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Design and Development of Multioperational Mechanical System

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Abstract: ***This paper presents the machine called Multioperational mechanical system mainly carried out for production based organizations. Industries are basically meant for Production of useful products at low manufacturing. Today in thisworld every process have been made quicker due to technology development but this development also demands huge investments, every organization objective to make high productivity rate maintaining the quality and standard of the product at low cost. We have developed a machine which is capable of performing different operation simultaneously, and it should be economically efficient .In this machine we are actually giving drive to the main shaft using belt pulley arrangement is directly attached, bevel gears are used for drilling operation. On the main shaft we have use bevel gears system for power transmission at three locations. Through bevel gear we will give drive to drilling, grinding as well as polishing centers. The model facilitate us to get the operation performed at different working centers simultaneously as it is getting drive from single power source. Objective of this model are conservation of electricity (power supply), reducing the movement of product, increase in productivity, reduced floor space.***
Keywords: Multioperational, high productivity, Gear mechanism

I. INTRODUCTION

Production industries are basically meant for production of useful goods and services at low cost. But to perform various operations on workpiece different machines required which demands huge investments and expenditure. Small scale industries required to invest huge amount in machinery which is unaffordable some times. In view of this, every industry desires to achieve a high productivity rate while maintaining the quality and standard of the product at a low cost. The idea behind this project is to develop a system which would be capable of performing different operations simultaneously while also being economically efficient. The Multioperational mechanical system have different work-stations which capable of carrying out a series of machining operations on the same machine which would otherwise require several machines in order to perform the same machining operations. The purpose of this project is to design and construct a low capital Multioperational machine system for the machine shop of the industries. We made system can perform operations like Drilling, Cutting, Grinding, and Polishing some lathe operations at different working centers simultaneously which implies that industrialist have not to pay for machine performing above tasks individually for operating operation simultaneously. The idea behind this project is to combining various basic engineering operations in one system which runs on single power supply.

A. Need of Development of system

In the present scenario, different machines used to perform various machining operations on workpiece. Because of that movement of the workpiece increases which leads to the increase cost of material handling and material damage chances also increases as well as production cost and time required to perform these operations is increases. Also we required more electric energy to run all these machines to complete the operation. Use of multipurpose mechanical machine reduces the machining equipment cost as four machining operations combined together and can used simultaneously on same platform.

II. LITERATURE REVIEW

The literature review focuses on the literature study done on the review of related journal papers, articles available as open literature. This literature covers the contribution given by different researcher in the field of filling machines and their performances. The papers focused on multipurpose machines different types, out of that which is better as per applications also their different components of multipurpose machines

In [1], Dr. Saif Imam et.al, proposed an innovative synchronous machine which will have ability to perform multiple mechanical operations of several machines instead of having one machine for one work. Utilizing this machine they are able to achieve the goal of low investment machine for not only use but also for various colleges for practice. In future these machine complex variations can help to fulfill the requirement.

In [2], Sharad Srivastava and Shivam Srivastava et.al. Propose the conceptual model for multifunction mechanical operations. In this conceptual model they provide drive to the main shaft where scotch yoke mechanism is used. Because of scotch yoke mechanism sawing operation is performed. They used bevel gears on main shaft to provide power at two locations at drilling & grinding centre. The conceptual model is get power from single power source to perform different operations at different work stations simultaneously. The objective of this conceptual model is to conserve electricity reducing initial cost, floor area with increasing productivity

In [3], J. Sreedhar. et.al, the fabricated machine is able to perform five operations like drilling, cutting, shaping, grinding as well as circular sawing. It is new concept to reduce machining time and cost. Instead of using single machine for single mechanical operation all five mechanical operations are combined in one system with single power source. This was save the added investment cost that occurs during drilling and shaping the devices in the industries. For perform drilling operations bevel gears are used in this machine. Driller, bevel gear, drill bit, chuck, bearings, slotting tool, shaping tool and grinding wheel are the significant parts of the machine which one can use simultaneously. In [4], R.Vijayakumar et.al, they fabricated the multi operation machine which able to perform four operations like cutting, grinding, slotting, and drilling. Because of that cost of using separate machine for every separate operation reduces and machining time and electricity saved. For power transmission different methods are used like belt and pulley system, or through gear-shaft. Power transmission is done in such way that it minimizes the loss or no loss happened between them. In [5], Prof. Kumar Penumuru et.al, Aim of paper is to design and develop a multipurpose machine which capable to perform multiple operations at once. To operate the machine drive gave to main shaft where worm gear mechanism is used. For sawing operation worm gear mechanism is used. To transfer the power in redial direction for drilling bevel gear mechanism is used which attach to the main shaft. Grinding wheel is directly mounted on motor shaft for grinding. The model is capable to perform three operations at same instant using single motor as power source. Solid work software used for designing of machine and using ANSYS software (version 13) various tests like deformation, stress and weight carrying capacity are carried out. And finally the model is prepared. The main objective of this machine is to save electric power, reducing machine and manufacturing cost with increasing production. Because of combing three mechanical operations in one machine floor area required less.

