

DESIGN AND FABRICATION OF MULTIPURPOSE MECHANICAL MACHINE

Saikat Dey¹, Dr Sajal Chandra Banik² and Swapnil Das³

¹⁻³Department of Mechanical Engineering
Chittagong University of Engineering and Technology, Chittagong-4349, Bangladesh
¹deysaikat838@gmail.com, ²baniksajal@yahoo.com, ³swapnil.mecuet@gmail.com

***Abstract-** This project aims to develop a conceptual model of a mechanical machine which can perform multi-operations such as Drilling, Cutting and Grinding. This project will facilitate us to get the operation performed at different working center simultaneously as it is getting drive from single power source. Bevel gear mechanism is used in this machine for transmitting required speed at three working centers. V belt and v belt pulley is used to transmit power from electric motor to the main shaft. This model is designed to be a portable one and economically efficient. The main objectives of this model are conservation of electricity, reduction in cost associated with power usage, increase in productivity, reduced floor space.*

Keywords: Bevel Gear, V belt, V belt pulley.

1. INTRODUCTION

Machine employs power to achieve desired forces and motion. A machine has a power source and actuators that generate forces and movement and a system of mechanisms that shape the actuator input to achieve a specific application of output forces and movement. Multi-purpose mechanical machine, also known as multi-function operating machine is machine which can perform multi operations simultaneously. This project is designed to perform three operations like grinding, cutting, drilling at the same time. One electric motor is used to run the machine and gear mechanism is the obligatory part of this machine. Bevel gear is used in this model for power transmission at different working centers. Corresponding machine tools are mounted on the respective shafts for required operation. This machine can be implemented to get useful services at low machinery cost and low inventory cost and it will help industries where a considerable portion of investment is being made for machinery installation. Moreover, lathe machines are quite costly and heavy one. Mini lathe machine is an advancement over conventional lathe machine. But, buying a lathe machine is problematic for small scale industries. This project may be an approach to solve financial problems and fabricate a model for performing multi operation at a lower cost.

2. LITERATURE REVIEW

Perhaps the first example of a human made simple machine is hand axe, made to form wedge and the idea of that machine came from a very well-known Greek philosopher Archimedes around the 3rd century BC. Then day followed day, night followed night, various

types of machine both single and multipurpose are designed for various purposes. Consultation over various research paper makes an important impact on this project.

Dharwa Chaitanya Kirtikumar[1] designed and developed a multipurpose machine which does not require electricity for several operations like cutting, grinding etc. This is a human powered machine runs on chain drives mainly with human efforts. But it can also be operated by electric power. It has some special attachment so use both human power as well as electric power. The design is ideal for use in the developing world because it doesn't require electricity and can be built using metal base, chain, pulley ,rubber belt, grinding wheel, saw, bearing, foot pedal (for operated by human) ,electric motor, chain socket.

S.G.Bahaley, Dr A.U. Awate, S.V. Saharkar[2] designed and fabricated a pedal powered multipurpose machine. It is a human powered machine which is developed for lifting the water to a height 10 meter and generates 14 Volt, 4 ampere of electricity in most effective way. Power required for pedaling is well below the capacity of an average healthy human being. The system is also useful for the work out purpose because pedaling will act as a health exercise and also doing a useful work. The pedal powered multipurpose mechanical machine is shown in figure 2.1.



Fig 2.1: Pedal powered Multipurpose Machine

Linxu, Weinan Bai, Jingyu Ru, Qiang Li [3] designed and developed an automatically reciprocating pedal powered electricity generator (ARPPEG) in conjunction with the management and control over harvesting the kinetic energy, electricity generation, electric storage and the output of electricity. According to the operation testing results, this system has been proved to be effective in power generation. In view of the simple structure and low costs of this system without territory and time limits, the application of ARPPEG designed by them could open a new path to saving the energy and helping build a new energy society.

Dr. Toshimichi Moriwaki[4] has revealed a recent trends in the machine tool technologies that surveyed from the view point of high speed and high performance machine tools, combined multifunctional machine tools, ultra precision machine tools and advanced and intelligent control technologies. 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.

3. ESSENTIAL EQUIPMENT

The basic components that are used to construct this model are described below:

3.1 Electric Motor

An electric motor is an electrical machine that converts electrical energy into mechanical energy. Electric motors can be powered by DC and AC sources. Electric motors are used to produce linear or rotary force (torque). Motors are used normally to drive any shaft. Different types of motor varying in rpm change and powering source are available. An AC motor is used in this project to get the operations done. The AC motor commonly consists of two basic parts, an outside stationary stator having coils supplied with alternating current to produce a rotating magnetic field, and an inside rotor attached to the output shaft producing a second rotating magnetic field. Single phase AC electrical supply is what is typically supplied in a home. Three phase electrical power is commonly only available in a factory setting. AC motors are usually sized in horsepower. The most common sizes are what are called fractional horsepower motors, such as 1/2 horse power or 1/4 horsepower.

