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Design and Fabrication of Square Hole Drilling Machine

Rajat Kumar Jaiswal*, Sagar Gurnani *,Dr. Ajay Kumar **
*(UG Scholar, Department of Mechanical Engineering, KIET College, Ghaziabad, India
Email:sagargurnani1234@gmail.com)
** (Assistant Professor, Department of Mechanical Engineering, KIET College, Ghaziabad, India)

ABSTRACT
The mechanical layout of a tool for generating square holes, which is based on the Reuleaux Triangle. In order to build a specific tool that drills precisely square holes, our paper's major goal is to examine how circular motion can be changed into a square motion by only using mechanical linkages. Reuleaux Triangle is the geometrical construction that achieves the stated goal. In order for this geometry to function like a rotating drive (such as a drill press), the Reuleaux triangle must be forced to rotate inside a square. To accomplish this, a square guide must be used to constrain the Reuleaux triangle, and a special coupling must be used to explain how the center of rotation moves within the guide.

1.INTRODUCTION
All machine components have holes, which have different functions. These openings could be circular, square, depending on the need or design, the shape might be rectangular or any other shape. The equipment is readily accessible on the market for round holes. However, the methods currently in use for making square or other types of holes include broaching, electrode-discharge machines, and electro-chemical machines. They are quite expensive and are called very specialized equipment. Franz Reuleaux, a pioneering mechanical engineer, made a number of geometrical discoveries, including the reuleaux triangle, a well-known curving triangle that is now utilized in many devices. Works for Watts Brother Tools. Despite not being the first to depict and take into account the shape created by the intersection of three circles at the corners of an equilateral triangle, Franz Reuleaux did it first.Yet since Sir James Watts first used this curve and its distinctive properties to make polygonal holes in 1914, the geometry has undergone rapid change to precisely replicate the square in which it circulates nevertheless. The Mobius strip and the Reuleaux Triangle are examples of various groups of geometrical discoveries that did not find widespread application until quite late in the intellectual history of humanity. The famed curved Reuleaux triangle wasn't used in many devices until around 1875, when renowned German mechanical engineer Franz Reuleaux addressed it.

1.1 PROBLEM STATEMENT
To remove material, electrical discharge machining creates debris in the working gap made up of electrode erosion byproducts and byproducts of dielectric disintegration. In the interest of discharge, evenly dispersed gap contamination of a particular threshold is preferred.However, because of insufficient flushing, excessive debris concentration in the gap limits the discharge to isolated domains, which results to repetitive localization of the discharge in the same location.As a result, the machined surface's integrity, geometry, and process strength will all be compromised.

Because of this, proper gap cleansing is important for both machining productivity and machining quality surface. Flushing could be achieved by forcing dielectric fluids via tool holes, but this leaves its mark on the machined surface because the work form created by EDM complements the shape of the tool. Flushing could also be done through tiny holes that were purposefully made in the tool. If flushing holes cannot be made in either electrode, the dielectric could be regulated and directed as a jet from outside the machining region towards the gap. When the frontal machining area or milled depth is large, this technique is ineffective. The current works relate to and focus on the design and application of innovative kinematics tool inspired by the idea of an RT in this context. In order to sink regular and irregular polygonal cavities with sharp corners, the technique uses rotating curvilinear tools.Wire EDM is also utilized when broaching is impractical, and it yields good results with outstanding surface finishes..Each operation, however, has unique benefits and drawbacks. The limit of these procedures is reached if the thickness criteria are not permitted to regulate the procedure and the blind one-take square hole is still necessary. Thus, there should be a tool that can precisely and easily attach to the current manufacturing equipment while also directly providing the essential cutting. If such a device is easily accessible and affordable to use, it will undoubtedly have a good direct or indirect impact on the machining businesses as well as the customers.

1.2 SCOPE

The purpose of this article is to attach the tool holder at the end of the RT in order to manufacture the tool with three cutting edges and choose an appropriate material (EN9) to machine all surfaces. The possibilities to swap out tools of different sizes and the ability to machine square holes of different diameters.

Drilling produces polygonal holes that are superior to broaching in several ways.

1.) Components can be made stronger and better if holes are drilled rather than broached or press worked.

2.) Broaching is a practical option if you need a lot of components. Drilling is helpful since it allows for the productive and cheap production of small quantities.

3.) Broaching undercuts are not necessary, and the hole has flat, unobstructed ends.

1.3 RESULT EXPECTED

A more time- and money-consuming method is to create square holes. Square hole drilling technology has made it easier to create square holes quickly and affordably. The compact size of the machine allows for flexibility in producing square holes at low production costs. This prototype can demonstrate how a Reuleauxtriangle and universal joint arrangement can produce a square hole.

