DESIGN AND FABRICATION OF MOTORIZED PORTABLE MULTIPUPOSE MACHINE

Sudarshan S[1], Arvin Jason Crasta[2], K.V.Adith[3], Vishal Rajagouda Patil[4]

[1,2,3,4] *Students, B.E, Mechanical Engineering, Alva's Institute of Engineering & Technology, Mangalore, Karnataka.*

ABSTRACT

The project aims at designing and developing a multipurpose machine tool which is capable of performing multiple tasks simultaneously The fundamental functions of machine tools are to transform the raw materials with given mechanical properties to the finished parts with required geometry, dimensions and surface quality. As the demands are increasing to produce parts with higher quality at reduced cost, the machine tools are required to have higher machining accuracy and speed. So in this project we have a proposed a machine which can perform operations like drilling, cutting, shaping and grinding simultaneously which implies that industrialist have not to pay for machine performing above tasks individually for operating operation simultaneously. We have developed a conceptual model of a machine to operate through mechanism which fully automatically driven by 1HP Motor and have capacity of performing different operations simultaneously and is also economically efficient. The machine is operated by giving drive to the main shaft to the main shaft to which grinding wheel is attached, using scotch yoke mechanism is used for cutting operation and shaping operation by referring power from main shaft to another sub shafts by using different sized pulleys we have reduced the speed and by using bevel gear we are doing drilling operation.

KEYWORDS: *Drilling, Grinding, Shaping, Cutting operation, Scotch yoke mechanism.*

1. INTRODUCTION

Industries are basically meant for Production of useful goods and services at low production cost, machinery cost and low inventory cost. Today in this world every task have been made quicker and fast due to technology advancement but this advancement also demands huge investments and expenditure, every industry desires to make high productivity rate maintaining the quality and standard of the product at low average cost in an industry a considerable portion of investment is being made for machinery installation. The fundamental functions of machine tools are to transform the raw materials with given mechanical properties to the finished parts with required geometry, dimensions and surface quality. As the demands are increasing to produce parts with higher quality at reduced cost, the machine tools are required to have higher machining accuracy and speed. In recent years, the demands are also increasing to machine difficult to cut materials and parts with complex geometry. As the production lot size becomes smaller, a single part with complicated geometry has to be machined without a trial cut. In order to meet such requirements, the machine tools are expected to have multiple functions with modular and reconfigurable design architectures many of the parts are finished by a sequence of processes, which may include various cutting processes, grinding, deformation, heat treatment and other finishing processes. In order to manufacture such parts with small quantity, it is necessary to have one machine tool which can perform various manufacturing processes as opposed to distributing the operations to a series of many single purpose machine tools. Various kinds of multifunctional machine tools with integrated processes have been developed for general as well as for specific purposes. Typical combinations of processes of such machines are shown in Fig 1.The integration of various cutting processes has been accelerated in recent years for machining parts with small lot size but with complicated geometry and high accuracy in a short machining time. The turning centers and machining centers are typical machine tools of such multi-functional machine tools. The purpose of this keynote paper is to review the historical background and the recent developments of multi-functional machine tools used in metal cutting industry. So in this project we have a proposed a machine which can perform operations like drilling, cutting, and grinding simultaneously which

implies that industrialist have not to pay for machine performing above tasks individually for operating operation simultaneously. According to some economists, manufacturing is a wealth-producing sector of an economy, whereas a service sector tends to be wealth-consuming. Emerging technologies have provided some new growth in advanced manufacturing employment opportunities in the Manufacturing Belt in the United States. Manufacturing provides important material support for national infrastructure. Before starting our work we have undergone through many research paper which indicates that for a production based industries machine installation is a tricky task as many factor being associated with it such as power consumption maintenance cost, no. of units produced per machine i.e., capacity of machine, time consumption and many more.

