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Design and Fabrication of Hydraulic Broaching Machine for Internal Keyway.

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Abstract : The broaching machine is intended for creating keyways and can produce parts up to twenty-five times more quickly than using a conventional machining technique. In this project, we designed, fabricated a broaching machine, and conducted some experiments on aluminium gears to get the results that we wanted.

IndexTerms - Hydraulic broaching, Hydraulic Power pack, Broach tool, Keyways.

INTRODUCTION

A toothed tool called a broach is used in the machining process of broaching to remove material. Linear and rotational broaching are the two basic varieties. The cut is made by running the broach across the surface of the workpiece in a straight line, which is the more typical method of broaching. A broaching machine uses linear broaches. A unique, quick, wonderful, and exact method of creating internal and exterior polygon forms on the end of a workpiece is rotary broaching, also known as wobbling broaching. Any CNC, milling, screw, or other turning machine can use the rotary broach tool holder.

In comparison with saws, broaches have teeth that rise in height as the instrument is extended. The broach also has three unique sections: a roughing section, a semi-finishing section, and a finishing section.

A. About Broaching

A broaching machine, which is commonly known as broaching, uses linear broaches. In rotary broaching, the workpiece is rotated while a broaching tool is forced into it to create an axisymmetric shape. In a lathe or screw machine, a rotating broach is utilized. Both methods are particularly effective because the cut is made in a single broach pass. Broaching is utilized when precision machining is required, particularly for typical shapes. Examples of frequently machined surfaces include circular and noncircular holes, splines, keyways, and flat surfaces. Small to medium-sized castings, forgings, screw machine parts, and stampings are examples of typical workpieces. Broaching is typically favoured over other procedures when utilized for high-volume manufacturing runs, even though it can be expensive.

B. About Broaching Machine

The operation of a broaching machine is straightforward because all that is required from the operator is to move the broach in a straight line at a set speed. While a few specialized machines are mechanically driven, most are hydraulic. Whether the machines move horizontally or vertically helps to distinguish them from one another. The needed stroke is the main factor that determines which machine to use. Rarely are vertical broaching machines' strokes longer than 60 in. (1.5 m). Push, pull-down, pull-up, and surface broaching are all possible designs for vertical broaching machines. Push broaching machines typically have a capacity of 5 to 50 tones; they resemble an Arbor press with a guided ram. The most popular kind of broaching machine is the two-ram pull-down machine. This style of machine has rams under the table. The ram of a pull-up machine is located above the table; there are typically multiple rams. On a vertical machine, surface broaching is primarily performed.

LITERATURE REVIEW

A. Paper 1: This paper addresses that to improve product process quality, reduce scrap and rework rates, lengthen product life-spans, and decreasing product maintenance rates, thereby cutting down maintenance costs and reducing the social losses caused by environmental pollution. [1]

B. Paper 2: To Analyze and Determine the optimized Natural Frequency and Damping Ratio of Broaching machine and to find a suitable Broaching rate for avoiding resonance due to natural frequency. [2]

C. Paper 3: In this study, finite element analysis was conducted to examine the structural characteristics of broaching machine design. [3]

D. Paper 4: This review paper gives details of some of the design techniques which can be used for automatic hydraulic machines. [4]

E. Paper 5: This paper discusses the development of such a broaching machine which is specially developed for one of the market leaders in transmission component design and manufacturing. This paper mainly focuses on the basic modelling of machines. [5]

F. Paper 6: This paper has aimed to determine the Design and Develop a squared hole Broaching Machine for making the required shape of holes. [6]

G. Paper 7: This Paper investigates the effects of Broaching operation on the integrity of machined surfaces. [7]

METHODOLOGY

A. Selection of Motor

Yield stress $\sigma y = 276$ N/mm^2

Tau $\tau = 138$ N/mm^2

Now, $\tau = \frac{Force}{Area}$

Area = 180 mm^2

So, $\tau = \frac{Force}{180}$

$138 = \frac{Force}{180}$

$\therefore$ Force = 24840 N

$$\text{Pressure} = \frac{Force}{Area\ of\ piston}$$

$$= \frac{24840}{\frac{\pi}{4}\cdot 80^2}$$

$= 4.941$ N/mm^2

$= 4.941 \times 10^6$ N/m^2

$$\text{Power} = \frac{pressure \cdot Q}{\eta}$$

$$\text{Where, } Q = \frac{V}{Time}$$

$$= \frac{\frac{\pi}{4}\cdot 80^2 \cdot 500}{22} \cdot (10^{-3})^3$$

$= 1.1423 \times 10^{-4}$ m^3/sec

$$\therefore \text{ Power} = \frac{4.941 \cdot 10^6 \cdot 1.1423 \cdot 10^{-4}}{0.8}$$