2. METHODS

The phenomena will be accurately explained by the equations that follow. Let's start with the equilateral triangle with side "S" that is depicted in the figure. In the right-angled triangle ACR,

AC= S

AR= 0.5xS

CR= 0.866xS

Considering ΔACR,

AP=0.667xCR = 0.577 S

Considering Reuleaux triangle,

BP= S−AP = S − (0.577 x S) = 0.423×S

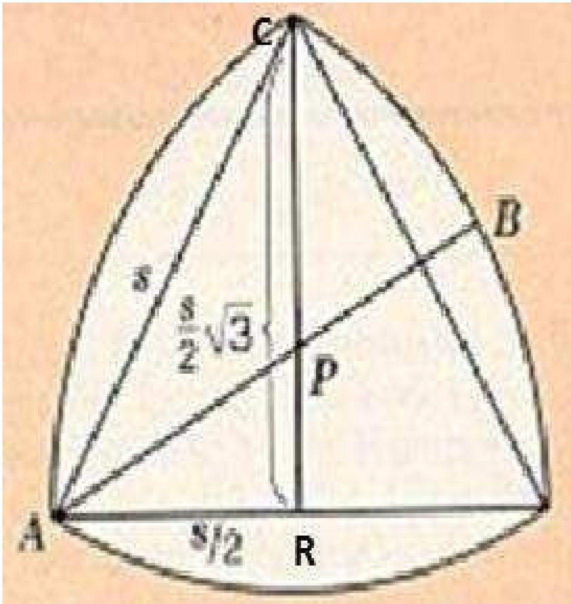

Figure 1. Reuleaux triangle

3. WORKING PRINCIPLE

The main concept behind creating a special tool to achieve the set goals is to create a mechanism that will change a shaft's rotational motion around its longitudinal axis to revolving motion around the same axis in each profile that is constrained by four governing ellipses at each corner, with their centers at the vertices of a confining square. This mechanism will guide the tool in the constrained profile while maintaining rotation. This will result in the square geometry being sliced as needed for the purpose. The rotation of the tool at the same speed as the chuck is required to cut a metallic component since cutting requires a lot of force. Thus, that the Reuleaux, revolution becomes a necessary component the center of the triangle must shift within the profile formed by those four ellipses since it is not fixed. After adhering to the fundamental principles, it becomes necessary to assemble the parts without jeopardizing how well they each function.

4.DESIGN

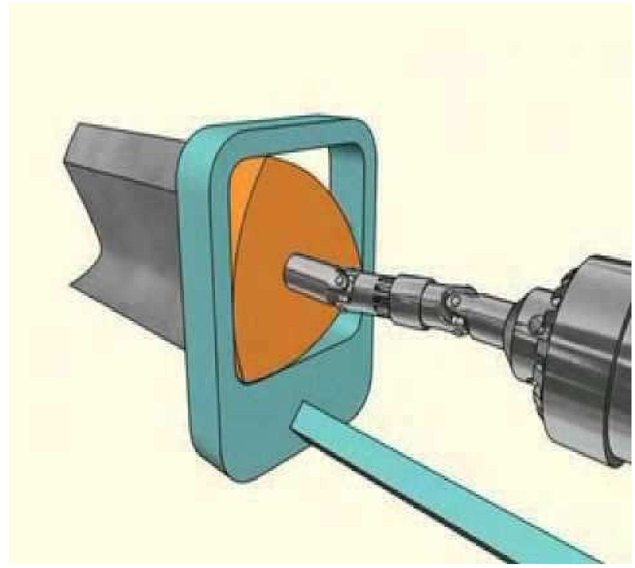

Figure 2. Model of square hole drilling machine

4.1REAULEUX TRIANGLE

To make a reuleaux triangle, the equilateral triangle's side S is measured at 25 mm.
RT =14.44mm from one edge to the center.

Arc length from each edge (RT width) = 25 mm
RT's 20mm thickness

Area OF RT $A = \frac{S \times S}{2} \times (\pi - \sqrt{3})$ $= \frac{25 \times 25}{2}(\pi - \sqrt{3}) =$ 439.98 mm^2

4.2TOOL DESIGN

a. Lower the total cost of manufacturing a product by finding the cheapest way to make pieces that are acceptable.
b. Improve production rate by creating tools that can create components as rapidly as feasible while maintaining quality by creating tools that can reliably create parts with the needed level of accuracy and precision.
c. Lower the price of specialized tooling by optimizing the designs' efficiency and cost.
d. Create tools that are secure and simple to use.

