
DESIGN AND FABRICATION OF 360 DEGREE FLEXIBLE DRILLING MACHINE

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ABSTRACT

Nowadays, the drilling machines are growing very rapidly with many uses as well as applications. The conventional drilling machines have limited movements and directions which is a major drawback for them. They work only in a particular direction. Also, there is very little space between the drill and the job. If we use hand drills, they also have issues with alignment while drilling. To overcome the shortcomings of the conventional drilling machines, we tried to come up with the idea of a 360 degree flexible drilling machine which can work in any direction and can also be adjusted as per the choice. It can be placed on a flat surface like a table or a wall and can be used to drill holes horizontally, vertically or even upside down making it possible for easy drilling in even complicated parts and surfaces. The next advantage is that this machine can achieve greater accuracy and precision since this machine setup can provide proper straightness to the drill bit. Through this machine we can get proper and efficient holes on the workpiece rather than the drill bits getting deformed. Another advantage in this machine is that the cost/price of this complete setup and manufacturing is comparatively lower than other drilling machines. The implementation of the project is expected to be good. The handling operations can be easily carried out by the operator. This 360 degree flexible drilling machine can prove its worth in every industry that uses drilling operations because of its great features like selective axis and angle of drilling with the great accuracy and precision. We make use of rotating hinges and connectors with motor mount and supporting structure to design and model a 360 degree flexible drill for easy drilling operations.

Keywords: 360 Degree, Drilling Machine, Drill Bit, Flexibility.

I. INTRODUCTION

Drilling is a cutting and removal of material process in which holes are made or enlarged with the help of a multipoint sharp cutting tool. Other machining techniques that include drilling are, Reaming, trepanning, counter boring and boring. All of these techniques when paired with a linear feed gets to have the same movement. The two different types of drilling are short hole and deep hole drills. The drilling process can be associated to turning in number of ways but the requirements for chip breakage and chip extraction are increasing. In drilling, this is important. The hole dimensions, as well as the size of the hole puts a limit to the amount of machining that needs to be done. The deeper the hole, the harder it is to maintain process control. Along with high quality, another important aspect to be considered is a high material removal rate. The main aim of our project is to study about this 360 degree drilling machine that can drill holes in horizontal, vertical and upside down direction, providing us ease in drilling complicated parts. Connecting arms play a crucial role as with the help of them, we may be able to drill in any axis and any degree as per the requirement. Due to this setup, we can get more accuracy of drilling in the workpiece and eliminate the different needs of different drilling machines. Proper selection of material plays a very important role. The material chosen should be such that it is able to sustain the force and vibrations that are caused by the drilling operations. The materials and components which we would be selecting for our project would resist any kind of vibrations and would make the setup rigid to make accurate drilling. The cost of handling and manufacturing cost is low in this machine compared to the old and traditional drilling machines. This 360 flexible drilling machine is not needed by skilled laborers as it is easy to handle and operate the drilling machine. Another highlight of this drilling machine is that it has its own swivel wheels which makes it portable and the wheels can provide the motion to the table. Due to occupying minimum space and being quite efficient it can prove to be quite helpful to the industries that use drilling operations. Drilled holes can be characterized by their sharp edge on the entrance

side and the presence of burrs on the exit side (unless removed). As the inside of the hole contains helical feed marks, thus we can easily identify the hole.

NEED OF STUDY

From early times we have seen that every industry has relied on drill machines for functioning. It is quite common in the industries now to drill holes in parts, sheets, and structures. To have a perfectly aligned drilling its crucial to make use of powerful and fixed drills. As the distance between the drill bit and the drill bed is quite small, thus some sections cannot be drilled using fixed drills. Making use of hand drills is also not worth here since they have their own shortcomings like alignment issues during drilling. In order to overcome these shortcomings we decided to work on a machine that could remove all the above shortcomings which is a 360 degree flexible drill machine that can be mounted on a table and used to drill holes horizontally, vertically, or even upside down. Due to this property, even complicated pieces and surfaces can be now easily drilled. Thus, we design and build a 360 degree flexible drill for convenient drilling operations by taking help of rotating hinges and connectors, as well as a motor mount and supporting framework.

II. LITERATURE REVIEW

[1]. Mr. K. I. Nargatti, Mr. s. v. Patil, Mr.G. N. Rakate (2016)- This project tries to focus on improving the design & Fabrication of Multiple Spindle Drilling Head for cycle time optimisation of the part. They developed a model that may drill two holes at a time with varying center distance between two drilling spindles.