3.2 Bevel Gear

Bevel gears are the type of gears that are designed to transmit between axes. Perpendicular arrangements are most common, but bevel gears can be manufactured for nearly any angle. As the term “bevel” would suggest, the face of a bevel gear is angled. Typically, a bevel gear is conical in shape, with the teeth running along the side of the cone, and the angle of the sides can be varied, depending on the application for the gear. The beveled design allows the gear to intermesh with another bevel gear at several different angles, depending on how it has been machined. There are many types of bevel gears - straight bevel gears, spiral bevel gears, hypoid bevel gears. It can be categorized according to number of teeth and tooth line. Bevel gears are normally used in automobile for differential mechanism.

3.3 Drill Bit

Drill bits are cutting tools used to remove material to create holes, almost always of circular cross-section. Drill bits come in many sizes and shape and can create different kinds of holes in many different materials. In order to create holes, drill bits are attached to a drill which powers them to cut through the job material, typically by rotation. The drill will grasp the upper end of a bit called the shank in the chuck. Drill bits are many types and made of on different materials depending upon their application. Twist drill bits, step drill bits, center and spotting drill bits, core drill bits, left hand bits, metal spade bits are most common drill bits used for wood, metal, plastic and most other materials.

3.4 Drill Chuck

A drill chuck is the part of a drill that holds the rotating drill bit. Drill chucks are designed to hold the bit tightly and not loosen even when there is a high amount of torque. They can also be used to hold other types of rotating tools, such as screwdrivers or rotating spades for making large holes. Drill chucks can be keyed or keyless, depending on the preference of the user and the requirements of the tool. A keyed drill chuck requires a removable key to open and close it. The key is a T-shaped tool that is inserted next to the chuck. When the chuck key is turned, it moves a gear that makes the collar rotate around the jaws to open or close them. A keyless drill chuck works on a similar principle, but instead of a key, the user turns the chuck with a sleeve at the end of the drill to open and close the jaws. Some people prefer keyless chucks, especially for home power drills, because the chuck key can easily be misplaced. However, a keyed chuck can hold the bit more tightly since it gives more torque and can be tightened by hand more efficiently using less force. Home drill chucks have up to six jaws, depending on how thick the surfaces are that the drill needs to penetrate. The more jaws a chuck has, the stronger it is. Four jaws are needed in a drill chuck that will hold a square bit. Most power drill chucks for home use have three jaws, and they are self-centering. This means that the three jaws move inwards and outwards evenly to grip a round bit and hold it straight. Drill chucks with independent jaws are used to hold oval bits, or in specialized jobs that require a great deal of precision

in centering the bit.

3.5 Grinding Wheel

A grinding wheel is an abrasive tool used to cut a material or polish a surface. It typically consists of a steel or aluminum disc, with a rough finish that is made up of particles held together with a gluing or bonding agent. There are many different types, sizes, and grades of grinding wheels. Common wheel types include straight, tapered, and cut-off, but there are many others available as well. The type of material and size of particles used generally determines the abrasiveness of the surface, and cutting action of the grinding wheel. The most common families of materials used for the abrasive particles are silicon carbide and diamond. There are many variants of these abrasive materials. Selecting the right grinding wheel for a specific application is primarily determined by the hardness of the material being cut. The abrasive material, bonding agent, density, grade, and grain-size are all also key considerations. The physical size of the abrasive particles, known as grain-size, will affect the cutting performance of the grinding wheel. A fine grain will remove less material, and is normally used for polishing and to achieve a fine surface finish. A large grain-size will cut material quickly, but create a rough surface finish. A grinding wheel is most often used in a grinder, which is a machine specifically designed for mounting and rotating the wheel at very high speeds.

3.6 Disc Cutter

A disc cutter is a specialized, often hand-operated, power tool used for cutting hard materials. It is type of machine tool used for cutting operation. It is a circular flat plate containing blade and type of power tool that is powered by electric motors. It is used for cutting different materials and selection of cutter depends on the hardness of material being cut. The base material, bonding agent, density, grade, and speed are all also key considerations. This machine tool is very similar to an angle grinder, with main difference being cutting disc itself.

