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Development of a Cleaning System for the Broaching Machine

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Abstract: ***The work deals with the development and implementation of an efficient cleaning system for the broaching machine. Broaching is a machining process that generates a significant amount of metal chips, debris, and coolant residues, which, if not properly managed, can affect the machine's performance, tool life, and product quality.***
Currently used cleaning methods are time-consuming and require frequent manual intervention, leading to production delays and increased cost.
This work is to design and integrate an automated cleaning system that effectively removes chips and contaminants after broaching operation without interrupting the production cycle.
Improvement of existing processes or implementation of the new process leads to enhancement in efficiency of operation, reduction in manufacturing lead time, and decrease in maintenance cost.

I. INTRODUCTION

Broaching is a machining process that involves removing material using a toothed tool called a Broach. Broaching is used to machine internal and external surfaces, such as splines, keyways, and holes with required precision, finish, and speed. This operation produces complex shapes that would be difficult with other machining processes like Milling, Turning, and Drilling.

A. Importance of Cleaning in Broaching

1) Tool Life: Cleansing the surface prevents the chipping and decreases the friction which improves the lifespan of the cutting tools.
2) Quality of Workpiece: Helps to achieve a better-quality workpiece as the tables are made sppon free from chips, contaminants, and oil residues.
3) Machine Longevity: Cleaning also prevents chips from accumulating and causing issues to the machine components, in case they build up.
4) Safety: Reduces the accumulation of toxic materials or components and the occurrence of fire or a technical accident.

B. Aim

The main objective of the project is to come up with a proper cleaning system as a part of the broaching machines used at Kinetic Gears. This system ensures the machines are clean all the time hence increasing efficiency in the manufacturing process by cutting time used in production, and increasing the quality of production by minimizing components that may have been produced wrongly because of hitches caused by chips, oil, and debris when broaching.

C. Objectives

1) Improve Machine Efficiency

Design a way through which there is constant clearing of chips, metal shavings and debris from the broaching machine tool.
The following are the benefits of this innovation: eliminate machine downtimes that result from manual cleaning, and increase productivity.

2) Ensure Safety and Ergonomics

Automate or semi automate the cleaning process to minimize the need for workers to clean manually so as to minimize cases of injuries due to working in awkward postures.
Prevent the workers come into contact with dangerous scenarios such as metal chips, sharp corners, and oil spills.

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II. LITERATURE REVIEW

"Design and Development of Broaching Machine for Splines: A Case Study" (Journal of University of Shanghai for Science and Technology, ISSN: 1007-6735, Authors: Vrushabh A. Madnaik, V. R. Naik)
This paper focuses on designing a broaching machine for splines that can be used with all its components.
"Design and Development of Broaching Fixture for Machine Pulley" (International Journal for Research in Applied Science & Engineering Technology (IJRASET), ISSN: 2321-9653, Authors: Mr. Shekhar Chavan, Mr. Rutwik Chitnis, Mr. Rahul Deshpande, Mr. Atharva Kulkarni, Prof. Sukhadip Chougule) focusing on development of broaching fixture for broaching machine.

III. METHODOLOGY

Methods used to develop cleaning system:

1) Study of Broaching operation and the movement of broach.
2) Calculations for the holes, pressure required.
3) Taking the require measurements to design the prototype.
4) CAD drawing
5) Testing the prototype on machine.
6) If it works go for actual design and implementation.

