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Design and Fabrication of Multi-purpose Metal Cutting Machine

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A B S T R A C T

Nowadays most of the conventional machineries are replaced by latest rapid machines with modernized technology which offers user friendly production environment in industry. It is not advisable to erect individual machine for each operation in the shop floor. Instead of that a single multipurpose machine can be developed to perform number several of operations. Aim of this project is to fabricate a multipurpose machine which is capable of performing various operations like grinding, drilling and shaping on small work pieces. So three different kinds of operations can be performed simultaneously. This machine is fabricated for small scale industries and also repairing purpose in home. The floor space used for three machines is reduced to one machine since all operations are made in a single unit. The fabricated machine comprises several mechanical elements such as gears, belt drives, shaft, cutting tools, motor and etc. The entire machine is modeled and assembled in Solidworks 2017 software and its motion behaviour is observed.

Keyword: Low cost, Multiple Operations, Drilling, Shaping, Grinding.

1. Introduction

The main goal of an industry or organization is to make profit in their business with low investment. After globalization in industries, everything becomes faster and faster with the help of upgraded technology. To meet the customer requirements the production rate of the goods are also increased with recent technological tools such as artificial intelligence, machine learning and industry 4.0. Multipurpose machine technique is recently evolved in manufacturing industries to achieve greater productivity without compromising quality. Such machine offers very less human interference, reduced machining time, less floor space and compact as well [1]. Grinding is a metal removing process accomplished by means of rotating rigid wheel which contains abrasive particle. In a macroscopic view, the grinding wheel act as a multi-point cutter and each abrasive particle is assumed to be single point cutting tool. Through grinding process extremely high surface finish can be attained with utmost accuracy. Drilling is a circular hole making process by removing the material from the workpiece by means of drill bit. Drill bit act as a multi-point cutting tool. Each cutting edge cutting off the material in the form of chips from the drilled hole. Shaper uses single point cutting tool. Material removal taking place when the cutting tool moves linearly on the workpiece. Cutting action taking place during the forward stroke and reverse stroke is idle. This movement can be obtained from quick return mechanism. In this project, a multi-purpose machine is designed and fabricated to perform grinding, drilling and shaping operations.

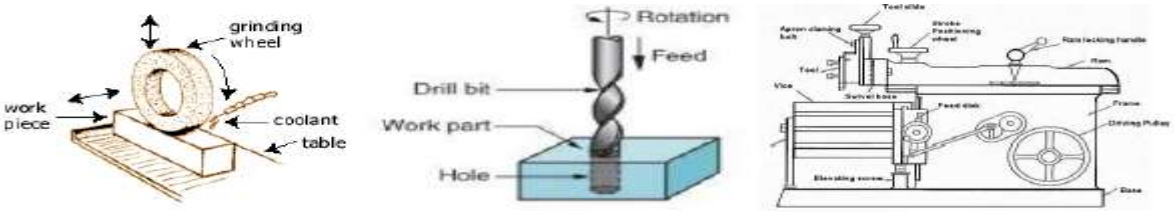

Fig.1. Grinding, Drilling and Shaping operations

Danie davis et al (2014) have done experimental investigation of pedal driven hacksaw. The hack saw is connected with the reciprocating rod. By pedaling the bicycle, the reciprocating rod moves to and fro, the hack saw will be moving with the rod. The plywood to be cut is placed under the hack saw.

Swapnil mane (2016) has Design and fabrication of prototype of multipurpose machine for sheet metal operations. Sheet metals are used in aerodynamically designed automobile bodies. The conventional machines could only carry out dent removing/rolling, cutting and v-grooving operations simultaneously. If these operations can be done on a single machine, it would not only make work quite easy and less tedious but also increases profitability.

Linxu et al (2011) have designed and implemented the reciprocating pedal powered electricity generating device. Automatically reciprocating pedal powered electricity generator (ARPPEG) in conjunction with harvesting kinetic energy, electricity generation and electric storage. According to the operation testing results, this system has been proved to be effective in power generation.