[2]. R. Anandhan, P. Gunasekaran, D. Sreenevasan, D. Rajamaruthu(2016)- This paper's focus was to make the drill rotate in any direction with ease, so that the job setting is no more complicated and the setting time shall reduce. This method can be considered as a useful method that can control the drilling machine manually. The wood, soft synthetic material, and lightmetals can be easily drilled using this system.

[3]. Mr. Jay M. Patel, Mr. Akhil P. Nair, Prof. Hiral U. Chauhan(2015)-The project is based on 3- Directional drilling machine that focuses on drilling holes based on their various location and movements. Due to this machine the operation can be done with less effort, high precision and accuracy. This method helps to improve the Productivity by reducing the total machining time , human effort and manufacturing cycle time.

[4]. Lookesh kumar sahu, Pranesh kumar sahu, Pranesh Mohan Mishra, Deepak kumar singh, Vijay kumar Yadu(2018)- In this research paper, the author tries to focus on a 360 degree drilling machine which may drill in horizontally, vertically and even upside down direction. The paper involves the use of drill bit that is made from carbon steel.

[5]. Nandewalia Prajal, Malaviya Krunal, Prof. Chauhan Hiral, Prof. vipul Goti(2018)-In this project , the author investigates about the Graphical Drilling Machine, and the author proposes that the drill used here can rotate about two axis which can be the x- axis & z- axis. These drilling machine may be used to drill on materials like wood and metal. And the main purpose of the project was to reduce time and vibration in machine.

[6]. Prof. A.A. Shingavi, Dr. A.D. Dongare, Prof. S.N. Nimbalkar(2015)- In this research paper, the authors discusses the case study and makes comparison of productivity of parts using conventional radial drilling machine and special purpose machine.

III. MATERIALS AND METHODS

The material selection is an important factor which can be able to influence the performance factor of a 360 degree flexible drilling machine. Given below are some of the factors through which we can improve the performance of this machine.

3.1 PHYSICAL PROPERTIES

- High Wear resistance and high cutting ability.
- Maintains high hardness upto a temperature of about 550°C due to which it may be able to cut metals and woods at a high speed.

3.2 MECHANICAL PROPERTIES

- High Tensile Strength
- High fatigue strength
- High fracture toughness and impact strength in order to restrict quick fracture.

3.3 RESISTANCE TO CORROSION

- Low corrosion rate which might increase the life of this machine.

3.4 MANUFACTURING EASE

- The conventional drilling machines used to have heavy metals and complex locomotive mechanisms for the drill machine movements.
- But this flexible drilling machine has a reasonable initial cost, low maintenance cost and has low production cost.

By looking at the above points, we have selected two materials for our machine which are the Mild Steel and High Speed Steel. Their material properties have been discussed in the table below:

Properties	Mild Steel	High Speed Steel
Phase at STP	Solid	Solid
Density kg/m ³	8000	78160
Tensile Strength (Mpa)	440	1200
Yield Strength (MPa)	250	1000
Young's Modulus of Elasticity(GPa)	370	200
Brinell Hardness (BHN)	200	720
Melting Point (C)	1510	1430
Poisson's Ratio	0.3	0.3
Thermal Conductivity (W/m.K)	15	41
Heat Capacity (J/gK)	460	470

DRILLING MACHINE CONSTRUCTION

The fundamental components of a drilling machine are its base, assisting arms, drill head and chuck. The base manufactured from hard fabric might rest on a bench or a ground relying upon its design. Large and heavy machines are grounded on the ground. The arms are placed on the base with the assist of a hinge to make rotation approximately it and supported with the aid of roller. It is correctly machined and the arms can circulate up, down and rotate approximately x-axis. The drill chuck, an electric powered motor and the mechanism which is meant for using the chuck at extraordinary speeds are positioned at the top of the top arm. Power gets transmitted from the electrical motor to the drill chuck.

PROCESS SCHEMATIC:

Drilling consists of axial and rotational motions between the drill and the job. Usually the drill rotates and advances into the job, but at few times the other might get real. The Chips that are formed during the process of drilling can be removed by flowing through the grooves or flutes and thus the coolant is required for higher rate of cutting , tool life.