IV. DESIGN OF THE PROTOTYPES

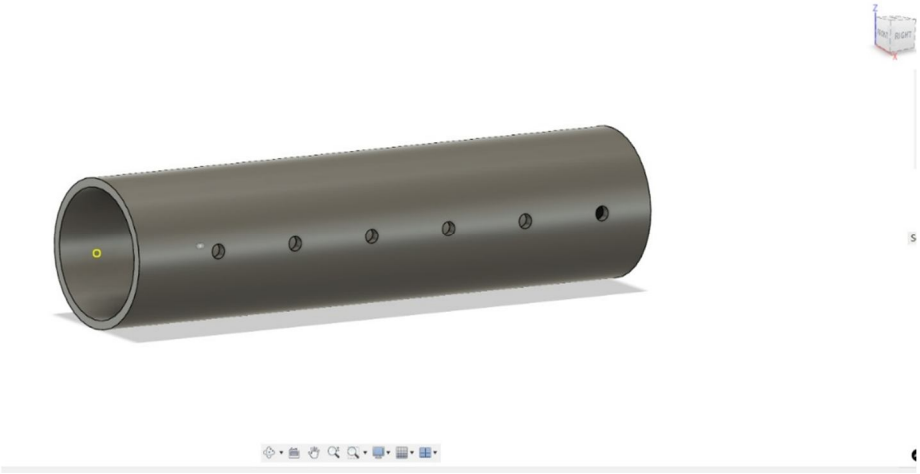

Fig. Prototype 1

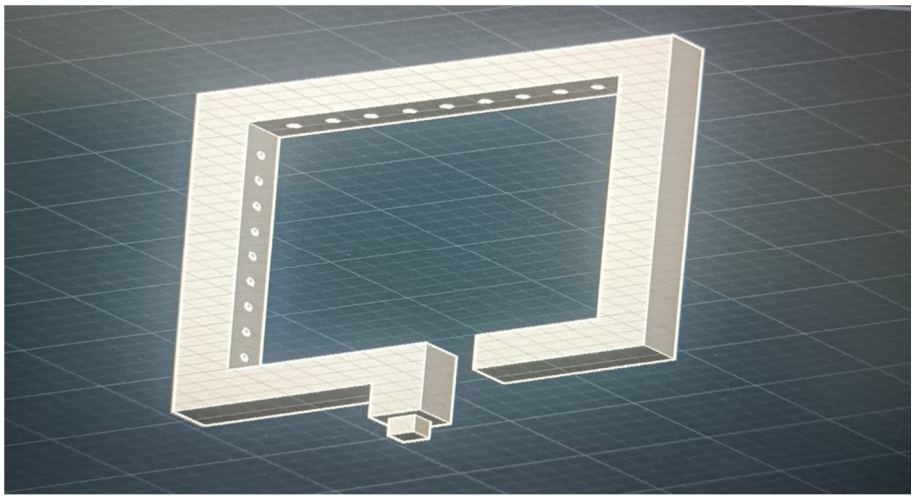

Fig. Prototype 2

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V. CALCULATIONS

Taking 1 HP pump
Maximum head of 1 HP pump (H) = taking 20.6
Acc. Due to gravity (g) = Taking 9.8

1. Diameter of a pipe (D) = 25 mm
2. Diameter of a hole (d) = 1 mm
3. Pressure = 1.5 Bar
4. Area of 1 hole (A_h) = pi*(Dia. Of hole)^2/4
   =7*10^{-7} m^2
5. Flow through pipe = (pi*D^2*n*H)/4*g
   = 1.48 m^3/h
6. Flow through 1 hole = C_d*A_h*(2p/density)$^{1/2}$
   = 0.3 m^3/h
7. Total flow through pipe = no. of holes*flow through 1 hole
   N = 1.48/0.3
   N = 5 holes

Now, for a 2 mm hole
(Taking the same specifications)

1. Diameter of a pipe (D) = 25 mm
2. Diameter of a hole (d) = 2 mm
3. Pressure = 1.5 Bar
4. Area of 1 hole (A_h) = pi*(Dia. Of hole)^2/4
   =3*10^{-6} m^2
5. Flow through pipe = (pi*D^2*n*H)/4*g
   = 1.48 m^3/h
6. Flow through 1 hole = C_d*A_h*(2p/density)$^{1/2}$
   = 0.13 m^3/h
7. Total flow through pipe = no. of holes*flow through 1 hole
   N = 1.48/0.13
   N = 11.3
   N = 12 holes (Approx.)

VI. CONCLUSION

During this project, we tried to enhance the cleaning operation used in the vertical broaching machine in Kinetic Gears with the help of an Automated cleaning tool. At the end of this project, the productivity is improved and the production time is reduced as compared to previously used manual cleaning. The newly developed cleaning system has provided several key benefits. As an extension of the studies, we can also add various Sensors to detect the metal chips, and debris for the further cleaning of the broaching tool. After implementing the designed frame, it cleans the broach tool with high-pressure coolant passing through the holes provided on it. The new cleaning system cleans the broach effectively as compared to the previous one. Manual coolant supply will be reduced because the frame supplies coolant continuously. The main focus of the study is to clean broach tool effectively in less time which can leads to improve productivity and reduces the rejections of the parts after completion of the operation.

