

Design and Fabrication of Square Hole Drilling Machine

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Abstract

The mechanical design and of a square hole producing tool based on triangle. The main aim of our paper is to investigate how the circular motion can be converted into a square motion by purely a mechanical linkages an application of which is to construct a special tool that drills exact square holes. The geometrical construction that fulfils the laid objective is triangle . Additionally, for this geometry to work like a rotating drive (such as a drill press) must force the triangle to rotate inside a square and that requires a square guide to constrain the triangle as well as a special coupling to describe the fact that the center of rotation also in moves within in the constrain. The practical importance of this enhancement is that the driving end can be placed in a standard drill press the other end is restricted to stay inside the fixed square, will yield a perfectly square locus and this can be turned into a working square-to drill hole.

I. INTRODUCTION

Hole serves various purposes in all machine elements. These holes may be round, square, rectangular or any other shape depending on the requirement or design. For circular holes, the machines are available in the market. But for square or any other type of holes, the Methods currently used are broaching, electrode-discharge machine (E.D.M.), and electro-chemical machine. These are very much expensive and require special tools or machines. The Reuleaux triangle is one example of a wide class of geometrical discovery by German mechanical engineer Franz Reuleaux, discussed the famous curvy triangle that is started being used in numerous mechanisms Watts Brother Tool Works. Although Franz Reuleaux was not the first to draw and to consider the shape formed from the intersection of three circles at the corners of an equilateral triangle .But the use of this curve and its special properties for producing polygonal holes was given by Sir James Watts in 1914 and the geometry has been constantly evolving from day to day exactly reproduce the square in which it revolves.The Reuleaux Triangle is example of a wide classes of geometrical discoveries like Mobius strip that did not find many practical applications until relatively late in humankind's intellectual development. Not until around 1875, when the distinguished German mechanical engineer Franz Reuleaux discussed the famous curvy Reuleaux triangle that it started being used in numerous mechanisms by Watts Brothers Tool Works.

II. PROBLEM STATEMENT

There are very limited options available in manufacturing if the geometry of an operation which is to be cut on a part is non-circular. In the present manufacturing processes, square hole are produced by Press working, Broaching, Non-conventional machining process like Wire EDM, Laser cutting, etc. Other methods can be used for drilling a square hole but all this process very much costly as it used a laser beam operations, some where use an EDM machine.We can rotate Reuleaux triangle inside a shape that is almost a square. The only problem is you cannot just spin the triangle. That would produce a circular hole. You have to move the centre of the triangle at the same time to create square hole.Thus to make a machine which can be mobile can be operated as manually and can be used for general purpose as well as mass production we have fabricated square hole drilling machine.

III. SCOPE

The scope of this paper is to machine a square hole using a tool with three cutting edges and to select suitable material (HCHCr) to machine all surfaces, by connecting universal couplings at end of RT. With options to replace the tool of various sizes and can machine square hole of varying sizes. The Polygonal holes made by drilling instead of EDM are better in different ways.

1. Electrically non-conductive materials can be machined only with specific set-up of the process.
2. Excessive tool wear occurs during machining.
3. The additional time and cost used for creating electrodes for ram/sinker EDM.
4. Power consumption is high.
5. Potential fire hazard associated with use of combustible oil based dielectrics.

IV. METHODS

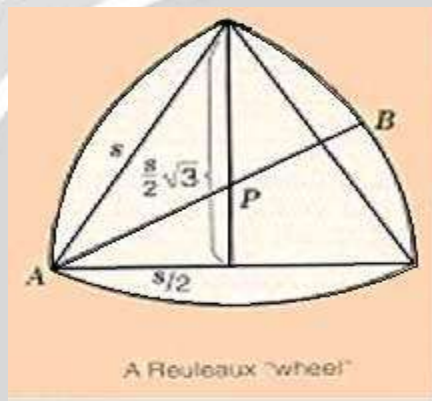


Figure: Reuleaux triangle

$$x = \frac{s}{6}(-3 + \sqrt{3} \cos \alpha + 3 \sin \alpha) \dots\dots\dots(1)$$

$$y = \frac{s}{6}(3 - 3 \cos \alpha - \sqrt{3} \sin \alpha) \dots\dots\dots(2)$$

The following equations will explain the phenomena correctly; Let us take an equilateral triangle of side „S“ as shown in the figure. In the right angled triangle ACR [1],

$$AC= S \quad AR= 0.5$$

$$CR=0.866*S$$

Considering ΔACR,

$$AP= 0.577S$$

Considering Reuleaux triangle,

$$BP= S-AP = S - (0.577 s) = 0.423 \times S$$

[2]The geometric centroid does not stay fixed, nor does it move along a circle. In fact, the path consists of a curve composed of four arcs of an ellipse. For a bounding square of side length, the ellipse in the lower-left quadrant has the parametric equations .

V. RESULT EXPECTED

The development of square hole Drilling Machine, it simplify machining square hole at low cost and time. Machine is compact in size, which provides flexibility to produce square holes with low manufacturing cost. This prototype can prove that square hole can be generated by using Reuleaux triangle and universal joint arrangement. Other method, to generate square hole is quite time consumable and costly.