2. LITERATURE REVIEW

Syed shahnawaz et al. (2017) [1]: In this paper study presents the design, analysis and fabrication of "MULTIPURPOSE MECHANICAL MACHINE". This mechanical machine is designed to perform multi operations specially drilling, cutting and grinding. The machine is designed to perform all the Operations at same time with desired speed. There model of the multi operational machine may be used in industries and domestic operation which can perform mechanical operation like drilling, cutting & grinding of a thin metallic as well as wooden model or body. In this study literature review and problem identification is performed.

R. Robert Henty et al. (2016) [2]: There are many ways to cut metals, but all these ways take more time our aim is to reduce the cutting time by "DESIGN AND FABRICATION OF A MULTI PURPOSE SCOTCH YOKE MECHANISM" and increasing the number of productivity. By this method six operations can be performing. There are four cutting, drilling and grinding at the same time by using the bevel gear attachment. The time required to cut four works by power hacksaw multi metal cutter is the time taken by other methods to cut a two work. This method reduces human effort and saves the metal cutting time. Apart from other methods this method can be used in places were to cut more work at low cost. If we want to drilling or surface finishing work it is also possible. The sawing machine is faster and easier than hand sawing and is used principally to produce an accurate square or mitered cut on the work piece.

Krishnappa R, et al. (2017) [4]: This paper presents the concept of Multi-Function Operating Machine mainly carried out for production based industries. Industries are basically meant for Production of useful goods and services at low production cost, machinery cost and low inventory cost. They have developed a conceptual model of a machine which would be capable of performing different operation simultaneously, and it should be economically efficient .In this machine they are actually giving drive to the main shaft to which scotch yoke mechanism is directly attached, scotch yoke mechanism is used for sawing operation. On the main shaft they have use bevel gear system for power transmission at two locations. Through bevel gear we will give drive to drilling centre and grinding centre. The model facilitate us to get the operation performed at different working centre simultaneously as it is getting drive from single power source. Objective of this model are conservation of electricity (power supply), reduction in cost associated with power usage, increase in productivity, reduced Floor space.

Yashraj V Patil et al (2018) [5]: This paper deals with fabrication of multi-purpose tooling machine. This machine is based on the mechanism of belt drive with pulleys, bevel gears, and scotch yoke. The various machining process in manufacturing industries are carried out by separate machining machine. It requires more space requirement and time with high expenses. But the fabrication of multi-purpose tooling machine, which contains five operations in a single machine. The operations are namely drilling, shaping, cutting, buffing and grinding. It is a new concept specially meant to reduce the work time and save the cost. This machine can perform multi-purpose operation at the same time with required speed and this machine is automatic which is operated by motor which is run with the help of electric power supply.

S.S. Kulkarni, et al.(2018) [6]: This paper presents the concept of Multi-Function Operating Machine mainly carried out for production based industries. Industries are basically meant for Production of useful goods and services at low production cost, machinery cost and low inventory cost. The model facilitate us to get the operation performed at different working centre simultaneously as it is getting drive from single power source. Objective of this model are conservation of electricity (power supply), reduction in cost associated with power usage, increase in productivity, reduced floor space.

Heinrich Arnold, (2001) [7]: He conducted a study with more than 100 interviewers, decision makers and industry experts who have witnessed the development of the industry over the last forty years. The study

establishes a connection between radical technological change, industry structure, and competitive environment. It reveals a number of important occurrences and interrelations that have so far gone unnoticed.

Dr. ToshimichiMoriwaki, (2008) [8]: He focused on recent trends in the machine tool technologies. He conducted a survey from the view points of high speed and high performance machine tools, combined multifunctional machine tools, ultra precision machine tools and advanced and intelligent control technologies.

Frankfurt-am Main, (2011) [9]: The crisis is over, but selling machinery remains a tough business. Machine tools nowadays have to be veritable "jack of all trades", able to handle all kinds of materials, to manage without any process materials as far as possible, and be capable of adapting to new job profiles with maximized flexibility. Two highly respected experts on machining and forming from Dortmund and Chemnitz report on what's in store for machine tool manufacturers and users.