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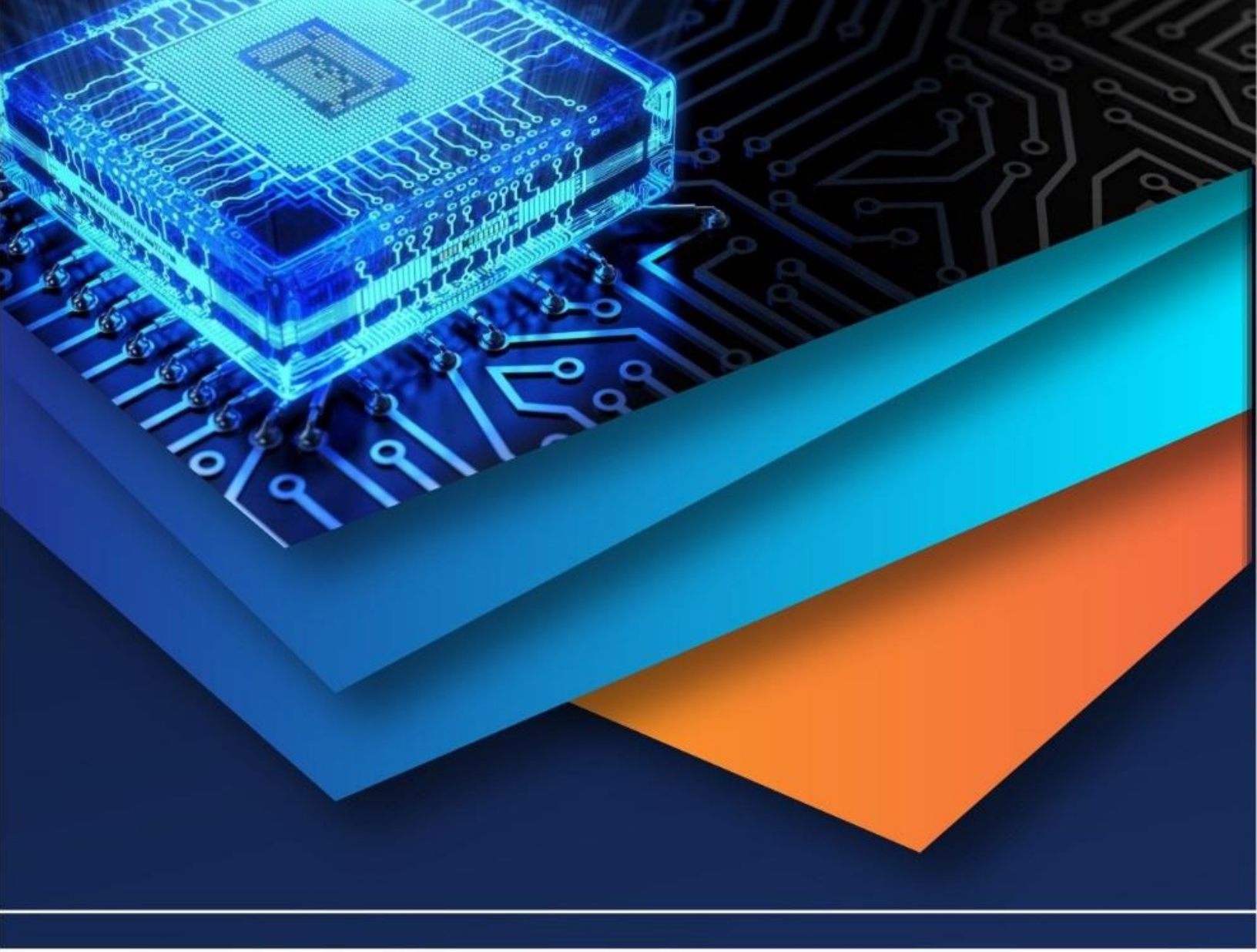

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