S.G.Bhaley et al (2012) have done performance analysis of pedal powered multipurpose machines. A human powered machine which is developed for lifting the water to a height of 10 meters and generates 14 Volt, 4 amperes of electricity in the most effective way. The power required for pedaling is well below the capacity of an average healthy human being. Pedaling will act as healthy exercise and doing useful work.

M.Khaja Gulam Hussain et al (2016) fabricated pedal powered hacksaw machine. The pedal powered hacksaw has a very simple mechanism operated with pedal by pedaling the wheel rotary motion is converted into to and fro motion of the cutting tool. The aim of this paper is to cut materials like wood, plastic etc., with less effort and quickly.

Pratik P Bargode et al (2015) have done work on design and fabrication of multi operational woodworking machine. Simplification of engineering and precise control of manufacturing process can result in significant cost saving. It can perform buffing and grinding operations and can be controlled or operated by motor.

Rohan R. Kurlapkar et al (2016) have performed design and static structural analysis of bevel gear. In this present work an attempt is made to design the bevel gear and static structural analysis is made using ANSYS. A pair of bevel gear while transmitting the power generally subjected to two types of Failure. The bending failure due to bending stresses and pitting failure due to contact stresses.

2. Problem Statement

Separate machines are required for each and every machining operation. It takes a lot of time and power for machining also the floor space is needed much. By introducing the multipurpose metal cutting machine the above said problems can be rectified. The machine comes with three machining processes such as drilling,grinding and shaping. So the floor space is very much reduced. The cost of manufacturing the machine is very much less.

2.1 Objective

- To reduce the consumption of power for machining process.
- To reduce the floor space.

3. Methodology

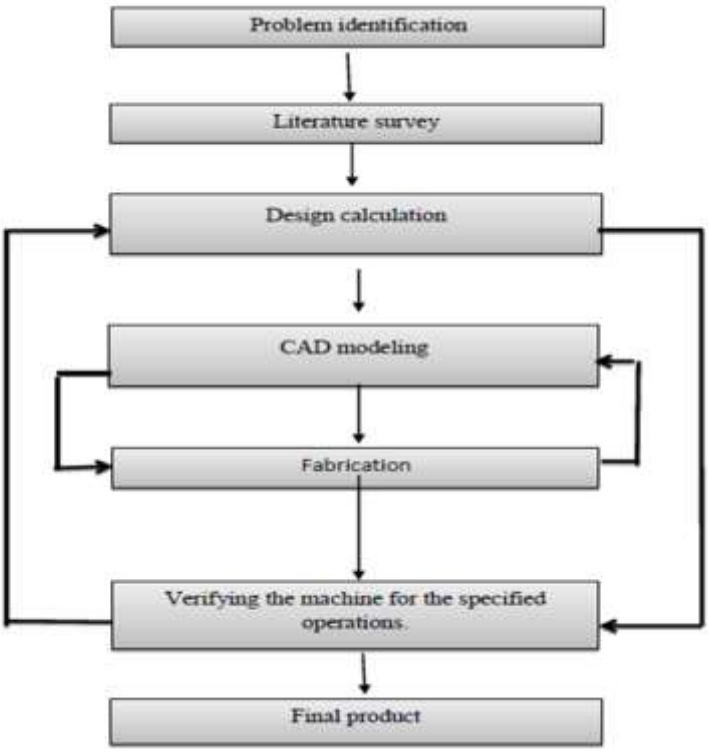

Fig 2. Methodology

4. Design Calculations

4.1 Design of pulley:

Power = 372W

Cross-section A:

The recommended minimum pulley pitch diameter is 75 mm.

Standard driven pulley diameter D= 224 mm

Centre distance C = 236 mm

Length of belt drive (L) = $2C+ [\Pi/2(D + d)] + \{(D-d)^2/4C)\}$ = 965 mm

The nominal thickness for the selected V-Belt section is 8 mm.