3.7 Belt (Mechanical)

A belt is a loop of flexible material used to link two or more rotating shafts mechanically, most often parallel. Belts may be used as a source of motion, to transmit power efficiently, or to track relative movement. Belts are looped over pulleys and may have a twist between the pulleys, and the shafts need not be parallel. In a two pulley system, the belt can either drive the pulleys normally in one direction or the belt may be crossed, so that the direction of the driven shaft is reversed (the opposite direction to the driver if on parallel shafts). Many styles of belts are often used in tools, such as electric drill motors, milling machines and lathes. A round belt is also commonly found in vacuum cleaners, kitchen appliances and limited automotive uses. Designed to provide optimal grip in a low-torque application, the round belt also is widely used in applications where the belt is required to twist, such as the case of two crossing jack-shafts. Unlike a typical V-belt commonly referenced as a fan belt, the rubber

used to manufacture round belts is very soft and pliable. This soft consistency allowed the belts to be stretched around two pulleys or shafts and operated without the aid of a belt tensioning pulley. The tendency of the rubber to become even stickier, therefore providing more grip as it becomes heated due to friction caused from minor slippage, makes this belt a good choice to use on a lathe or drill motor.

3.8 V Belt Pulley

A pulley is a type of wheel that is affixed to the motor or engine and is used to guide a belt that helps power peripheral devices. The type of motor pulley can vary according to its purpose. A v belt pulley is any type of pulley system that uses a v belt. These kinds of belts are called v belts because the cross section of them resembles the letter “v,” with the outer edge of the belt being wider while the inside edge is more narrow. Every v belt, with the exception of Harvester and Wedge belts, has a 40 degree angle between its faces. The inside edge of a v belt is normally more outstretched at the base than the “v” shaped groove in the v belt pulley wheel, allowing the grooves in the pulley and the belt to move past each other by friction. One of the main purposes of the pulley is to accommodate users with a pulley system that is easy to assemble and replace. The v belt pulley is widely used in automobile parts and industrial machinery because it has benefits over other transmission forms. It also provides quiet operation, simple and economical replacement, and effective grip. A v belt pulley is often made out of cast iron or steel because of its efficiency and resistance to wear. The designs and specifications can vary.

3.9 Hexagonal Nut and Bolt

A nut is a type of fastener with a threaded hole. Nuts are almost always used in conjunction with a mating bolt to fasten two or more parts together. A hexagonal nut is a type of metal fastener that has six sides. Most nuts are cut in a hexagonal shape, since it seems to be the easiest shape to grasp. Nuts may be made from steel, aluminum alloy, brass, and other materials, though steel hexagonal nuts are used more than any other type. Each side of a nut is frequently coated with a rust-proof material in order to prevent it from rusting. Nuts that have been rust-proofed can be used for both indoor and outdoor purposes.

A bolt is a form of threaded fastener with an external male thread. A machine bolt, also called a machine screw bolt, is a cylindrical fastener used to clamp two pieces of metal together. The bolt consists of a threaded shaft with a square- or hexagon-shaped head at one end. The shaft of the bolt is inserted through holes drilled in both pieces of metal, and a nut is threaded onto the protruding threads of the bolt. Proper clamping pressure is applied by tightening the nut to a specified torque. In some applications, a nut is not used, as the threads of the bolt engage a threaded hole in the second piece of metal. Most machine bolts are manufactured from low or medium carbon steel, although bolts made from stainless steel and silicon bronze are available as well. Stainless steel and silicon bronze bolts resist corrosion much better

then carbon steel ones, and are typically used in applications where they will be exposed to the elements. Aluminum and brass machine bolts are available for specialty applications in the aerospace and marine industries. Machine head bolts are available in both standard and metric sizes, and in left and right-handed threads. Coarse- and fine-thread varieties are available as well. A machine bolt can be categorized into one of several grades based on tensile strength and material composition. The three most commonly used grades in the US are grades two, five and eight.

