DESIGN AND DEVELOPMENT OF MULTIPURPOSE MACHINE FOR SAWING, DRILLING AND GRINDING

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Abstract: The numbers of operations are required in manufacturing processes which include but not limited to cutting, Drilling, Grinding, Welding etc. However the separate equipment is required for performing each and every operation and hence the cost of setup is very high. This project deals with the fabrication of multipurpose mechanical machine which is capable of performing a number of operations in single machine. The developed machine is capable of performing operations such as hacksaw cutting, drilling and grinding in a single machine which has only one prime mover. This not only saves the space but also helps in saving the power. In addition the cost of setting up the three machines is eliminated as the price of single machine is almost equivalent to the single drilling machine.

Keywords: Drilling, Cutting, Grinding, etc.

I. INTRODUCTION

In this ever changing environment need for manufacturing of products and higher rate is greatly enhanced by the market trend and demand. The process involved in manufacturing also needs a global approach and has to be done by making the process easier and reliable .Considering these aspects there is a need to design a methodology that would hope for the higher rate of production at greater quality.

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. So in this project we have a proposed a machine which can perform operations like drilling, sawing, grinding simultaneously which implies that industrialist have not to pay for machine performing above tasks individually for operating operation simultaneously.

The project focuses on fabrication of machine which can be used to perform different operations required in small fabrication shops in a single machine. This would not only cut down the cost of operations of three machines but also the cost of setting up a fabrication shop. The primary focus of this research work is to reduce the cost as well as the floor space required by these three machines.

II. LITERATURE REVIEW

Before starting our work we have undergone through many research papers 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 (electricity bill per machine), maintenance cost, no of units produced per machine i.e. capacity of machine, time consumption and many more…

Some research papers which have led us to approach to the idea of a machine which may give solution to all these factors are as follows:

R. Vijayakumar et.al found that how to increase the productivity by fabricating a Motorized Multipurpose machine that could perform four machining operation (Drilling, Sawing (Using Hacksaw), Grinding & Sheet Metal Cutting) at a time. The Bevel gear mechanism, Rack & pinion mechanism and CAM mechanisms were used in our project to make the Multi-operations possible with a single input.

Singh ankitkumar awadhesh et.al deal with design, development and fabrication of "Multipurpose Mechanical Machine". This machine is designed for the purpose of multi operations. They are as follows: 1. drilling, 2. cutting, 3. grinding & 4. shaping. This machine perform multipurpose operation at same time with required speed & this machine is automatic which is controlled or operated by motor which is run with the help of current. This machine is based on the mechanism of whit worth return and belt drive. this model of the multi operational machine is may be used in industries and domestic operation which can perform mechanical operation like drilling, cutting &shaping of a thin metallic as well as wooden model or body.

Sharad Srivastava et.al found 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. 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. We 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 we 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 we have use bevel gear system for power transmission at two locations. Through bevel gear we will give drive to drilling center and grinding center. The model facilitate us to get the operation performed at different working center 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.

III. METHODOLOGY

Problem Definition

Literature survey

Designing of the machine

Procurement of material

Development of the machine

Testing of the machine

Corrective actions

Conclusion

Report Writing & final Submission

IV. OPERATION INVOVLED

1. Sawing

The sawing operation is done by operating the Hacksaw in To & Fro motion. The To & Fro motion of the Hacksaw is obtained by the use of Cam mechanism. The sawing operation is fitted at one end of the machine. The common shaft is rotated by the pulley connected to it which is powered by the belt connected to the motor's pulley.

Fig 1: Sawing Operation

2. 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. The drilling tool is present at one end of the machine. The common shaft is rotated by the pulley connected to it which is powered by the belt connected to the motor’s pulley. The one end of the common shaft is connected to the bevel gear which converts the horizontal axis rotation of the common shaft into the vertical axis rotation of the drill chuck.

Fig 2: Drilling Operation

3. Grinding

A grinding machine, often shortened to grinder, is any of various power tools or machine tools used for grinding, which is a type of machining using an abrasive wheel as the cutting tool. Each grain of abrasive on the wheel's surface cuts a small chip from the work piece via shear deformation.

The grinding wheel is fitted in parallel with a small pulley which is powered by the large size pulley connected with the common shaft. The power transmission between the large pulley and small pulley is done using the chain drive.

Fig 3: Grinding Operation

V. DESIGN CALCULATION AND FORMULATION

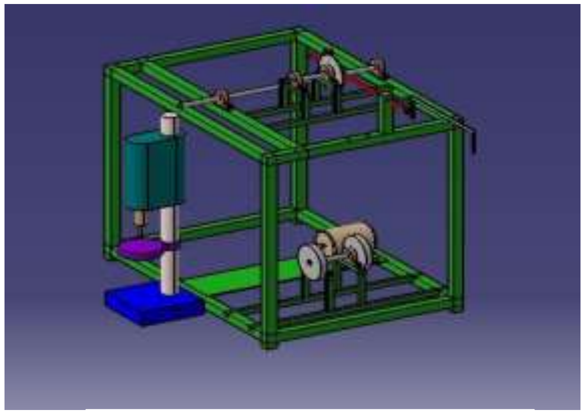

Fig 4: CATIA Model

1. Design of scotch Yoke mechanism

L = 2r
Where r = radius
Therefore, r = 80mm
Diameter of scotch disc D = 160 mm
Connecting rod length, L_r = 300mm
Thickness of disc, $T_s = 0.022D\ to\ 0.033D$
Considering standard size available in the market $T_s = 4mm$
Inner diameter of yoke pin, $d_{ip} = 2 \times T_s = 8mm$
Outer diameter of yoke pin, $d_{0p} = 2.5 \times T_s = 10\ mm$
Length of yoke, $L = 160\ mm$
Angular velocity of scotch disc, $\omega = \frac{2\Pi N}{60}$
Where N=speed of connecting rod=95 RPM $\omega = 9.94\ rad/s$