Sharad Srivastava, etal.(2014) [9]: He has fabricated a machine using scotch yoke mechanism, belt drive and gears. In an industry a considerable portion of investment is being made for machinery installation. They have proposed a machine which can perform operations like drilling, sawing, grinding at different working centers simultaneously which implies that industrialists do not have to pay for machine performing above tasks individually for operating operation simultaneously.

3. METHODOLOGY

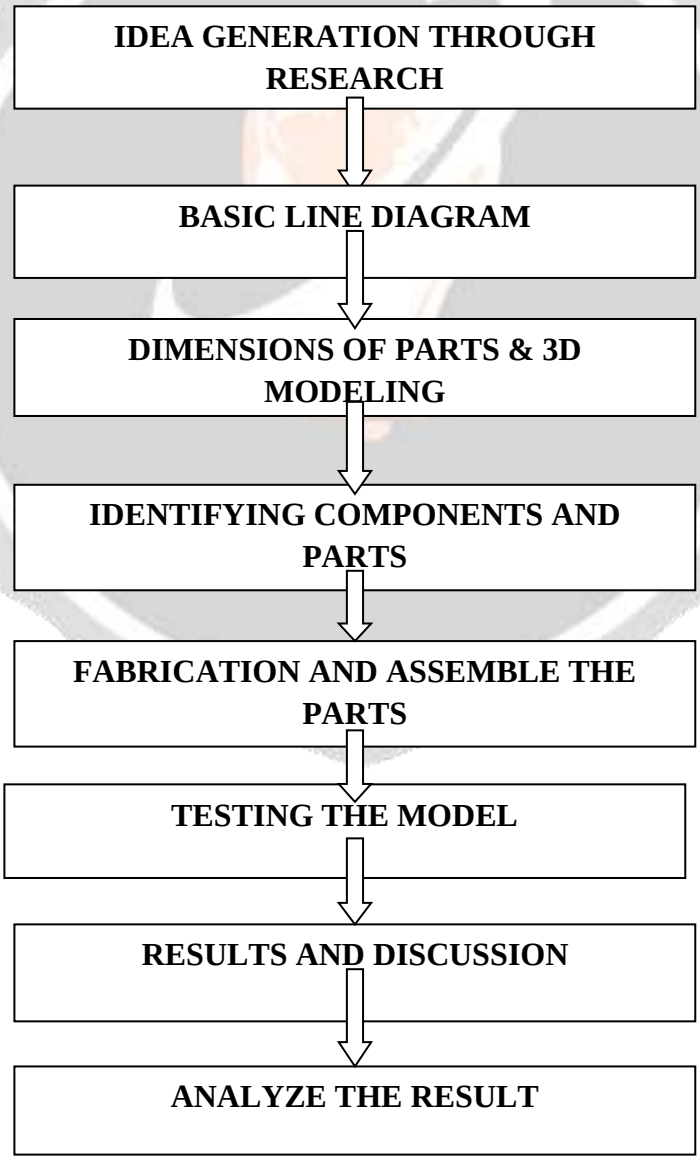

Fig 1: Methodology

4. WORKING PRINCIPLE

4.1 Scotch Yoke Mechanism:

The Scotch yoke is a mechanism for converting the linear motion of a slider into rotational motion or vice-versa. The piston or other reciprocating part is directly coupled to a sliding yoke with a slot that engages a pin on the rotating part. The shape of the motion of the piston is a pure sine wave over time given a constant rotational speed.