VI. WORKING PRINCIPLE

Drilling Or Hole Production Is One Of The Most Common Machining Processes In The Manufacturing Industry. Its Significance Has Long Been Recognized Due To The Large Number Of Holes To Be Drilled On Engineering Components And The Large Amount Of Costs Involved In The Process. There Are Number Of Machine Tools Producing Round And Taper Holes. But Many Engineering Components Require Square And Non-circular Holes. At Present Square And Other Non Holes Are Produced Using Cnc Machines Or Spark Erosion Or Slotting Machines. But There Is No Quality Machine Tool To Produce Square Holes At Minimum Cost. Thus We Made An Attempt To Design And Fabrication Of Square Hole Drilling Machine Which Would Produce Square Much More Easily Than The Current Method. There Is A Drill Bit Inside A Square Box That Cuts Perfectly Square Holes When You Drill. Circular Motion Can Be Converted Into A Four-sided Square Using The Reuleaux Triangle. The Process Relies On The Property Of Reuleaux Triangle's Diameter Being Consistent Across All Points, And When Rolled And Rotated Simultaneously, Tracing A Square Area With Slightly Rounded Corners.

VII. DESIGN

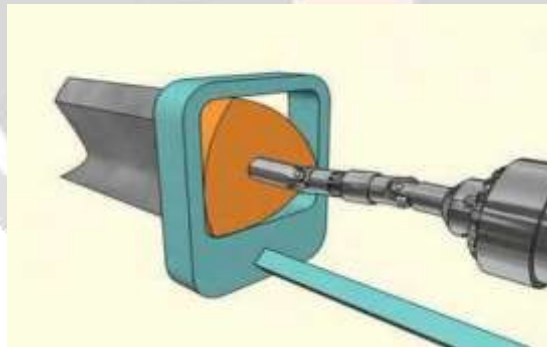


Figure :Model of square hole drilling machine

VIII. COMPONENTS

i. 3- Point Cutting Tool

The special tool mounted on RT which has 3 cutting edge in order to obtain the square hole. The tool is made up of EN36, which has high hardness strength. Predrilling is highly recommended, this reduces wear on tooling and the amount of swarf to be removed.

TYPE	C%	Si%	Mn%	Cr%
EN36	0.12 TO 0.18	0.10 TO 0.35	0.30 TO 0.60	0.60 TO 1.10

Table 1. The chemical composition of EN36

Hardening Temperature (°c)	780-860
Quenching Medium	OIL
Brinell Rock well hardness	61-63
Tempering Temperature(°c)	170-210

ii. Supporting Member

Square guide is a stationary part that guides the Reuleaux triangle to move in square shape and also helps the RT to rotate in fixed plane ,square guide is connected to drilling machine using two steel rods , these rods are clamped to the drilling machine by using clampers. Clampers are provided to attach supporting member to portable drilling machine.

iii. Universal joint

Universal joint is used to connect two shafts at an angle for transmitting torque. The centre of RT must rotate itself and also revolves in a noncircular path ,by using universal joint RT can revolve in noncircular path. coupling or joint which can transmit rotary power by a shaft at any selected angle, coupling in a rigid rod that allows the rod to 'bend' in any direction, and is commonly used in shafts that transmit rotarymotion.

iv. Drilling Machine

To provide rotating motion to RT and tool ,the impact drill is used .The end of universal joint is connected to tool holder of drilling machine. The spindle speed is constant for all operations, while the cutting speed varies all along the cutting edge. Cutting speed is normally computed for the outside diameter. The center of the chisel edge the cutting speed is zero; at any point on the lip and it is proportional to the radius of that point.

IX. RESULT & DISCUSSION

The tool developed is approximately 57 mm in length and it is slightly heavy with approximate weight of 3kg. The cutting tool after proper assembly and installation is found to be accurate up to 90 %. That is, it is able to cut a square profile with approximately 90% area of the original square with same dimensions as that of the cutting tool. The remaining 10% which is not cut is present on the four corner of the square in an arc form.

Working of the present tool is done on cardboard sheet. It is not employed on the workshop material as it is made with mild steel as the base material. So it does not have the required hardness to be able to check on market materials. The main aim is to observe the feasibility of the mechanism in fulfilling the required motion and to check its employment with a cutting tool for producing the square of its size. The first aim has been fulfilled as desired and success of about 80 % has been achieved in the secondary goal. In the future studies, the tool will be studied in detail and required modifications shall be provided thus there are certainly chances of 100% success rate.

X. EXPERIMENTAL SETUP



Figure : View of square hole drilling machine and special tool.

XI. CONCLUSION

Fabricated square hole drilling machine and it is found that it is capable of drilling square holes on various wooden materials (pre-drilling is essential). The project is simple in construction and compact in size for use. With less installation cost and less labor skill square holes can be drilled using this arrangement, hence it can be used in small scale industries. The future scope of project is to clamp the machine on bench drill to obtain constant working feed and also the size of drill bit can be made compact using Oldham coupling instead of universal joint.

XII. ACKNOWLEDGEMENTS

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