3.10 Bearing

A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts. Rotary bearings hold rotating components such as shafts or axles within mechanical systems, and transfer axial and radial loads from the source of the load to the structure supporting it. The simplest form of bearing, the plain bearing, consists of a shaft rotating in a hole. Lubrication is often used to reduce friction. In the ball bearing and roller bearing, to prevent sliding friction, rolling elements such as rollers or balls with a circular cross-section are located between the races or journals of the bearing assembly. Ball bearings, also known as anti-friction bearings, are small metallic or ceramic spheres used to reduce friction between shafts and axles in a number of applications. They are often used in a series to absorb the weight placed on a moving part, or in individual cages to reduce friction in axle assemblies. Most are manufactured to meet very exacting standards of roundness, since any deformation can cause the moving parts to fail unexpectedly. A wide variety of bearing designs exists to allow the demands of the application to be correctly met for maximum efficiency, reliability, durability and performance. Common motions permitted by bearings are axial motion, linear motion, spherical motion, hinge motion. Different bearing types have different operating limits. Speed is typically specified as maximum relative surface speeds. Generally there is considerable speed range overlap between bearing types. Plain bearings typically handle only lower speeds, rolling element bearings are faster, followed by fluid bearings and finally magnetic bearings which are limited ultimately by centripetal force overcoming material strength. Bearings required periodic maintenance to prevent premature failure and many others require little maintenance.

4. CONSTRUCTION AND OPERATION

4.1 Design

Before constructing the project, a model has been designed by using SolidWorks. The SolidWorks design is inserted below:

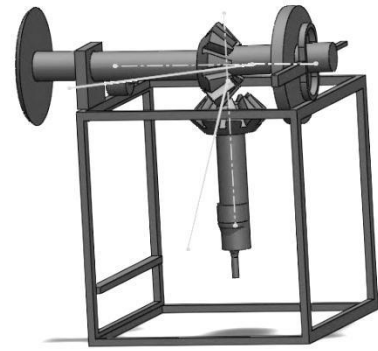


Fig 4.1: SolidWorks design of the project

4.2 Construction and Operation

In this project, the basic structure is made through a square frame. Other components are mounted on it with the help of drilling. Three shafts are provided for carrying grinding wheel, disc cutter and supporting drill chuck. The shafts are supported through bearings. Grinding wheel and disc cutter is made concentric with bolts and tightened with hexagonal nuts. The shaft carrying the drill chuck is also supported by a bearing. The outer end of the bearing is covered with bearing cover and it is welded to the frame. A base is set at the end of drilling center to provide feed motion. Rotary and reciprocating motions are available at that base. The major principle behind this project is power transmission through bevel gears. Bevel gear arrangement is implemented to transmit the required power at three working centers. Bevel gears are meshed effectively. Finally, an electric AC motor is mounted on the frame and connected with shaft through v belt pulley and v belt. The side view and top view of final model is shown in figure 4.2 and figure 4.3 respectively.



Fig 4.2: Final setup of the project (side view)



Fig 4.3: Final setup of the model (top view)

5. CONCLUSION

This multipurpose mechanical machine is effective for small industries. For practical applications this is fabricated for light duty operation. Its height, settings and other mechanical designs may not be suitable for heavy operation. Though simultaneous operation of different working center is a difficult task, it is overcome by proper alignment of equipment. No calculations are made for controlling vibration and reduction of noise and replacement of belt will be problematic. Effective speed for grinding operation is not available at this design. Motor with high horse power can be used for getting required speed but it will create problem for drilling operation as high speed is not recommended for that operation. Although the operations performed by this machine can be done by lathe machine, it is considered to be an advancement over conventional lathe machine. This conceptual model of multi-purpose mechanical machine will be a solution to the production based industries who want low production cost and high work rate. It also minimizes cost of power usage and cost of installation as a handsome portion of investment of an industry is used for installation of machine.

Again, simultaneous operation at different working centers will reduce the time consumption at an appreciable limit and it facilitates with low maintenance cost. So, this project may be useful in all industries though it is fabricated for light duty operation. Further modifications can be made for better control and functioning. Various operations can be performed individually by using coupling (engagement and disengagement) between them and speed regulator can be used.

6. REFERENCES

References that are used for preparing this report is mentioned below:

- [1] Dharwa Chaithanya Kirthikumar, "A Research on Multi- Purpose Machine", *International Journal for Technological Research in Engineering*, Vol.1, Issue.1, ISSN:2347-4718, 2013.(access on 2 July, 2016)
- [2] S.G. Bahaley, Dr A.U. Awate, S.V. Saharkar, 'Performance analysis of Multipurpose Mechanical Machine', *IJERD*, Vol. 1 e- ISSN:2278-0181 (access on July 2, 2016)
- [3] Linxu, Weinan Bai, Jingyu Ru, Qiang Li, "Design and Implementaion of the Reciprocating Pedal Powered Electricity Generating Device", *Advanced Materials Research* , Vol.282-283, 2011, pp 735-738. (access on July 2, 2016)
- [4] Dr. Toshimichi Moriwaki "Trends in Recent Machine ToolTechnologies" Professor Department of Mechanical Engineering Kobe University ,NTN Technical Review No.74(2006).(access on July 2, 2016)