A. Brad Point Drill Bit (Lip and Spur drill bit)

Brad Point drill bit is variance of the twist bit which can improve drilling in wooden. Brad Point drill bit is likewise called lip and spur drill bit. For metalwork, that is generally encountered via drilling a pilot hollow with a spotting drilling bit. The lip and spur drill bit can be an alternate answer for drilling operation in woods.



B. Twist Drill Bit

Twist drills bits are the widely used among all the drilling bit sorts. This drilling bit can drill / cut anything such as wood, metals, plastics, concrete, etc. They are maximum broadly used for doing metallic reducing/cutting. It's a steel/metal rod casted into twist bit which have specific diameter which has 2, 3 or four spiral flutes used most of its period.

Two-flute drills are used for primary drilling, while three and four-flute drills may be used for enlarging the holes for the duration of production.



IV. COMPONENTS

❖ Motor

Motor is an electrical tool that converts electric strength to mechanical energy. It rotates shaft which support through bush in it when power is provided via rectifier. This shaft connects with drill bit via chuck to rotate drill bit and make hole on job whenever required. It is high torque capable which is required for drilling. An electric motor is an electrical machine which converts electric power into mechanical strength. The reverse of this system is the conversion of mechanical strength into electric energy which is completed via an electric generator, that has tons in commonplace with a motor. Most electric vehicles perform via the interplay among an electric motor's magnetic subject and winding currents to generate pressure. In diverse programs, which include in regenerative braking with traction cars, electric motors may also be used as generators to convert mechanical power into electric powered strength.



❖ Connecting Arm

It is used for connecting 2 solid objects with the help of a hinge, which allows us to move at different angles of rotation between bodies. Two objects are rotated about a constant axis of rotation connected through an ideal hinge, all other sort of rotational or translational motion being prevented and therefore a hinge has a single degree of freedom. In this, we are using a rack and pinion mechanism over the arms to make it a telescopic arm comprising of the outer arm and the inner arm to increase and decrease the arm length. The pinion gets attached to the outer arm and the rack gets attached to the inner arm which together makes motion between the arms possible.

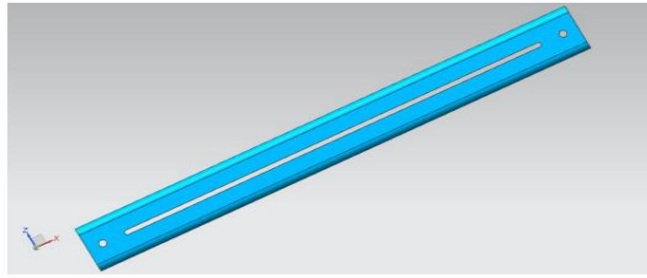


Figure: Outer Arm

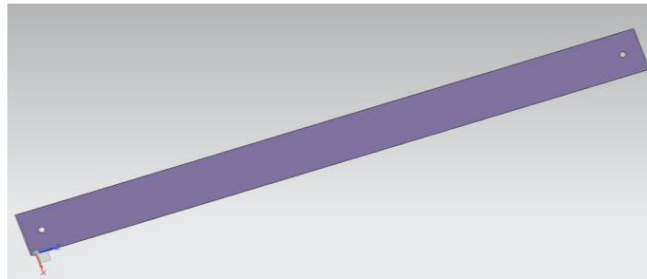


Figure: Inner Arm

❖ Permanent Magnetic Chuck

Magnetic chucks make use of magnetism force from a permanent static magnet , electromagnet or electromaterial to achieve chucking magnetic material . There are many people who are benefitted from using a magnetic chuck. Consistent clamping strength guarantees that there is no difference in how close the workpiece is left loose. The support of surface on workpiece reduces the cycle time by safing its centre sector. They have fast setup time, and downtime since the workpiece gets always laid out down to magnetic plate, and sometimes vices secured by a magnet. For our project, for the lightweight drill, we will use the permanent rectangular chuck magnet.

Reasons for making use of Permanent magnetic chuck:-

- No requirement of power supply for magnetization.
- The cost of additional clampers gets reduced, not always necessary.
- Easier to load and to unload.
- Space Storage for workpiece expands.
- Less time required for setting up workpiece.

