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# Design of Square Hole Drilling Machine Based on Reuleaux Triangle

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**ABSTRACT:** Based on the Reuleaux Triangle, the mechanical design and manufacture of a square hole generating tool is the objective of the present work. The major goal of this work is to look into how a circular motion may be turned into a square motion using only a mechanical connection, with the goal of building a specific tool that drills accurate square holes. The Reuleaux triangle is a geometric construction that accomplishes the desired outcome. Furthermore, in order for this geometry to work as a rotary drive (such as a drill press), the Reuleaux triangle should be forced to rotate inside a square, that also necessitates the use of a square guide to restrict the Reuleaux triangle and a special coupling to define the fact that the center of rotation continues to move within the constrain. The benefit of this modification is that the driving end may be used in a standard drill press, but the other end must stay within the fixed square, resulting in a perfectly square locus that can be translated into a functional square-to-drill hole.

**KEYWORDS:** Eccentricity, Reuleaux, Geometry, Drilling

## I. INTRODUCTION

The hole serves a variety of roles in all machine parts. The holes could be circular, square, rectangular, or other form depending on the requirement or design. Round hole machines are commercially available. For square or other sorts of holes, broaching, electrode-discharge machine (E.D.M.), and electro-chemical machine are presently used. These are extraordinarily expensive and necessitate the use of sophisticated equipment or technology.

The Reuleaux triangle is an example of a large category of geometrical major discoveries by German mechanical engineer Franz Reuleaux, who created the well-known curved triangle that has found its way into a number of gadgets. Despite the fact that Franz Reuleaux was not the first to sketch and study the shape made up of three circles converging at the points of an equilateral triangle, he was the first one to examine it. Sir James Watts, on the other hand, exhibited the use of such a curve as well as its specific features for producing polygonal holes in 1914, as well as the geometry has been steadily developing since then to perfectly reproduce the square where it spins. The Reuleaux Triangle is one of several geometrical innovations, like the Mobius strip, that can't seem to find widespread use until much later in human history. It wasn't until around 1875, when Franz Reuleaux, a well-known German mechanical engineer, presented the famous curved Reuleaux triangle, that it was used in a number of systems.

Nowadays, we occasionally need to drill square holes (in metal or wooden parts) and, due to the difficulties of drilling square holes, we explore alternate ways. Most traditional techniques to create a square hole begin by drilling a hole with a diameter equal to or slightly less than the hole's width. Then you may either saw it square, file it square, or drill little holes at the corners that are tangent to the lines. Punch presses and hardened dies are commonly used in industry to create various hole shapes. However, it is costly and requires external power to work, in addition to the fact that it is not movable and must be utilized in a permanent location. In manufacturing, square holes are common. In some of the couplings, examples of these applications are used. Because the hole and shaft have a square form, couplings will be fully engaged.

## II. RELATED WORK

The article discusses the prevalent and useful practice of generating square holes in the industry, as well as issues such as high manufacturing costs and complexity. Round and taper holes may be made with a variety of machine equipment. However, square and non-circular holes are required by many engineering components. Currently, CNC machines, spark erosion, and slotting machines are used to make square and other non-circular holes. However, there is no good machine tool for making square and polygon holes at a low cost. As a result, we attempted to develop and manufacture a drilling machine attachment that would make square holes far more readily than the present way [1].

The primary purpose of this article is to examine how a circular motion may be converted to a squared motion using simply a mechanical connection, with the goal of creating a one-of-a-kind tool that drills flawless square holes as an application. The Reuleaux Triangle is a geometrical construction that accomplishes the desired result. In order for this geometry to work with a rotary drive (such as with a drill press), the Reuleaux triangle must be forced to rotate inside a square, which necessitates the use of a square blueprint to constrain the Reuleaux triangle as well as a special coupling to draw attention to the fact that the focus of rotation moves [2].

The mechanical design and fabrication of a square hole producing tool based on the Reuleaux Triangle. The main purpose of our article is to investigate how a circular motion may be converted to a square motion using simply a mechanical link, with the ultimate goal of creating a tool that drills precise square holes. The geometrical construction that meets the desired aim is the Reuleaux Triangle. Furthermore, in order for this geometry to work as a rotating drive (such as a drill press), the Reuleaux triangle must be forced to rotate inside a square, which necessitates the use of a square guide to constrain the Reuleaux triangle as well as a special coupling to define the fact that the center of rotation continues to move within the constraint [3].

A hole serves a multitude of purposes in any machine element. These holes might be circular, square, rectangle, or any other form depending on demand. Round hole machines are available on the market. For square or other sorts of holes, broaching, Electrode Discharge Machine (E.D.M.), and Electro-Chemical Machine are presently used. These are exceedingly expensive and need the use of specialized instruments or equipment [4].

The utility model provides a small combined machine tool that integrates drilling and slotting operations into one body, which solves the problem that the prior art separates the above two machining operations and performs them through two different types of devices with excessive accessories and a larger occupation space. Many machine machines can produce round holes; however, many technical components require square and non-circular holes. In today's world, square and non-circular holes are made by CNC machines, Spark Erosion machines, or Slotting machines. A low-cost, high-quality machine tool for producing square and polygonal holes is unusual [5].

### III. METHODOLOGY

The basic idea behind developing a special tool to accomplish the stated goal is to develop a process that will convert a shaft's rotational motion around its longitudinal direction into a revolving motion around the same axis in a given profile restricted by four governing ellipsoids at each edge, their centres at the vertices of a confining square, which will direct the tool with in desired profile while maintaining rotation.