$= 705.513$ W

$\cong$ 800 W

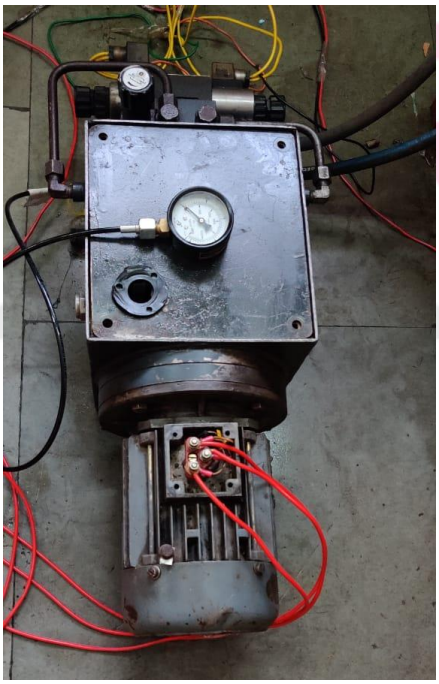

Figure 1 Hydraulic Powerpack

B. Structure

The whole structure or the frame of the broaching machine was made of plates and C channels made up of steel and cast iron. The structure was built in a college workshop and was completed by us students. The structure was interconnected with the hydraulic power pack and piston with the help of nuts and bolts. The hydraulic power pack was interconnected with the piston through hose pipes.

Figure 2 Structure of our project

C. Working of Machine

Working on the hydraulic broaching machine is quite easy. There is a main power switch that gives power to our motor or hydraulic power pack which is a three-phase AC connection, and a single-phase AC connection is given to the solenoid which is going to direct the motion of the piston. The broaching tool will be kept on the tip of the piston cylinder and the gear in which we want the keyway will be kept on the holder which will get help from Bush to stay in one position without moving so that the job does not move.

When the machine is turned on the tool will start to cut the gear and when the first cut is completed the tool falls at the bottom and is collected safely. A slip gauge is inserted at the place of cut, and the operation is performed once again.
We can do the same process by adding more slip gauges to get more depth and hence we will get the required length of the keyway. We can also change the bush size to insert different sizes of gear as per requirement. In total, we created three bushes of different sizes 25mm (about 0.98 in), 30mm (about 1.18 in) and 35mm (about 1.38 in) (all are diameters of the bush).

To avoid letting the hydraulic power pack run dry and increasing the risk of the motor burning, we must also check the oil level in the power pack before starting the motor. Hydraulic oil of the ISO 68 grade is used in the motor.

Continue applying cooling oil while cutting is being done to reduce heat and achieve clean cuts. There is an incredibly significant possibility that the broaching tool will break if we do not apply the oil.

Figure 3 Broach Tool 6mm

Figure 4 Gauges

D. Table

Total run time (forward and reverse stroke of piston) sec	48
Time taken (to cut the material) sec.	9
Depth of cut in each pass mm.	1.5
Material	Aluminum
Thickness of material mm	12
Diameter of gear mm	62
Pressure at the inlet of piston kg/cm^2	10
Pressure at the outlet of piston kg/cm^2	20

E. Result

After the fabrication of the broaching machine, we decided to cut a keyway of 6mm (about 0.24 in) with each pass of 1.5mm (about 0.06 in). It took us four passes to cut a keyway of 6mm. Similarly, we decided to cut a keyway on another gear of 4.5mm (about 0.18 in). It took three passes to cut the keyway. Initially, we performed a test run where we cut 1.5mm (about 0.06 in) of material in a single pass.

Figure 5 Square hole made during Operation.

F. Conclusion

We aimed to determine the design and fabrication of a Hydraulic broaching machine for internal keyways for making the required size of keyways by changing the bush and adding gauges that can be used by small and medium-scale industries at affordable cost.

G. Future scope

1) Automation can be done for broach tool holding and collecting it after the completion of each run. This must be modified because a human error could cause the tool to break.

2) Different size of shape of Broach tool can be used to get different outputs. For example, a square-shaped broach tool can be used to make square holes in a job.

3) Reinforcement can be done on the frame of the project so that the machine can be used for high-defined materials while using high defined broach tool.

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