Operation:- Continuous Rectangular magnetic chucks use their magnetic strength for holding a workpiece on while it's in place for work done. The magnets does work by causing polarity in ferrous function material connecting through its north and the poles to the south. When a job is put around the magnet's poles, this flux flows in. The ferrous elements have poles opposite to each other of the magnet's polarity, to draw them all.

Expanding and monitoring that flux is the important element to magnet application working in metal operation. Nearer gap between piece of work and magnet increases the attraction nor "pull" of the magnet. Smoothly superimposed workpieces are held tighter than armor to air. The strength of the magnetic attraction depends upon the amount of flux given.

Working:- It is the Pole alignment that determines the magnet status (Whether on or off). These magnetic poles are relocated in service to lever on and off the permanent magnet with a 180 degree help flip the knob. Magnetic power holds the workpiece mounted when it is in service work around. The magnets work by imposing polarity in ferrous material connected through north and the south pole. When a workpiece gets positioned across the poles of the magnet, the flux starts to flow. The Ferrous components come with poles. The magnet's polarity is kept opposite so that they may be able to pull each other up.

Advantages:- The permanent magnet has Chucks which are independent of electrical power and quite easy to install for shifting from one machine to another. They don't produce heat, which results in deforming the poles

or workpieces, and have a very durable build quality. Since they don't depend on electric current, there is no danger of the pieces getting thrown away or released by power failure.

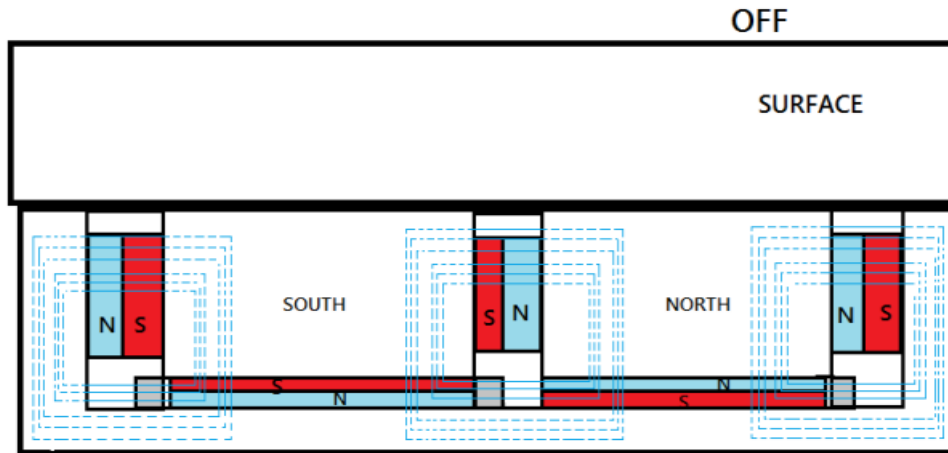


Figure: The surface is not attached to magnetic plate. It means the system is OFF

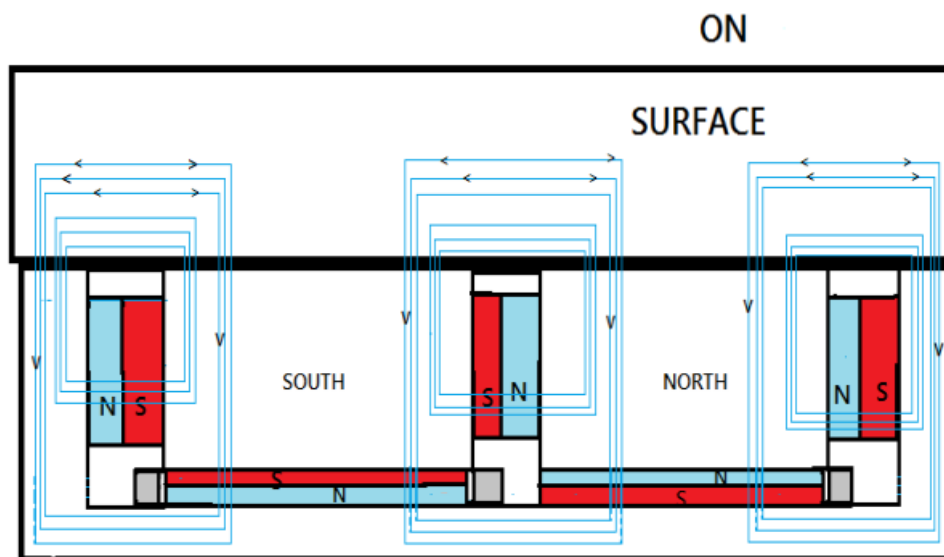


Figure: The surface is attached to magnetic plates and the magnetic field gets formed
This means system is ON.