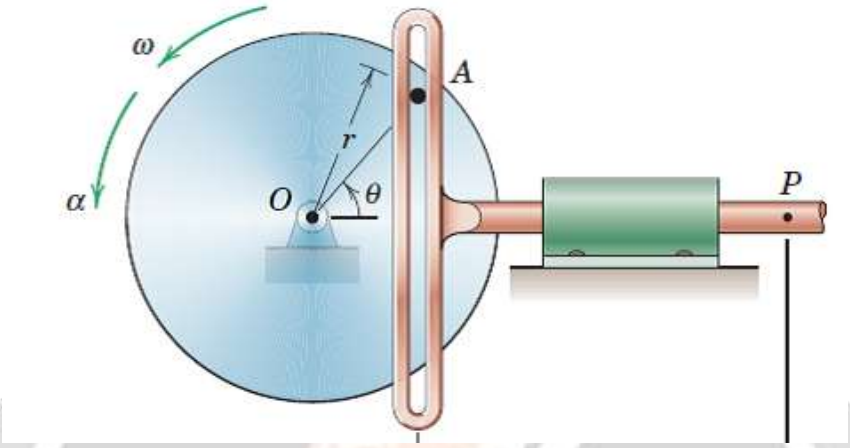

Fig 1: scotch yoke mechanism

4.2 Power Transmission through Gears:

Bevel gears are gears where the axes of the two shafts intersect and the tooth-bearing faces of the gears themselves are conically shaped. Bevel gears are most often mounted on shafts that are 90 degrees apart, but can be designed to work at other angles as well. The pitch surface of a gear is the imaginary toothless surface that you would have by averaging out the peaks and valleys of the individual teeth. The pitch surface of an ordinary gear is the shape of a cylinder. The pitch angle of a gear is the angle between the face of the pitch surface and the axis.

Fig 2: Bevel gear

4.3 Power transmission through v belt and pulleys:

The transmission of power through the v belt and pulley to the drilling, cutting and grinding. The belts can be used as a source of movement, to transmit control productively or to monitor relative development. The belts are surrounded by pulleys and may have a turn between the pulleys, and the poles must not be parallel.

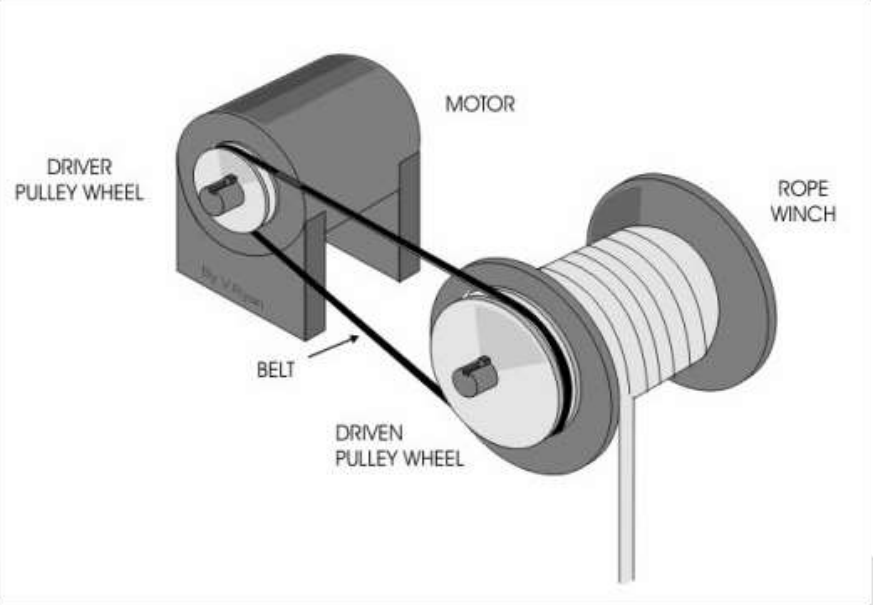

Fig 3: Pulley

5. OPERATIONS PERFORMED

1. Drilling.
2. Cutting.
3. Shaping.
4. Grinding.

5.1 Drilling: Drilling is a cutting process that uses a drill bit to cut a hole of circular cross-section in solid materials. The drill bit is usually a rotary cutting tool, often multipoint. The bit is pressed against the work piece and rotated at rates from hundreds to thousands of revolutions per minute. This forces the cutting edge against the work piece, cutting off chips from the hole as it is drilled.

5.2 Cutting: Cutting is the separation of a physical object, into two or more portions, through the application of an acutely directed force. Implements commonly used for cutting are the knife and saw, or in medicine and science the scalpel and microtome. However, any sufficiently sharp object is capable of cutting if it has a hardness sufficiently larger than the object being cut, and if it is applied with sufficient force. Sawing is a secondary machining process and saws are used mostly for cutting bar stock in preparation for other machining operations.