In [6], Singh Ankitkumar Awadhesh et.al, Propose machine able to do multi operations at same instant. Machine can perform four mechanical processes like shaping, grinding, drilling and cutting using electric motor run on electricity as single power source. Using electric motor, machine got required speed for various processes with automatic function in it. For power transmission whit worth and belt drive mechanisms are used. Machine can be used in small scale industries as well as domestic purposes where above gave mechanical operations required for thin metallic or wooden raw material.

In [7], R. Robert Henty et.al, Scotch yoke mechanism is used in this machine to perform the sawing operation at four places. Scotch yoke mechanism converts rotational motion into linear motion. Pistons like reciprocating parts are directly coupled to sliding yoke with a slot that engages a pin on the rotating part. In I.C. engines linear motion converted in rotational motion by means of crankshaft, piston and rod that connects them. The scotch yoke mechanism is considered as more efficient to produce rotational motion.

In [8] A. Raja et.al, Machine designed for multi operations like cutting, shaping, and cutting using hacksaw. Whit worth quick return mechanism is used for hacksaw cutting and also electric motor is used to power the operations due to which required speed and automatic control obtained.

In [9] Rakesh Ambade et.al, Propose multipurpose machine capable of performing multiple operations simultaneously using human power. It is economically conceptual model mainly for remote area where power shortage is problem. It is designed as a portable for drilling, sawing and grinding .power required for pedaling is well below the capacity if an average human being.

III. EXPERIMENTAL SET UP AND WORKING

A. Experimental set up of Multioperational Mechanical System

In this system we have involved the gear arrangement and belt pulley for power transmission at different working centers, basically gear is a rotating machine part having cut teeth which mesh with another toothed part in order to transmit torque, in most cases with teeth on the one gear being of identical shape, and often also with that shape on the other gear. Two or more gears working in tandem are called a transmission and can produce a mechanical advantage through a gear ratio and thus may be considered a simple machine. Geared devices can change the speed, torque, and direction of a power source.

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Figure 3.1 Set Up of Multioperational Mechanical System Front View

The most common situation is for a gear to mesh with another gear; however, a gear can also mesh with a non-rotating toothed part, called a rack, thereby producing translation instead of rotation As shown in project set up figure 3.1, we used dual shaft motor for getting the both side power at the same time for multiple operations to perform which will placed on higher platform where on one side of motor shaft we attached grinding wheel. Using this grinding wheel we able to perform grinding of workpiece. Other side of the shaft is attached to the pulley on which belt is placed for further power transmission. Below the higher platform shaft is insert in bearing with other pulley in it. Power will come from motor shaft pulley to the shaft pulley end using V belt.
On both end of this shaft bevel gears are mounted for next use. Lower platform right end is attached with bearing inserted with shaft attaché with drilling chuck and drill bit in it for drilling operation. Below this Toggle jack with screw operated clamp is used to hold the work piece for drilling. Because of this arrangement we are able to hold tightly the workpiece and move up down axles as per requirement. For cutting operation we used the cutting wheel and workpiece hold by worker for required amount of cutting of workpiece. Cutting disc mounted on shaft interested in bearing and other end of shaft with bevel gear 90^0 mesh with other bevel gear mounted on shaft common for drilling and cutting operation power supply. Also for polishing operation the polishing belt is mounted on the shaft which one end is fixed attached with the bevel gear meshing with the cutting wheel attached bevel gear making the differential mechanism. And belt other end also mounted on other shaft linearly with tension.