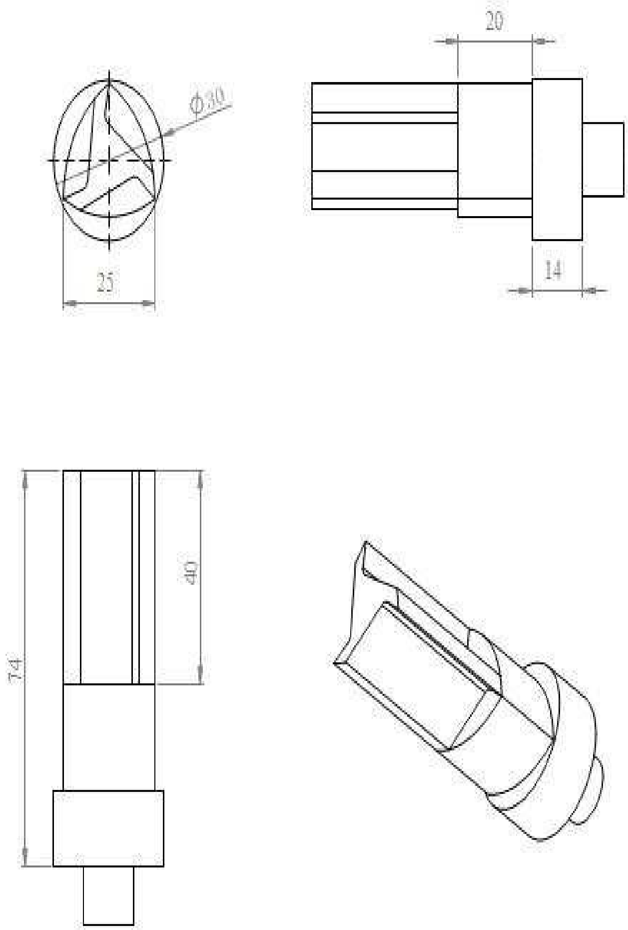

Figure 4. Cutting tool and RT

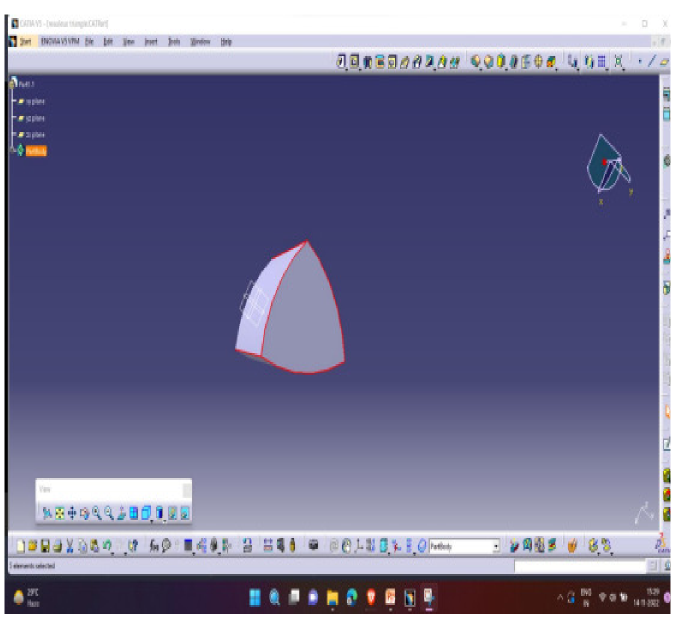

Figure 5. Reauleux triangle in CATIA

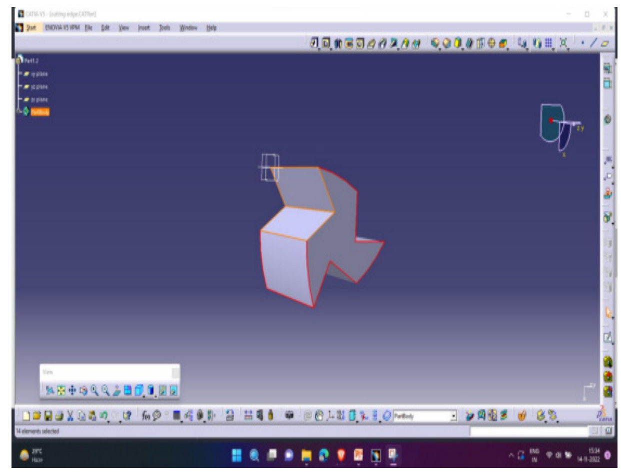

Figure 6. Cutting edge in CATIA

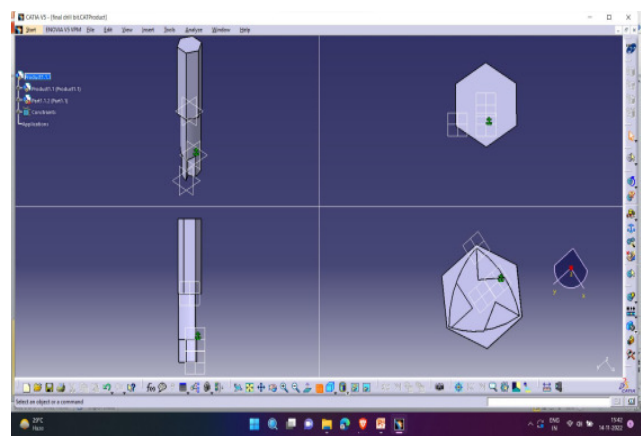

Figure 7. Cutting tool in CATIA

5. COMPONENTS

a. 3- Point Cutting Tool

To create a square hole, a special tool with three cutting edges is installed on RT.

The tool is constructed of EN36, a material with heat and strength. Predrilling is strongly advised since it lessens swarf removal requirements and tool wear. Moreover, it relieves some of the pressure on the tool, resulting in a longer tool life. The tool, which is manufactured of EN36, is placed on a 25mm (about 0.98 in) Reuleaux triangle.

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

Table 2.EN36 steel properties

b. Participating Member

The Reuleaux triangle is guided by a stationary component called the square guide to move in a square form and to spin in a fixed plane. The square guide is attached to the drilling machine by two steel rods, which are then secured to the drilling machine using clampers. To attach a supporting part to a portable drilling machine, clampers are offered. The square hole was created larger than the width of the RT to enable smooth movement of the tool inside the square guide. This prevents tool rotation from jamming inside the square hole.

30 cm square hole size

Mild steel is a material.

c. Universal joint

To transmit torque between two shafts at an angle, utilize a universal joint. By adopting a universal joint, RT can revolve in a noncircular path without having to rotate its center or follow a circular path. coupler or joint that permits a stiff rod to "bend" in any direction and is frequently used in shafts that transmit rotational motion. It may convey rotary power by a shaft at any chosen angle.It consists of two hinges that are close to one another and are 90 degrees apart, linked by a cross shaft. A constant-velocity joint is not the universal joint.

d. Drilling machine

The impact drill is utilized to give the RT and tool spinning motion. The drilling machine's tool holder is attached to the end of the universal joint. While the cutting speed fluctuates along the cutting edge, the spindle speed remains constant throughout all operations.