5.3 Shaping: A shaper is a type of machine tool that uses linear relative motion between the work piece and a single-point cutting tool to machine a linear tool path. Its cut is analogous to that of a lathe, except that it is linear instead of helical. A wood shaper is a similar woodworking tool, typically with a powered rotating cutting head and manually fed work piece. A metalworking shaper is somewhat analogous to a metalworking planer, with the cutter riding a ram that moves relative to a stationary work piece, rather than the work piece moving beneath the cutter. The ram is typically actuated by a mechanical crank inside the column, though hydraulically actuated shapers are increasingly used. Adding axes of motion to a shaper can yield helical tool paths, as also done in helical planning.

5.4 Grinding: Grinding is an abrasive machining process that uses a grinding wheel as the cutting tool. A wide variety of machines are used for grinding:

- Hand-cranked knife-sharpening stones (grindstones)

- Handheld power tools such as angle grinders and die grinders
- Various kinds of expensive industrial machine tools called grinding machines
- Bench grinders often found in residential garages and basements

6. Components and Design calculations

The main components are used in this project are

- Bevel gear
- AC Motor
- Pulley
- Bearing (ball & sliding bearing)
- Hacksaw blade
- Abrasive saw blade
- Tool post
- Drilling chuck
- Drill tool
- Single cutting tool
- Frame
- Belt drive
- Wheels

1. <u>Chain Drive:-</u>

- **Speed of sprocket B (n_B):**

  Speed of shaft (n_1) = 2850 rpm

  Number of teeth in sprocket-1 (Z_1) = 14

  Number of teeth in sprocket-2 (Z_2) = 43

  We have to find out speed of sprocket B (n_2)

  We know that: $\boldsymbol{i = \frac{n1}{n2} = \frac{z2}{z1}}$

  $$\frac{2850}{n2} = \frac{43}{14}$$

  n2=927.90 rpm and speed ratio i = 1.11

- **Pitch:**

  $p \leq 10\left(\frac{60.67}{n1}\right)^{\frac{2}{3}} = 10\left(\frac{60.67}{47.5}\right)^{\frac{2}{3}} = 11.77$ **[Here, n_1 =47.5rps]**

- **Velocity:**

  $$\mathbf{V} = \frac{\mathrm{P\ z1\ n1}}{1000} = \frac{12.70*14*14.70}{1000}$$

  V = 469.623 m/min

2. <u>Shaping operation :</u>

- **Speed of the shaft:** $n_1 = 927.90\ rpm$

  $$\frac{n_1}{n_2} = \frac{d_2}{d_1}$$

  $$\frac{927.90}{n_2} = \frac{200}{52}$$

  Speed of Circular plate rotation $\boldsymbol{n_2 = 241.254\ rpm}$

- ***Length of Belt:***

  $$L = 2c + \frac{\pi}{2}(D + d) + \frac{(D-d)^2}{4c}$$

  $$L = (2 * 440) + \frac{\pi}{2}(200 + 52) + \frac{(200 - 52)^2}{(4 * 400)}$$

L = 1288.28 mm

- ***Arc of Contact of belt on pulley:***

$\theta = 2\,cos^{-1}(\frac{(D-d)}{(2*C)})$

$\theta = 2\,cos^{-1}(\frac{(200-52)}{(2*440)}$

$\boldsymbol{\theta = 160.63°}$

3. <u>Cutting operation :</u>

- **Cutting speed**

Speed of the shaft: $n_1 = 927.90\ rpm$

$$\frac{n1}{n2} = \frac{d2}{d1}$$

$$\frac{927.90}{n2} = \frac{200}{52}$$

n2 = 241.254 = n3

$$\frac{n3}{n4} = \frac{d4}{d3}$$

$$\frac{241.254}{n4} = \frac{200}{100}$$

n4 = 120.627 rpm

- **Velocity of cutting hacksaw:**

Velocity (V) = (L*N*(1+k)/1000) m/min
Length of Ram stroke (L) = 50mm
No. Of full stroke (N) = 120.627 stroke/min

