chucks can be fitted with twist drills, reamers, countersink drills, or spot-facing cutters.

A drilling machine, also known as a drill press, is a machine tool used for drilling holes in various materials, such as metal, wood, plastic, and more. Here's how a drilling machine typically works:
Setup: The first step is to set up the drilling machine. This involves securing the workpiece to the drill press table or workbench, and adjusting the height and alignment of the drill bit to ensure it lines up with the desired drilling location on the workpiece. Selecting the Drill Bit: Choose the appropriate drill bit for the material you are drilling. Different materials require different types of drill bits, such as twist drills for metal, brad point bits for wood, or spade bits for large holes. Adjusting Speed and Depth: Most drill presses allow you to adjust the speed of the drill bit rotation and the depth to control the drilling process. Slower speeds are typically used for harder materials, while faster speeds are suitable for softer materials.

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Power On: Turn on the drilling machine and adjust the speed to the desired setting. Some drill presses have variable speed controls, while others have a selection of preset speeds.

Drilling: Position the workpiece under the drill bit and bring the drill bit down by lowering the quill (the spindle that holds the drill bit) using the feed handle or a lever. Apply a consistent, even pressure to the workpiece to ensure a clean and accurate hole. The drill bit will rotate and cut into the material.

Withdraw the Drill Bit: Once the hole is drilled to the desired depth, release the pressure on the feed handle or lever, and then raise the quill to withdraw the drill bit from the hole. Be sure to turn off the drill press when not in use. Workpiece Removal: After completing the drilling operation, remove the workpiece from the machine. It's essential to follow safety precautions when using a drilling machine, such as wearing safety glasses, securing the workpiece properly, and using appropriate cutting fluids or lubricants when drilling metal to reduce friction and heat. Keep in mind that there are various types of drilling machines, including benchtop drill presses, floor-standing drill presses, and portable hand-held drills, each with its own features and capabilities. The specific operation and controls may vary depending on the type and model of the drilling machine you are using. Innovation in drilling machines has led to the development of multifunctional machines that can perform various tasks in addition to drilling holes. These multi-tool drilling machines are designed to increase efficiency, save space, and improve versatility. Here are some innovations in multitool functions for drilling machines:

Combination Drilling and Milling Machines: Some machines can switch between drilling and milling operations. This versatility is valuable for applications where precision holes and complex shapes need to be created in the same workpiece. Tapping and Reaming: Multi-tool drilling machines can also perform tapping and reaming operations. Tapping is the process of creating threads in a hole, while reaming is used to achieve a precise diameter and smooth finish in drilled holes. Rotary Tool Attachments: Some machines come with attachments that allow them to function as rotary tools. This enables tasks like grinding, polishing, and sanding in addition to drilling.

II. LITERATURE SURVEY

Dae-ji Kim, Jaewon Kim, Booyeong lee, Min-Seok Shin, Joo-Young Oh, Jung- Woo Cho, and Changheon song **Prediction Model of Drilling Performance forPercussive Rock Drilling Tool** this study focused on predicting the drilling performance of a death hammer. a numerical analysis model of the death hammerwas established and validated through comparison with the results of an in situ drilling test. -the results of this work are summarized as follows: simulations considering the effect of rock strength were used to quantify the energy efficiencyaccording to the rock strength, impact energy required for crushing, and performance of the hammer. the developed model was applied to an actual deathdrilling system. -e model predicted a drilling speed of 5.4 mm/s, and themeasuredspeed was 5.7 mm/s. similar results validated the proposed model. themodel allows the performance of the drill bit and death hammer (i.e., the key components of the drilling system) to be predicted by considering the sensitivityof the major design factors and the effect of the rock mass. the validity of the proposed prediction model for the drilling performance was experimentally verified. the results of this study suggest that the performance of drilling equipment can be predicted by considering the sensitivity of major design factorsfor the drilling tool and the effect of the rock type.

F. Forestier, V. Gagnol, P. Ray, and H. Paris **Modeling Of Self-Vibratory Drilling Head-Spindle System For Predictions Of Bearings Lifespan** this paper, a comprehensive approach to developing a hybrid model of the dynamic behaviour of the spindle self-vibratory drilling head—tool system has been proposed. this approach has resulted in a numerical model enriched with physicaldata. the various components of the system are modeled using a specific beam element, taking into account the gyroscopic effects, centrifugal forces, and sheardeformation. the receptance coupling method is used to identify the dynamic behaviour of the interface. the complete system is vibration then obtained by assembling the beam model of each component using spring-damper elements.