The outside diameter is typically used to calculate cutting speed. Cutting speed is related to the radius of any point on the lip and is zero in the middle of the chisel edge. Drilling is distinguished by this difference in cutting speed along the cutting edges.

Specifications:

1. Chunk size: 13 mm
2. Power: 350 W
3. Frequency: 50 Hz
4. Current: 1.5 A
5. Speed: 0 - 2800 rpm
6. Voltage: 220 V

6. RESULT & DISCUSSION

The instrument that was created measures about 250 mm in length and weighs around 3 kg in weight. After proper construction and installation, it is discovered that the cutting tool is up to 90% accurate. In other words, it can cut a square profile with a similar cutting tool's dimension and an area that is around 90% of the original square. On each of the four corners of the square, in the form of an arc, is the remaining 10% that is not cut. The current tool is operated on a cardboard sheet. Since mild steel is the primary component of its construction, it is not used for workshop materials. Thus, it lacks the necessary hardness to allow for a comparison with commercial materials. The main goal is to evaluate whether the mechanism can perform the necessary motion and to see if it can be used with a cutting tool to create a square of the desired dimension. The primary goal has been accomplished as intended, and the secondary goal has experienced success to the extent of around 80%. There is a 100% possibility of success since the tool will be thoroughly examined in subsequent tests and the necessary improvements will be made.

7. CONCLUSION

It was discovered that the constructed square hole drilling machine can drill square holes on a variety of wooden materials (pre-drilling is crucial). The project's size is ideal for use and its building is straightforward. Square holes can be drilled using this arrangement with minimal labor expertise and installation cost, making it suitable for small-scale companies. The project's future goals include clamping the machine to a bench drill to achieve continuous operating feed and compact drill bit size utilizing an Oldham coupling rather than a universal joint.

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