4.2 Selection of ball bearing:

Bearing No. 6203 (Single-row deep groove ball bearing)

Outer Diameter of Bearing (D) = 40 mm

Thickness of Bearing (B) = 12 mm

Inner Diameter of the Bearing (d) = 17 mm

The maximum permissible speed for this bearing is 16,000 rpm

5. CAD Modeling

5.1 Multipurpose machine:

This is the 2D drafting of the multipurpose machine. Processes such as drilling, grinding, and shaping can be performed in this machine. The design is made using the Solidworks 2017 software.

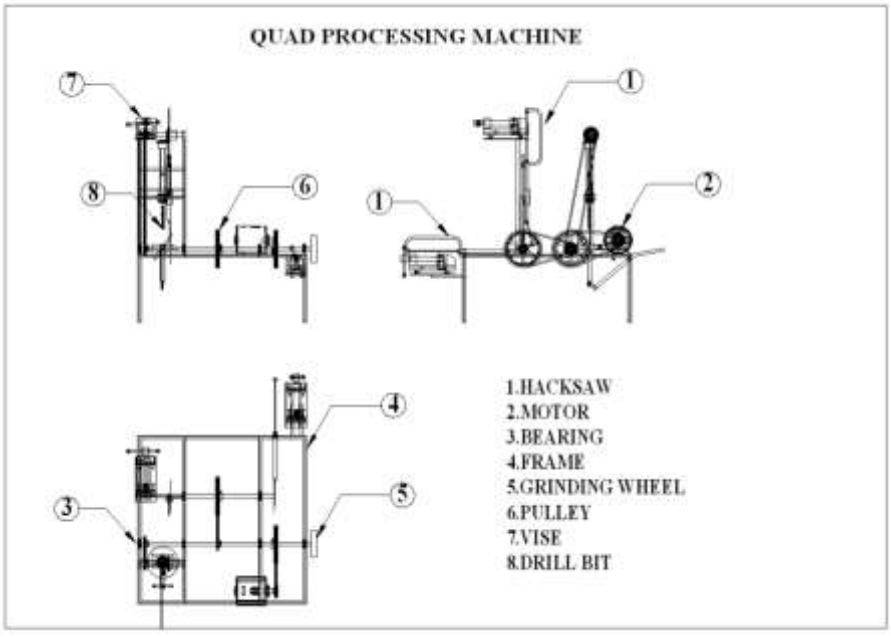

Fig.3 Metal Cutting Machine

5.2 Frame

A frame is a structural system that supports other components of a physical construction. Mild steel material is used for the frame. The thickness of the frame is 30 mm.