B. Working Principles

There are only three major principles on which system generally works:

1) Belt pulley mechanism
2) Power transmission through bevel gears

C. Working of the Model

In the model of “Multi operational mechanical system” we are giving electric supply to the two shaft motor as shown in figure.3.2, as grinding wheel start to rotate at high speed where we able to perform grinding operation workpiece as shown in fig 3.2 While other motor shaft mounted with pulley start rotating where belt on it. This belt on other end next pulley mounted on the shaft common for drilling and cutting as well as polishing operation. This shaft start rotating with both sides attached bevel and give power further bevel gears mesh at 90^0. Drill holder with drill bit will rotate at high rpm ready to drill the workpiece. Workpiece will place between screw operate clamps mount on toggle jack for up down movement.

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Figure 3.2 Set Up of Multioperational Mechanical System Top View

On other hand, bevel gears will rotate and transmit the power to the shaft connect to the cutting wheel. Also with this bevel gear pinion is mesh and attach to shaft on which the polishing belt placed on it. As per this, all three operations will perform simultaneously using single power supply and at near working centres.

D. Operations performed by System

As shown in figure 3.1, Multioperational mechanical system performed following four operations using single power source i.e. dual shaft motor.

1) *Grinding :* Material removal and surface generation are the processes involved in grinding process that is intended to shape and finish the components that are created by metals and other materials. The exactness of the operation and the surface finish obtained by grinding process exhibit performance of up to 10 times when compared to turning or milling process. Grinding makes use of an

Figure 3.3 Grinding operation

abrasive product. The product used by the grinding machine is generally the rotating wheel. The wheel which is rotating experiences a controlled contact with the work surface. The wheel in the grinding machine is called as the grinding wheel, which is created by abrasive grains that are kept together in a binder. These grains possess a similar functionality as that of the cutting tools which involve in removing tiny chips of material that are generated during the operation. When the abrasive grains become torn and worn out, the additional resistance causes fracture to the grains and deterioration to the bonds. The pieces which are dull break. And only those that are fresh exposing sharp grains endure the cutting operation.

2) *Drilling :* The functionality that involves in causing a hole into the work-piece by the aid of a rotating cutter is called drilling and the rotating cutter device used is referred as drill. As shown in figure Bevel gears mesh with each other in 90^0 in which main shaft is attaché tothe horizontal gear and drill chuck shaft to vertical gear. Because of this arrangement drill bit rotate at high-speed and this arrangement makes drill chuck stationary.

Figure 3.3 Drilling operation

Workpiece is mounted on the toggle jack on which flat plate with nut and bolt arrangement on it to hold the workpiece. Toggle jack is used to move the workpiece up and down while the drill chuck is stationary. In general arrangement workpiece is stationary and drill bit moves up and down.

3) *Cutting :* If all raw stock was delivered in ready-to-machine shapes and sizes, there would be no need for sawing machines in a metal working shop. Machine operators could merely go over to the stock. Select the suitable work piece and perform the necessary finishing operations such situation rarely exists, due to the fact that the majority of the stock requires to be cut in some way prior to starting a machining schedule. The alternative to this primary operation of sawing is to buy-in prepared lengths and shapes; this however introduces a service which the company has to pay for and, in the majority of the cases it is simpler and more economical to carry out the basic cutting to size operation in house.

Figure 3.4 Cutting operation

One of the major advantages of sawing over all other kinds of machining is the narrowness of cut op. Most sawing machines perform the cut-off operation, where a piece of stock is cut to a workable length prior to subsequent machining operations. Machines that accomplish this job include hacksaws, band saws and circular saws. As shown in figure 3.1 to perform cutting using cutting wheel. Cutting wheel rotate at high speed and workpiece is hold by worker which cutting according to the requirement.

4) *Polishing :* Polishing and buffing are finishing processes for smoothing a workpiece's surface using an abrasive and a work wheel or a leather strop. Technically polishing refers to processes that use an abrasive that is glued to the work wheel, while buffing uses a loose abrasive applied to the work wheel. Polishing is a more aggressive process while buffing is less harsh, which leads to a smoother, brighter finish. A common misconception is that a polished surface has a mirror bright finish, however most mirror bright finishes are actually buffed.