Prof.M.B. Bankar ,Prof. P.B. Kadam , Prof. M.R. Todkar **Improvement In Design & Manufacturing Process Of Multiple Spindle Drilling Attachment** drilling is nothing but the use of a rotating multi-point drill to cut a round hole

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into a workpiece. in a lot of manufacturing processes, one of the most indispensable machining tools is the multiple spindle drilling machine. thedrilling machine is commonly called a drill press and is responsible for drilling various sizes of holes in any surface area and to precise depths. aside from the fact the drilling machine is used primarily in drilling holes, there are a few otherfunctions that the multiple spindle drilling machine is capable of performing. these functions include tapping, spot facing, reaming, countersinking, and counterboring to name a few. there are four major categories of drilling machineswhich include the upright sensitive drilling machine, upright drilling machine, radial drilling machine, and special purpose drilling machine. although these multiple spindle drilling attachments perform basic drilling operations, there aresome specific functions that are performed more accurately and conveniently byeach of these types.

J. Panju, M. Meshreki, M. H. Attia **Design Of A Retrofittable Spindle Attachment For High Frequency Vibration Assisted Drilling** A retrofittable hf-vad spindle attachment for hsk 100a tool holder comprising a piezoelectric actuator system was designed and fabricated. a controlled amplified sinusoidal signal was fed into the actuator enclosed in the rotating toolholder through the slip ring. as a result, an hf-vad system was developed in which simultaneous rotatory and vibratory motion on the drill bit are superimposed. the system has acapability of providing high frequency (up to 2,500 hz) and low amplitude (up to5 µm) vibrational motion to the tool excluding resonance condition. at the resonance frequency of 900 hz, the amplitude goes up to 100 µm. this high frequency vibrational motion is superimposed to the high speed rotational motion(up to 10,000 rpm) of the tool. experiments on the system revealed a shift in amplitude response of the system under no load and spring loaded conditions. the frequency, at which maximum amplitude response is obtained, shifts from 800 hz (in no load condition) to 1,500 hz (in spring loaded condition). the hf-vadexperiments conducted on al60601 using this attachment showed remarkable improvement in cutting forces. finer chips with break-off serrations were formedduring hf-vad as opposed to difficult-to-remove thick spiral chips in conventionaldrilling test.

Shinde Nikhil , Vishwakarma Prem , Sanjay Kumar , Godse Rahul, P.A. Patil **Design & Development Of Twin Drill Head Machine And Drilling Depth Control** The twin-spindle drilling attachment is mounted on the drilling machine spindle sleeve, for extra stability an support sleeve may be mounted. the cuttingtools as per the job requirements are mounted in the respective three drill chucksof the drilling attachment.

M. Madhavi* , B. Karthik Anand **Optimization And Analysis Of Multi Tool Arbor** After completing the major project on `milt' tool arbor" we am much happy and would like to thank our professor. guides and the lectures of the concerned department who have guided us. while making project we have been able to learn a lot and understand the various aspects of - multi tool arbor" we can use our knowledge, which we get during our study.

