Design and Fabrication of Drilling Cum Cutting Machine

Rajendra Kelwa

Abstract— In an industry a considerable portion of investment is being made for machinery installation. So in this project I have a proposed a machine which can perform operations like drilling, cutting 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. This project presents the concept of Multi-Function Operating Machine mainly carried out for production based industries. I have developed a conceptual model of a machine which would be capable of performing different operations simultaneously and is also economically efficient. On the main shaft a bevel gear system is used for power transmission at two locations. These bevel gears are used to transmit motion in the radial direction and drives drilling centre. By using scotch yoke mechanism perform cutting operation. This model facilitates to complete two operations simultaneously with a single power source.

Index Terms— Design, Fabrication, Drilling and Cutting, Multi-Operations, Machine.

1. INTRODUCTION

Industries are basically meant for production of useful goods and services at low production cost, machinery cost and low inventory cost. Nowadays, every task has been made quicker and fast due to technology advancement but this advancement also demands huge investments and expenditure. Every industry desires to increase the productivity rate maintaining the quality of the product at comparatively low cost. In any industry considerable portion of investment is being made for machinery installation.

The present work mainly focuses on designing and developing a new machine which can perform two different operations viz. Drilling and Cutting. Lathe is a versatile machine tool which can perform any operation desired. However, some of them are to be carried out at different working centers where as with the present machine this need is eliminated due to the fact that the operations were performed 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 sector. Manufacturing provides important materials support for national infrastructure and for national defense also. It performs multiple operation simultaneously, giving the workers more opportunity to perform their work quickly and efficiently without the hassle of using different machines for performing different operations on work piece.

1.1 Machine equipments:

Drilling: A drill is a tool fitted with a cutting tool attachment, usually a drill bit used for drilling holes in various materials or fastening various materials together with the use of fasteners. The attachment is gripped by a chuck at one end of the drill and rotated while pressed against the target material. The tip of the cutting tool does the work of cutting into the target material. Drills are commonly used in woodworking, metalworking and construction. Specially designed drills are also used in medicine, space missions and other applications. Drills are available with a wide variety of performance characteristics, such as power and capacity.

Bevel gear: A bevel gear is a type of mechanical gear. These 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 bevel gears is a cone.

Fig.1 Bevel gear

Vice: It is a device consisting of two parallel jaws for holding a work piece; one of the jaws is fixed and the other movable by a screw, a lever, or a cam. When used for holding a work piece during hand operations, such as filing, hammering, or sawing, the vise may be permanently bolted to a bench. In vises designed to hold metallic work pieces, the active faces of the jaws are hardened steel plates, often removable, with serrations that grip the work piece; to prevent damage to soft parts, the permanent jaws can be covered with temporary jaws made from sheet copper or leather. Pipe vises have double V-shaped

jaws that grip in four places instead of only two. Woodworking vises have smooth jaws, often of wood, and rely on friction alone rather than on serrations. For holding work pieces on the tables of machine tools, vises with smooth hardened-steel jaws and flat bases are used. These machine vises are portable but may be clamped to the machine table when in use; means may also be provided for swiveling the active part of the vise so that the work piece can be held in a variety of positions relative to the base.

Bearing: A bearing is a device to permit constrained relative motion between two parts, typically rotation or linear movement. Bearings may be classified broadly according to the motions they allow and according to their principle of operation. Low friction bearings are often important for efficiency, to reduce wear and to facilitate high speeds. Essentially, a bearing can reduce friction by virtue of its shape, by its material, or by introducing and containing a fluid between surfaces. By shape, gains advantage usually by using spheres or rollers. By material, exploits the nature of the bearing material used. Sliding bearings, usually called bushes bushings journal bearings sleeve bearings rifle bearings or plain bearings. Rolling-element bearings such as ball bearings and roller bearings. Jewel bearings, in which the load is carried by rolling the axle slightly off-center. Fluid bearings, in which the load is carried by a gas or liquid magnetic bearings, in which the load is carried by a magnetic field. Flexure bearings, in which the motion is supported by a load element which bends. Bearings vary greatly over the forces and speeds that they can support. Forces can be radial, axial (thrust bearings) or moments perpendicular to the main axis. Bearings very typically involve some degree of relative movement between surfaces, and different types have limits as to the maximum relative surface speeds they can handle, and this can be specified as a speed in ft/s or m/s. The moving parts there is considerable overlap between capabilities, but plain bearings can generally handle the lowest speeds while rolling element bearings are faster, hydrostatic bearings faster still, followed by gas bearings and finally magnetic bearings which have no known upper speed limit.