V $= L * N\frac{(1+k)}{1000}$ m/min

V$= 50 * 120.627 * \frac{2}{100}$

V = 12.0627 m/min

- **Length of belt-1:**

$$L = 2c + \frac{\pi}{2}(D+d) + \frac{(D-d)^2}{4c}$$

L$= (2 * 340) + \frac{\pi}{2}(200+52) + \frac{(200-52)^2}{(4*340)}$

L_1 = 1091.94 mm

- **Arc of contact of Small pulley-1:**

$\theta_1 = 2\cos^{-1}(\frac{D-d}{2c})$

$\theta_1 = 2\cos^{-1}(\frac{200-52}{(2*340)})$

$\boldsymbol{\theta_1 = 154.85°}$

- **Length of belt-2:**

$$L = (2 * 300) + \frac{\pi}{2}(200 + 100) + \frac{(200 - 100)^2}{(4 * 300)}$$

L_2 = 1079.57 mm

- **Arc of contact of Small pulley-2:**

$$\theta_2 = 2\cos^{-1}(\frac{D - d}{2c})$$

$$\theta_2 = 2\cos^{-1}(\frac{200 - 100}{(2 * 300)})$$

$$\boldsymbol{\theta_2 = 160.81°}$$

4. <u>Drilling operation :</u>

- **Pinion speed (n_p):**

Speed of the shaft: $n_1 = 927.90\ rpm$

$$\frac{n_1}{n_2} = \frac{d_2}{d_1}$$

$$\frac{927.90}{n_2} = \frac{200}{52}$$

n2 = 241.254 rpm = n3

$$\frac{n_3}{n_4} = \frac{d_2}{d_1}$$

$$\frac{241.254}{n_4} = \frac{30}{52}$$

Speed of Pinion $\boldsymbol{n_p = n4 = 418.1736}$rpm

- **Gear speed:**

Number of teeth's in pinion (Z_p) = 48
Number of teeth's in gear (Z_g) = 20

$$\frac{n_p}{n_g} = \frac{z_g}{z_p}$$

$$\frac{418.1736}{n_g} = \frac{48}{20}$$

Speed of gear/drilling Speed$\boldsymbol{n_g = 174.239}$rpm

- **Length of belt:**

$$L_1 = 2c + \frac{\pi}{2}(D + d) + \frac{(D - d)^2}{4c}$$

$$L_1 = (2 * 610) + \frac{\pi}{2}(200 + 52) + \frac{(200-52)^2}{(4*610)}$$

$$\boldsymbol{L_1 = 1624.81\ mm}$$

$$L_2 = 2c + \frac{\pi}{2}(D + d) + \frac{(D-d)^2}{4c}$$

$$L_2 = (2 * 735) + \frac{\pi}{2}(52 + 30) + \frac{(52-30)^2}{(4*735)}$$

$$\boldsymbol{L_2 = 1598.96\ mm}$$

7. Photos of Model

8. CONCLUSION

We can see that all the production based industries wanted low production cost and high work rate which is possible through the utilization of multi-purpose ma-chine which will less power as well as less time, since this ma-chine provides working at different center it really reduced the time consumption up to appreciable limit. In an industry a considerable portion of investment is being made for machinery installation. So in this project we have proposed a machine which can perform operations drilling and cutting at different working centers simultaneously which implies that industrialist have not to pay for machine performing above tasks individually for operating operation simultaneously. I have aimed to reduce workload, space, time, and money associated with the Cutting and Drilling by incorporating them in a single, multipurpose machine. As all the operations can be performed at one place and small area this machine will be very useful in small scale industries. This project has wide range of scope in the small scale industries. In coming future, this type of lightweight and potable machine will be implemented in every small and large scale industries. This type of machine can be used by anyone due to its simplicity of working and doing wide range of operations.

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