Figure: Permanent Magnetic Chuck

❖ Bearing

It is an element of machine that constrains relative motion to the desired movement and decreases the friction among transferring components. The design of the bearing may provide loose linear movement of the transferring component or loose rotation round a hard and fast axis or, it might save you a movement through controlling the vectors of regular forces that undergo at the moving elements. Most bearings facilitate the favored motion by using decreasing friction to the fullest. Bearings are categorised widely according to the form of operation, the motions allowed and the guidelines of the masses/ forces carried out to the components.

Rotary bearings preserve rotating components inclusive of shafts or axles inside mechanical systems and switch axial and radial masses from the supply of the weight to the shape assisting it.



❖ Nut & Bolt

A Nut & Bolt joint is a 1 degree of freedom kinematic pair that is used within the mechanisms. Nut & Bolt joints provide single-axis translation by using the threads of the threaded rod to offer such translation. This type of joint may be used majorly on maximum forms of linear actuators and certain types of Cartesian robots. A Nut & Bolt joint is every so often referred as a separate type but it's a variation of bolted joint. The simplest difference is that a bolts is used, which requires an internal thread in one of the jointed components. This can save space, however continuous reuse of the thread could probably harm the coils, making the entire component now not appropriate to be used. Some nuts threads are designed for mating with a complementary thread, referred to as a woman thread (inner thread), regularly inside the shape of a nut or an item that has the internal thread shaped into it. Other nuts threads are designed to cut a helical groove in a softer fabric as the bolt is inserted. The maximum commonplace makes use of of nut & bolt joints are in retaining items together and in positioning the items.

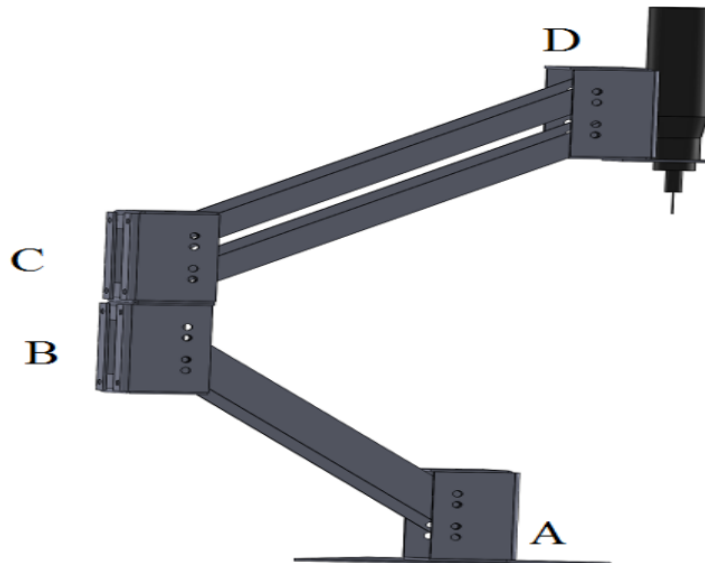


❖ Drill Bit

The tools that are required to remove a material for creating holes or enlarging them, are mostly of circular shape. Drill bits are available in variable shapes and sizes and can create various types of holes as required for operation in various different materials. It is made up of carbon steel. In our model we have assumed to use a drill bit of diameter 2mm. These bits can be used to make drill holes on wood, plastic, light metals, etc.



V. WORKING



- From the diagram we can see that Box A is mounted on a plate. The whole mechanism can rotate at 360 degree angle at the vertical axis of box A.
- Box B is now attached with Box A by the help of two slant links, thus make an angle of forty five degree angle among each of the two boxes. Now this box B can now rotate at 360 degree angle on the vertical axis of box A.
- Box C is mounted on Box B in the sort of manner that it could rotate at 360 degree angle on its vertical axis.
- Box D is hooked up to box C with the help of four movable links, as a result reaching a vertical movement of box D. Therefore the box D can now rotate at 360 degree angle at vertical axis of box C.