Drilling tool: Drilling tool is a cylindrical end-cutting tool used to originate or enlarge circular holes in solid material. Usually, drills are rotated by a drilling machine and fed into stationary work, but on other types of machines a stationary drill may be fed into rotating work or drill and work may rotate in opposite directions. To form the two cutting edges and to permit the admission of a coolant and the ejection of chips, two longitudinal or helical grooves or flutes are provided. The point or tip, of a drill is usually conical in shape, and it has cutting edges where the flutes end. The angle formed by the tapering sides of the point determines how large a chip is taken off with each rotation of the drill. The degree of twist of the helical flutes also affects the drill's cutting and chip-removal properties. For general purpose twist drills the helix angle is about 32°. The angle formed by the two sides of the tapering point is 118° for standard drills, while for drilling tough metals, a flatter point with a 135° angle is recommended. The peripheral portion of the drill body not cut away by the flutes is called the land, and to reduce friction and prevent the land from rubbing against the sides of the hole, most of the land is cut away, leaving a narrow ridge called the margin that follows the edge of the side of the flute that forms the cutting edge. The fluted part, or body, of a drill is either hardened high-carbon steel or high-speed steel; other drills have inserts of cemented carbide to form cutting edges or are made from sintered-carbide rods. The shanks of twist drills are either straight or tapered and when not integral with the body are made from low-carbon steel and welded to the body.

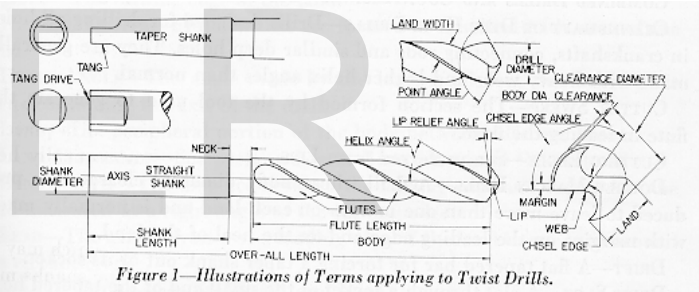

Figure 1—Illustrations of Terms applying to Twist Drills.

Fig.2 Drilling tool

1.2 Part Descriptions:

Sr. no.	Part Name
1	MOTOR
2	BELT AND PULLEY
3	BEARING
4	SHAFT
5	BEVEL GEAR
6	DRILL CHUCK
7	CLAMPING VICE
8	CUTTER

9	BASE FRAME

1.3 Advantages and Applications:

Advantages- Low manufacturing & maintenance cost.

Reduces time and increases production rate.

Easy to operate

Low maintenance

Easy to implement

Application- Used in small scale industries to reduce machine cost.

In such places where frequent change in operation are required.

2. LITERATURE REVIEW

Heinrich Arnold conducted a study with more than 100 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 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 states that 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. Multi-purpose machines are the declarations of independence. The trend towards the kind of multi- purpose machining centre's that are able to cost efficiently handle a broad portfolio of products with small batch sizes accelerated significantly during the crisis. "With a multi-purpose machine, you're less dependent on particular products and sectors", explains Biermann.

2.1 Multi-Purpose Machine Tool:

The basic components of the machine tool are motor, bevel gears, bearings, drill chuck, pulleys, V-belt and hack saw blade with frame.

2.2 Operations Carried Out by the Multi- Purpose Machine

Drilling: Drilling is the operation of producing circular hole in the work-piece by using a rotating cutter called drill. The machine used for drilling is called drilling machine. The drilling operation can also be accomplished in lathe, in which the drill is held in tailstock and the work is held by the chuck. The most common drill used is the twist drill.

Cutting: Cutting is a process of separating the component / material from the given stock. It is a primary manufacturing process and it calls for subsequent operations to be carried out to bring it to the final shape and size.

2.3 Working of the Modal

Here the bevel gear arrangement is used for carrying out the operations. Bevel gear is used to perpendicular (90) power transmission. One of the bevel gear is connected with the motor and another one with the drill chuck hence when the motor is rotated the drill chuck also rotates. The motor pulley shaft is connected to a scotch yoke mechanism on the other side. scotch yoke mechanism converts rotary motion into reciprocating motion and the reciprocating motion is used for the cutting operation. A vice is mounted on the table to hold the work piece.

3. PROBLEM IDENTIFICATION

PROBLEM STATEMENT: To design and development of multipurpose machine a structure which is designed for the purpose of multi operations i.e., drilling and cutting.

PROBLEM IDENTIFICATION: This machine performs multi operations at the same time with required speed and this machine is automatic which is controlled and operated by motor and run with the help of current. This machine is based on the mechanism of Scotch yoke.

This modal of the multipurpose machine is may be used in industries operation which can perform mechanical operation like Drilling and Cutting.

4. METHODOLOGY

In this project I have generally give the power supply to the shaft on which a bevel gear is mounted on it, and a second bevel gear at a right angle to it has been mounted on a drill shaft to which a drill bit is being attached. At one end of the shaft is connected to power supply, other end is being joined to a circular disc, through this circular disc scotch yoke mech-

anism is being performed (rotator y motion is converted to reciprocating motion).