2. Cutting speed:

Speed of the motor: N_{m} = 1425 RPM.
Motor Pulley Diameter d1=60 mm
Driven pulley diameter d2= 300 mm
Therefore we have to find the wheel speed. $\frac{N_w}{N_m} = d_1/d_2$

$$N_w = \frac{d_1}{d_2} \times N_m$$

Substituting the values in above formula we get speed of wheel, $N_w = 285\ RPM$
For scotch and Yoke mechanism One stroke of is completed in 1 Revolution of crank i.e. K=1
Stroke length of scotch-yoke mechanism L = 2r
Where 'r' is the radius of the wheel.
In our case r = 80 mm
So $L = 160\ mm$

Number of strokes,

$$N = Speed\ of\ the\ wheel = N_w = 285$$

Therefore we know Velocity of cutting machine

$$V_c = (L \times N \times (1 + K))/1000\ m/min$$

Ratio of return time to cutting time $K = 1$
Therefore, velocity of cutting machine after substituting in the above equation. $V_c = 91.2\ m/min$

3. Grinding Speed:

Diameter of sprocket at grinding wheel $D_g = 60mm$

$$\frac{N_g}{N_m} = d_1/D_g$$

$$N_g = 885\ RPM$$

Radius of the Grinding wheel $R_g = 75\ mm$

Angular Velocity

$$\omega = \frac{2\Pi N}{60}$$
$$= 92.67\ rad/s$$

Linear Velocity $V = \omega R_g = 6.95\ m/s$

According to the grinding wheel specifications, the maximum speed of 30 m/s is allowed. Hence it is within safe limits.

4. Selection of Bevel Gear

A bevel gear is used to change the direction of drive in a gear system by 90 degrees. In this case a Bevel gears with different numbers of teeth and with axes at right angles. The number of teeth of bevel gear selected is 10 and 16 resp. A Straight bevel gears used have conical pitch surface and teeth are straight and tapering towards apex. For design simplification it is assumed that there is no power loss in changing the direction of drive. The material for the bevel gear selected is mild steel.

5. Drilling Speed:

Speed of shaft 285 RPM
Gear train used: bevel gears
Teeth on driver =10
Teeth on driven = 16
Therefore speed of drill chuck=534 RPM without any speed adjustment.

6. Selection of Belt

As per the design handbook, the prescribed belt type for the given distance between the two pulleys is V-belt. So, all the belts selected in this project are V-Belt.

7. Design of hacksaw blade:

Consider hacksaw blade under axial load. So due to axial load hacksaw blade will bend.
Axial force (p),
Maximum permissible deflection (e),
With the help of a maximum permissible deflection, we can find the critical load.

Let

Length of blade l=400 mm
As per standard,
72 teeth
TPI (teeth per inch) =5
Width=32 mm
Thickness=6 mm

VI. Working of model

In the model of "Multipurpose Machine" we are giving supply to the main shaft, as we move along the axis of shaft we have mounted a pair of bevel gears, through the pinion shaft we are giving drive to drill shaft through belt-pulley arrangement, we have installed the stepped pulley in the arrangement therefore we can made the speed variation for the drilling operation.

As we can see that the scotch yoke mechanism is directly fabricated to the second shaft which is taken drive from the main shaft with the help of chain drive, also the grinding wheel is mounted on third shaft which is driven by the main shaft.

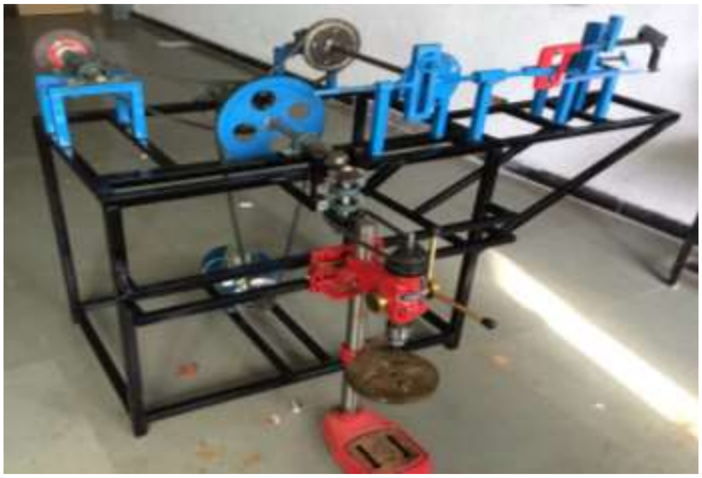

Fig 5: Actual Model

Specification of components used in the model
i. Frame of model: length=1066mm, width=762mm, height=864mm.
ii. Bevel gears: no of teeth T_1=10 T_2=16
iii. Shaft dia, D_1=25mm D_2=D_3= 20mm where, , D_1, D_2,D_3=Diameters of shaft 1,2,3 resp.
iv. Shaft material is mild steel.
v. Material of bevel gear is mild steel.
vi. Type of belt used is V-Belt.
vii. Diameter of pulleys Main pulley=300mm Motor pulley=60mm.
viii. Frame is made of steel pipes.
ix. Bearing used is pedestal bearing no. UC205.

VII. CONCLUSION

In an industry a considerable portion of investment is being made for machinery installation. So in this paper we have proposed a machine which can perform operations like sawing, drilling and grinding at different working centers simultaneously which implies that industrialist have not to pay for machine performing above task individually for operating operation simultaneously.

Thus this paper could reduce the external power requirement for machining process and at the same time could increase the productivity.

VIII. REFERENCES

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