III. METHODOLOGY

3.1 Methodology Chart

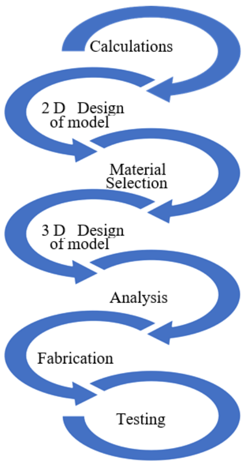

Fig.1 Methodology Chart

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3.2 Assembly

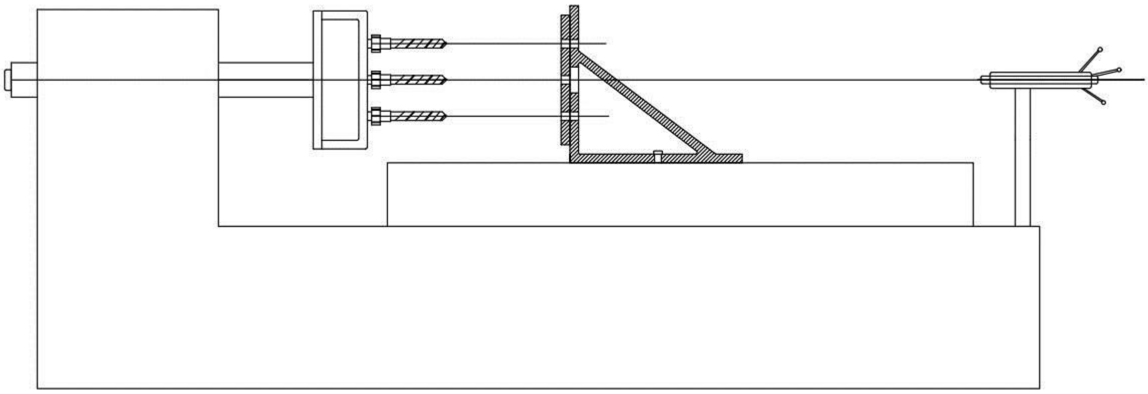

Fig 2- Assembly

3.3 2D & 3D Design

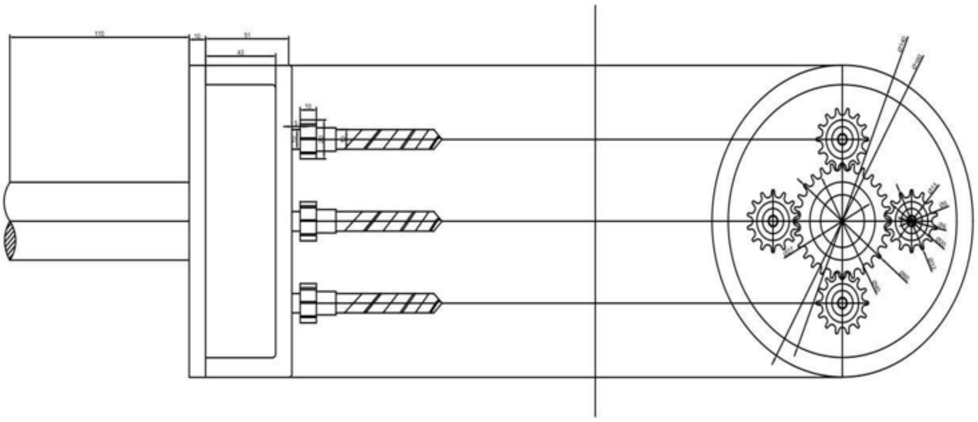

Fig. 2D Design

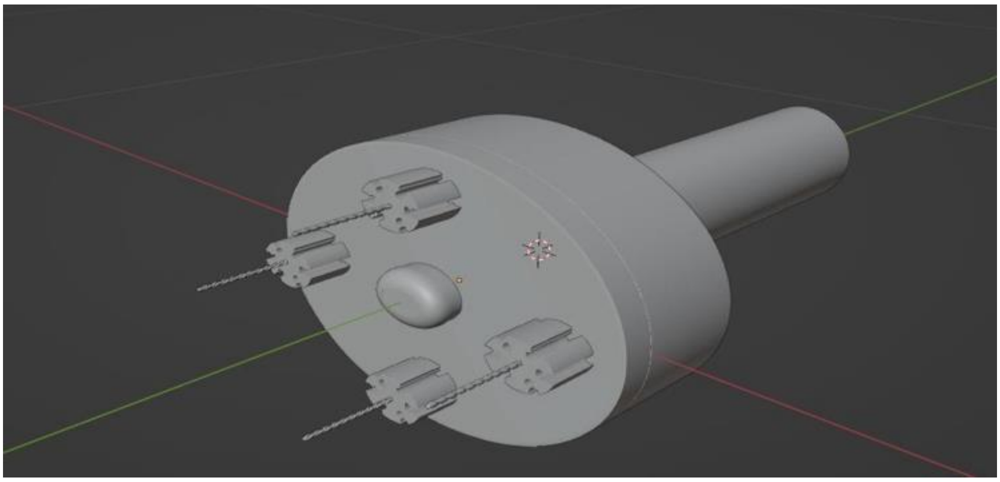

Fig. 3D Design

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IV. SPECIFICATIONS & CALCULATIONS

4.1 Specifications of Lathe Machine:

Light Duty Lathe Machine

- Motor RPM: 1440 RPM
- Power : 1 HP
- Power transmission : 0.75 KW

Spindle RPM-VARIABLE 230-830 RPM

1. To calculate Drill RPM:We have,

For pinion gear , D1: 32mm   No of teeth: 14

For sun gear , D2 : 60mm   No of teeth : 28   Speed = 830 RPM.

WE KNOW,

$$\text{DRIVEN GEAR RPM} = \frac{\text{DRIVER GEAR RPM X DRIVER GEAR TEETH}}{\text{DRIVEN GEAR TEETH}}$$

…(Spur gear RPM Transmission Formula.)

$$= \frac{830 \text{ X } 28}{14}$$

$$= 1660 \text{ RPM.}$$

SPUR GEAR CALCULATION

Design power = 1000 W
Speed of gear,
Z1=44
Z2=22
N1=900 rpm
N2=1800 rpm Gear ratio, i = 1:2
Pressure angle, $\phi = 20^\circ$

Tooth Profile = 20^0 Full Depth
Material for gear, AISI 1010 Steel havingBending Strength σb= 140 MPa
Design on the basis of bending strength:
Modified Lewis form factor,
Y=0.330
Diameter of gear, D1 =m*Z = 44m, mm
Diameter of gear, D2 =m*Z = 22m, mm Solving for D1