4.1 Experimental Set-Up

In this conceptual model I have involved the gear arrangement for power transmission at different working -centers, basically gear or cogwheel is a rotating machine part having cut teeth, or cogs, 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. 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.

4.2 Working Principle

There are only two major principle on which our proposed machine (conceptual model) generally works:

1. Scotch-Yoke mechanism.
2. Power transmission through gears.
    a. Bevel gears

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.

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.3 Power transmitted through gear

5. DESIGN FABRICATION &ANALYSIS

5.1 DESIGN AND ANALYSIS:

Power of Motor

P = 100 Watt

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 Milter gear is used. Milter gears are mating bevel gears with equal numbers of teeth and with axes at right angles. The number of teeth of Milter gear selected is 28. 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 cast iron.

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.

Design of Frame: The frame on which the whole components of machine are mounted is termed as table. The material selected for this purpose is steel and this frame is made up of steel angles of 4 mm thickness. The height of the table is taken as 1300 mm whereas length and width as 1000 mm.

5.2 FABRICATION OF THE MACHINE

There are few types of fabrication methods that are done on the machine. They are:

Cutting: In this project it is used to cut the raw material such as plates, rod. This is done by power hexa cutting machine.

Drilling: Drilling is used to produce holes in objects. In this project the square type pipe required the holes for making assembly. These holes are done by vertical type drilling machine.

Grinding: It is nothing but a grinding process, which is done as smooth with fine grains. It is done by convention grinding machine.

Turning: It is used in this project to make the groove on the both sides of top cover plate. This is done by conventional lathe.

5.3 Further Operations

Cleaning: It is the operation to clean the all machined parts without burrs, dust and chip formals. By meaning the parts they are brightened and good looking.

Assembling: It is the operation, its deals with the assembling of various parts produced by above operations.

5.4 Final Model of the Drilling cum Cutting Machine

Fig.4 Model of Drilling cum Cutting Machine

In fig.5 shows the drilling operation performs by the model. In this two bevel gear is attached at90 degree one is mounted on the main shaft and another is mounded on other shaft and the other end of this shaft mounted the Drilling chuck.

Fig.5 Drilling operation on the Model

In fig.6 shows the power hexa cutter in which the cutting operation is perform. In this a reciprocator is attached with the main shaft.

Fig.6 Cutting operation on the Modal

6. RESULT & CONCLUSION

RESULT: The following comparisons can be drawn from the work carried out.

Table- Individual Vs Multi-Purpose Machine:-

Sr. No	Type of Machine	Cost Range of Basic Individual Machines with Multi-Machine
1	Individual Machine	Drilling Machine: Rs. 10,000-15,000 Power hacksaw cutting machine: Rs.8,000-10,000
2	Multi Machine	Cost of Multi Purpose Machine: Rs. 10,000

So that we can ultimately reduce the overall manufacturing cost compared to individual cutting, and drilling machines. This also reduces the floor space when compared to Individual Machines. The overall power consumption is also reduced by the replacement of Individual Machines with Multi-machines.

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 machine which will less power as well as less time, since this machine 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.

In this project I have aimed to reduce workload, space, time,

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.

The following conclusions can be drawn:

- The machine is useful particularly for small scale industries.
- Workers movements can be minimized.
- Number of operations can be carried out on the single machine.
- Power consumption is reduced.
- Floor area required is reduced.
- Cost of manufacturing is also reduced.
- Two different operations viz. drilling and cutting.

7. FUTURE WORK

a. We can perform various operations like drilling, cutting or shaping individually by introducing coupling (engagement and disengagement) between them.

b. We can perform grinding operation by introducing a grinding tool at the main shaft.

c. We can perform boaring operation by introducing a boaring tool replacing drilling tool.

d. We can change the speed of motor by regulator.

8. REFERENCES

[1] V.B. Bhandari, "Design of Machine Elements", TMH Publishers, New Delhi, 2ndEdition, 2013.

[2] R.K. Jain, Machine Design, Khanna Publishers, New Delhi.

[3] Joseph E.Shigely, "Mechanical Engineering Design", TMH Publishers, New Delhi, 9th Edition, 2010

[4] R.K Jain and S.C Gupta, "Production Technology", Khanna Publishers, 17thEdition, 2012.

[5] Dr. ToshimichiMoriwaki, "Trends in Recent Machine Tool Technologies", Professor Department of Mechanical Engineering, Kobe University, NTN Technical Review No.74, 2006.

[6] D. Chaithanya, "A Research on Multi Purpose Machine", International Journal for Technological Research in Engineering, Vol.1, Issue.1, ISSN: 2347-4718, 2013.

[7] Heinrich Arnold1"The recent history of the machine tool industry and the effects of technological change "University of Munich, Institute for Innovation Research and Technology Management, November 2001.