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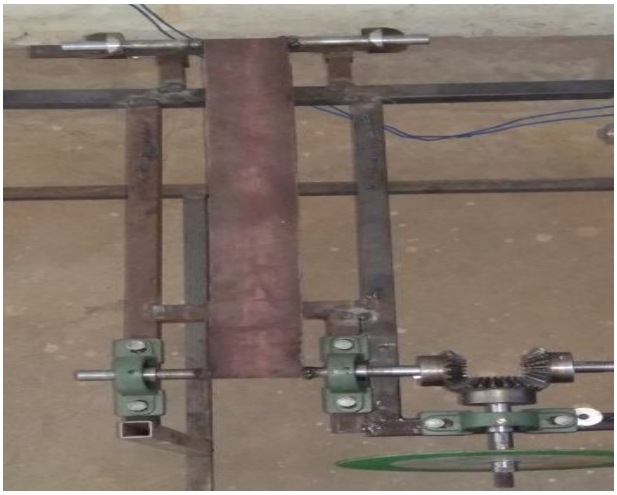

Figure 3.5 Polishing operation

Polishing is often used to enhance the appearance of an item, prevent contamination of instruments, remove oxidation, create a reflective surface, or prevent corrosion in pipes. In metallography and metallurgy, polishing is used to create a flat, defect-free surface for examination of a metal's microstructure under a microscope. Silicon-based polishing pads or a diamond solution can be used in the polishing process. Polishing stainless steel can also increase the sanitary benefits of it. The removal of oxidization (tarnish) from metal objects is accomplished using a metal polish or tarnish remover; this is also called polishing. To prevent further unwanted oxidization, polished metal surfaces may be coated with wax, oil, or lacquer. This is of particular concern for copper alloy products such as brass and bronze. In our model as shown in fig polishing belt is mounted on two shaft parallel to each other and inserted in ball bearings. Drive shaft is attaché to the bevel gear which is mesh with other gear and gets power to rotate the belt. We did the polishing operation on driven shaft.

IV. RESULTS AND DISCUSSION

The main goal of the work proposed is to signify an innovative concept. For this, certain useful data are extracted from our theoretical model, and a calculation on the deviation percentage derived from the standard calculated values is deliberated as follows.

A. Calculation of Grinding Speed

As in Multioperational mechanical system, grinding wheel is fixed to the shaft of dual shaft motor. So the speed of motor is the speed of grinding wheel so the speed of motor is 1440 rpm because of that theoretical speed of grinding wheel is 1440 rpm for grinding operation. But using tachometer, the speed of grinding wheel measured as 1490 rpm.

B. Calculation of Drilling speed

To calculate drilling chuck theoretical speed we need to first the common shaft speed so,

$$\frac{d}{D} = \frac{N_1}{N_2} \qquad \frac{125}{414} = \frac{1440}{N_2}$$

N_2 = 435 rpm

And using tachometer, the actual speed of common shaft is 460 rpm

Now theoretical speed of drilling chuck

$$\frac{T_P}{T_g} = \frac{N_1}{N_2}$$

$$\frac{18}{30} = \frac{460}{N_2}$$

N_2 = 276 rpm

And using tachometer actual speed of drilling chuck comes 290 rpm

C. Calculation of Cutting Speed

As we calculated the common shaft theoretical speed is 460 rpm and its one end is attaché gear which mesh with the gear wheel cutting wheel is attached.

$$\frac{T_P}{T_g} = \frac{N_1}{N_2}$$

$$\frac{18}{24} = \frac{460}{N_2}$$

N_2 = 345 rpm

And using tachometer we measured the cutting speed of 360 rpm

D. Calculation of polishing speed

To calculate the theoretical polishing belt speed, we took the gear teeth ratio of gear which attaché to polishing belt shaft and cutting wheel attaché shaft as both meshes with each other.

So

$$\frac{T_P}{T_g} = \frac{N_1}{N_2}$$

$$\frac{24}{18} = \frac{345}{N_2}$$

= 460 rpm

Theoretical speed of polishing belt is 460 rpm but using tachometer the speed measured is 485 rpm.

In following table 4.1 all process actual speed and theoretical speed are summarized

Table no 4.1 Theoretical and actual speed of different mechanical operations

Sr.No.	Mechanical Operation	Theoretical Speed (Rpm)	Actual Speed (Rpm)
1	Grinding	1440	1490
2	Drilling	276	290
3	Cutting	345	360
4	Polishing	460	485

V. CONCLUSION

We can see that all the production based industries want low production cost and high work rate which is possible through the utilization of multipurpose machine which will require less power as well as less time, since this machine provides working at different centers it really will reduce the time consumption up to appreciable limit. In an industry a considerable portion of investment is being made for machinery installation. So we conclude in this project, proposed system which can able to perform operations like drilling, sawing, grinding and polishing at different working centers simultaneously which implies that industrialists have not to pay for machine performing above tasks individually for operating operation simultaneously. This efficiently reduces the size of the system because of the use of dual shaft motor. Due to the combing of systems, maintenance cost of the system also reduces. The main advantages of this system are that it is easy to rectify the fault and increase the productivity of the system with less input electricity used.