VI. SPECIFICATIONS

A. Specification Of Motor:

Type – Direct Current (DC)
 Rated voltage- 24 volt
 Working voltage- 12 volt
 Speed-10000 revolutions per minute (rpm)
 Diameter – 36 millimeter (mm)
 Length - 57 millimeter (mm)
 Current- 0.2 ampere - 1.2 ampere
 Power – 2.4 watt - 15 watt
 Shaft diameter- 3.17 millimeter (mm)
 Shaft length- 14 millimeter (mm)
 Material – Aluminium (Al)
 Color- Black

B. Specification Of Connecting Rod:

1st rod i.e. Outer Arm – 200 mm (Quantity-2)
 2nd rod i.e. Inner Arm – 200 inch (Quantity-1)

C. Specification Of Permanent Magnetic Chuck:

Magnet grade :- N35,N52,N38,N40.
 Pole pitch :- 30 millimeter (mm)
 Size :- 120L* 75W* 45H
 Shape :- Rectangular
 Pole Gap:- 14 millimeter (mm)

D. Specification Of Chuck:

Diameter (Outside) - 21 millimeter (mm)

Range Of Clamping- 0.3 millimeter (mm) - 4 millimeter (mm)

Taper- 6 millimeter (mm)

E. Specification Of Drill Bit:

Type- brad point bit

Diameter- 3 millimeter (mm)

Length – 60 millimeter (mm)

Material- High Speed Steel (HSS).

Cutting Parameters

A. Calculation of V (Cutting Speed) :

$$As, V = (\pi * D * N)$$

$$N = 1750$$

$$V = 274.88 \text{ mm/sec}$$

B. Calculation of f (Feed Rate) :

$$\text{Feed rate} = 40 \text{ mm/min}$$

C. Calculation of d (depth of cut) :

$$As, d = (D/2)$$

$$So, d = 1.5$$

D. Calculation of Material Removal Rate (MRR) :

$$MRR = (\pi * D^2 * f * N / 4)$$

$$MRR = 494800.84$$

E. Calculation of Machining Time :

$$As (L/f) = t$$

L is the length of the hole which is to be drilled which equals 100 millimeter (mm)

f is the feed of drill which equals 40 mm/min

t equals 2.5 minutes

F. Calculation of Torque :

Power(P) equals 15 watts ,

N equals 1750 revolutions per minute (rpm)

$$P = (2 * \pi * N * T / 60)$$

$$\text{Torque}(T) = (P * 60 / 2 * \pi * N)$$

$$T = (15 * 60 / 2 * \pi * 175 * 10)$$

Torque (T) equals 81.851 N-mm

ADVANTAGES:

- 1) They may provide efficient drilling
- 2) They can provide 360 Degrees of Rotation
- 3) They are flexible to use
- 4) No requirement of skilled labours cause they are functioning is quite easy
- 5) They can drill in congested and difficult places
- 6) This machine comes with low cost
- 7) The Handling Cost for this machine is very less
- 8) The drilling time is Reduced with this machine
- 9) The Overall Manufacturing Cost gets reduced with this machine
- 10) We can achieve increased productivity with this machine

APPLICATIONS:

1. They can be used to place holes with higher accuracy on engine heads, blocks and cylindrical shells.

2. This machine can be Used in making furniture.

VII. FUTURE SCOPE OF THIS MACHINE

- 1) It might be utilized in industries.
- 2) It would be used with automation for computerized drilling.
- 3) In the coming years it can be used in every area wherever drilling is required.
- 4) We also can use this approach of rotation of arm in different machining operation.
- 5) Good future in marine and robotics sector.
- 6) Codings and programmes can be used in this machine.
- 7) This machine shall get operated through computers and smartphones someday.

VIII. CONCLUSION

Effective performance and competitive costs can be guaranteed by this project, as many operations can be done via this machine. Many holes with greater efficiency can be cut by this machine. It works well and is quite economical compared to other resources available. Considering its use and model price this machine can prove to be quite economical as compared with other machines. This provides a working space between the drill bit and the drill bed where there are small gaps. For this we have suggested to use a rack and a pinion mechanism over the arms to make it a telescopic arm to increase and decrease arm length. A magnetic base plate is also introduced in our project for the purpose of clamping a working piece. Machine size is less than the older drilling machines. Therefore, the required space is also small. The clamping of the working piece has been removed due to the base plate of the magnet. With this machine it is possible to drill as many holes as we need without moving the working piece. Therefore, it reduces the amount of equipment needed and reduces human error.

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