Tangential tooth load on gear, $Ft = \frac{Pd}{Vp}$

Pitch line velocity $Vp = \frac{\pi DN}{60000} = \frac{\pi * 44 * 900}{60000}$ m/s

Bending strength of gear, $Fb = \sigma b.Cv.b.Y.m$

Assuming velocity factor, $Cv = \frac{3}{3+vp}$

Face width, b=8.5 m <b < 12.5m
Taking b=10m
Using relation, Ft=Fb

$$\frac{Pd}{Vp} = \sigma b.Cv.b.Y.m$$

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After solving, we get
m = 1.2 mm
Standard module, m = 1.75mm
Diameter of gear, D1 = 76 mm
Pitch line velocity, Vp = 2.07m/s
Tooth load, Ft = 483.09 N
Face width, b = 15mm
Bending strength, Fb = 615.08 N
As Fb> Ft (Design safe)

Solving for D2
Tangential tooth load on gear, Ft = $\frac{Pd}{Vp}$
Pitch line velocity Vp = $\frac{\pi DN}{60000} = \frac{\pi*22*1800}{60000}$ m/s = 2.07 m/s
Bending strength of gear, Fb=$\sigma b. Cv. b. Y. m$
Assuming velocity factor, Cv = $\frac{3}{3+vp}$
Face width, b=8.5 m <b < 12.5m
taking b=10m
Using relation, Ft=Fb

$$\frac{Pd}{Vp} = \sigma b. Cv. b. Y. m$$

V. CONCLUSION

In conclusion, the multiple spindle drilling attachment represents a significant advancement in drilling technology. Its ability to enhance productivity, precision, and cost-effectiveness makes it a valuable addition to any manufacturing setup. Future work may focus on further refining the design to accommodate more complex drilling patterns and integrating automation features to further streamline the drilling process.

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REFERENCES

[1]. R.J.M. Vullers, R.V. Schaijk, I. Doms, C.V. Hoof, and R. Mertens "Micropower energy harvesting" Solid state electron, vol. 53,no 7,pp .684-693, 2009.

[2]. P.D. Mitcheson, E.M Yeatman, G.K. Rao, A.S Holmes and T.C. Green "Human and machine motion for wireless electronic devices" Proc. IEEE vol. 96, no. 9, pp.1457-1486,sep.2008

[3]. M. Ferrari V. Ferrari, D. Marioli and A. Taroni "Modeling, fabrication and performance measurements of a piezo electric energy convertor for power harvesting in autonomous micro system", IEEE Trans. Instrum Meas vol.55,no.6'pp.2096- 2101,Dec 2006.

[4]. N. U. Kakade, Piyush Bhake, Sumit Dandekar, Rohan Kolte, Sumit Selokar, "Fabrication of Combine Drilling and Tapping Machine", International Research Journal of Engineering and Technology (IRJET), Volume 04, Issue 03, 2017,

[5]. L. M. Aage, Kanchan, Badgujar, Rutik Hylinge, Pratik Khodade, "Design & Fabrication of 6- Way Drilling Machine", International Conference on Science, Technology and Management, Guru Gobind Singh Polytechnic, Nashik, Feb 2017

[6]. Mr. K. I. Nargatti, Mr. S. V. Patiland, Mr. G. N. Rakate, "Design And Fabrication of Multi- spindle Drilling Head with Varying Centre Distance", International Journal of Trend in Research and Development, Volume 3

[7]. Prof. Ms. A. A. Shingavi, Dr. A. D. Dongare andProf. S. N. Nimbalkar, "Design of Multiple Spindle Drilling Machine", International journal of research in advent technology, International conference on advent trends in engineering, science and technology (ICATEST 2015), Special Issue 1, March 2015,

[8]. Tushar B. Malode, Prof. R. R. Gandhe, "Design and Fabrication of Multi-Spindle Machine", IJIRST – International Journal for Innovative Research in Science & Technology, Volume 3, Issue 02, July 2016, Pages 290 – 295.

[9]. Yaman Patle, Nikalas Bhandakkar, Prashant Wangarwar, Pranay Thakre, Sagar Awachat, Ms. Manisha Fande, "Design and Fabrication Multi Spindle Drilling Machine with Different PitchHole", International Research Journal of Engineering and Technology (IRJET), Volu me 04, Issue 3,March 2017

[10]. Santosh Athashere, Kapil Pund, Amol Mahale, Swapnil Nirmal, Prof. H. B. Jagtap, Prof. D. P. Sonawane, "A Review on Development of SPM for Drilling an Angular Hole", International Journal of Emerging Technology and Advanced Engineering, Volume 7, Issue 2, February 2017