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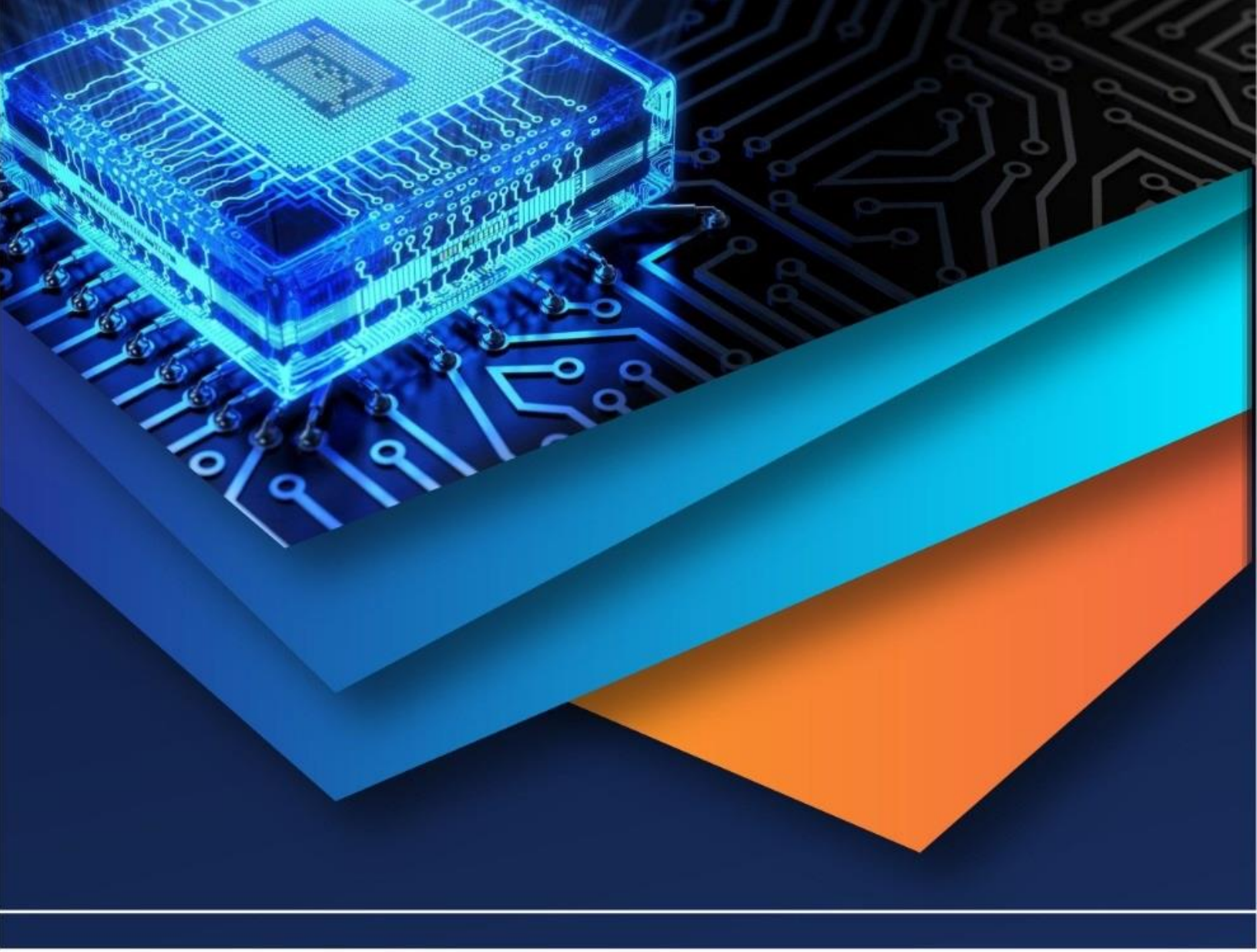

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