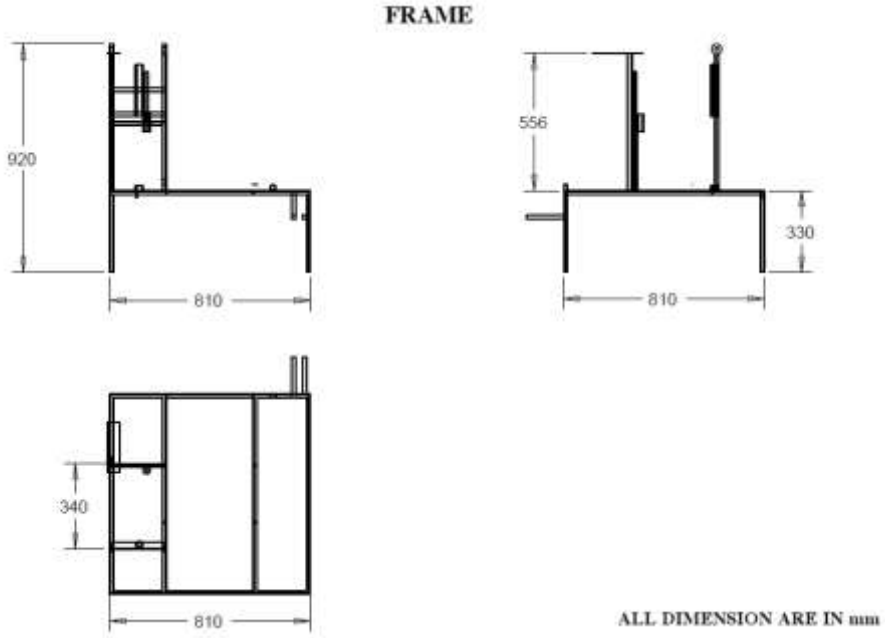

Fig 4: Frame

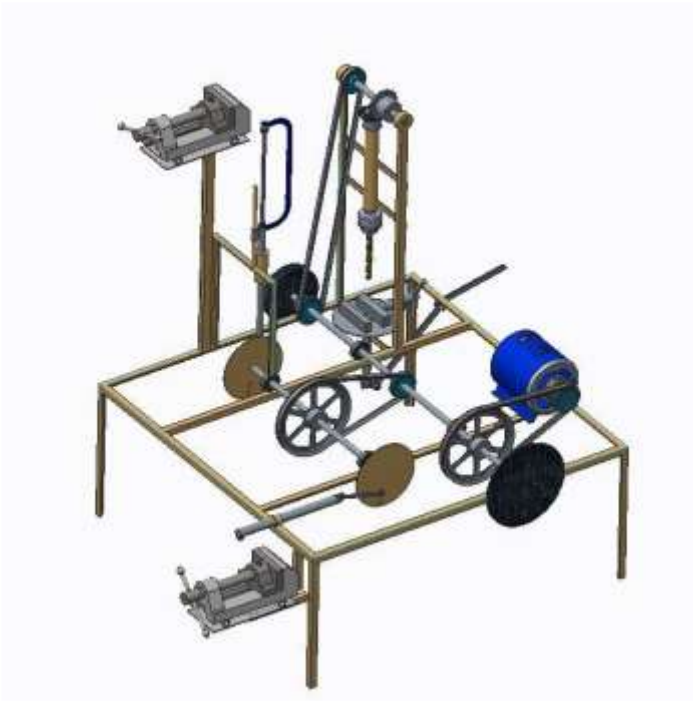

Fig. 5 Assembly Model

The machine tool comprises the following machine elements as indicated in the above figure.

1. AC motor
2. Grinding wheel
3. V-belt
4. Shaft
5. Machine vice
6. Drilling setup

7. Bevel gear

Operation

This machine tool is intended to perform three different kinds of operations such as grinding, shaping, and drilling in the same working spot. The electric power is supplied to the AC motor that can rotate about 1400 rpm. Then the power is transmitted to the main shaft pulley by means of V-belt drive. From the main shaft, the power is transferred to another parallel shaft by means of another belt and pulley system. One end of the second shaft is reformed into a scotch yoke mechanism. A shaper tool is tightly fixed in the tool holder. A machine wise is also provided near to the scotch yoke mechanism to hold the work piece to perform shaping operation. The ram in the shaper mechanism reciprocates and the cutting tool travels forward and backward over the workpiece. In an idle shaper machine, cutting off material takes place during forward stroke, the reverse stroke is idle. Depth of cut is applied by moving the machine vice towards down. Shaping cutter is made of carbide material. The main shaft supplies power to perform two operations namely drilling and grinding. The drilling setup is mounted 556 mm from frame. The drilling setup operation is done by straight bevel gear and V-belt. High Speed Steel drill bit of diameter 10 mm is used for drilling operation. However, a maximum of 30 mm diameter drill bit also can be used in this machine. For grinding purposes 150*25*32 mm A36 type wheel is used. This is the general-purpose grinding wheel used in bench grinders.

Result and Discussion

Reduction of number of machines into single machine to obtain the shaping, drilling, and grinding process. Thus, the complete design of the project is done in Solid works 2017 software. In the shaping process automation is done by including the scotch yoke mechanism which converts rotary motion into linear motion. By using this machine, the power required for entire operation can be reduced and have reduced floor space, man power, the productivity is increased and cost is reduced.

Conclusion

The multi-purpose metal cutting machine has been designed, using the Solidworks 2017 software. This machine is of no doubt can be used in an industry to reduce power consumption, as all the processes are made in a single machine. The machine can be extended by connecting more shafts to the motor and thus other machining operations can be included.

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