As just an outcome, the squared geometry will be reduced to fit the situation. The tool must revolve at the same speed as the chuck in which it is put since it must overcome a large amount of pressure to cut a metallic component. Because the Reuleaux centre is not stationary and should travel in a profile produced by those four ellipses, revolution is required. Following the fundamental concept, all of the components must be connected without jeopardising the tool's overall operation.

#### A. Working

The Reuleux triangle is used to operate the square hole machine. It claims that by rotating a Reuleux shaped cam in a square guide, the rotational motion of the shat and rotor may be converted into a square guided by the square guide. A motor or a manual drill can be used to provide the rotating motion. To rotate the shaft eccentrically, that is, away from the centre of the motor's chuck, a flexible coupling is necessary. This will aid the rotation of the Reuleux triangle-shaped cam in the square guide. Because the drill is given eccentric motion, it can dependably spin in the guide, allowing the drill bit to drill a square shaped hole in the workpiece.

#### B. Reuleaux Triangle

Franz Reuleaux, a late nineteenth German engineer who revolutionized the investigation of devices that could transform one sort of motion into the other and used the Reuleaux triangle in the design, was the inspiration for the Reuleaux triangle concept.

The first in a sequence of Reuleaux polygons with constant-width curves created by regular polygons with odd numbers of sides is the Reuleaux triangle. Coin shapes have been created using some of these curves. The Reuleaux triangle may be stretched into 3 directions in a range of methods: the Reuleaux tetrahedron (the intersections of quartet ball whose centers are on a typical tetrahedron) does not really have a constant width, but the Meissner tetrahedron does. The surface of revolution of the Reuleaux triangle, on the other hand, does have a consistent width.

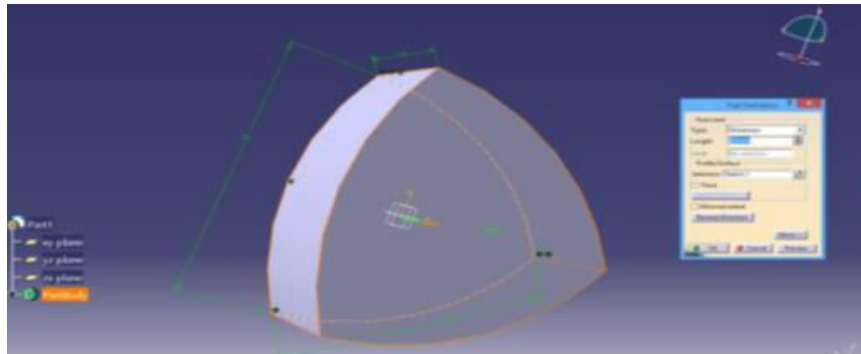


Fig. 1: Reuleaux Triangle

### C. Flexible couplings

The rotational motion must be converted into square movement. Flexible connections can be used to accomplish this. The flexible couplings that can be utilized to produce the needed motion include the non-coaxial Oldham's coupling, double universal joint, and Richard Schmidt couplings. Flexible couplings are capable of converting one sort of motion into another.

The most significant fact is that the center of rotation of the Reuleaux polygon will not remain fixed during rotation. To transmit torque from the drill to the cam, a non-coaxial coupling that can transmit torque between non-aligned axles is required. Non-coaxial couplings include the Oldham coupling, Universal coupling or Hook coupling, and Richard Schmidt coupling.

### D. Drill Bit

This drilling machine's drill bit is not the same as the circular hole drill bit. To direct tool action in a square form, the tool's shank is shaped like a Reuleux triangle. To begin, we chose an arbitrary drill size. Then we received all the relationships for obtaining all the dimensions related with the Reuleux triangle based on the calculations for drilling square holes.

### E. Square guide

A square guide is a flat metal sheet made of mild steel with a square hole. With the aid of the Reuleux triangle and universal coupling, the square guide is necessary to travel or guide the drill bit in square shape motion. The drill bit's Reuleux triangle form must be turned in the square guide by tapping one of its sides. It will force the drill bit to revolve in the same direction as the Reuleux triangle, allowing for the drilling of a square hole in the workpiece. The width of the Reuleux triangle, i.e. the side of an equilateral triangle, is used to determine the size of the square guide. The algorithm automatically generates mask image without user interaction that contains only text regions to be inpainted.

## IV. EXPERIMENTAL RESULTS

Drilling square holes takes roughly the same amount of time as drilling round holes, although it takes less time than alternative square hole procedures. Drilling square hole by using a vertical drilling machine arrangement is possible. The motor or hand drill in a circular motion machine can be converted into square action by using flexible coupling.

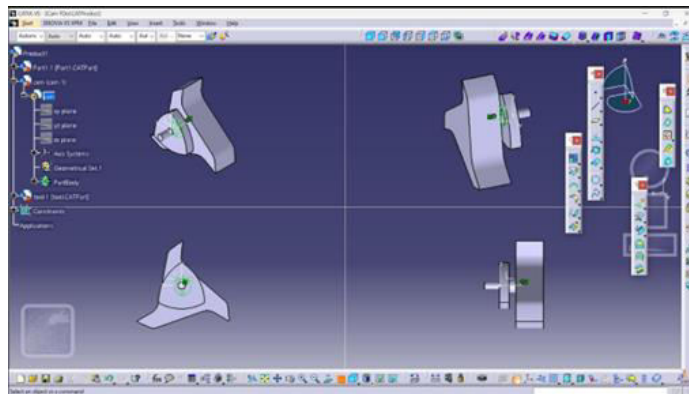


Fig. 2: Cam connected to cutting tool

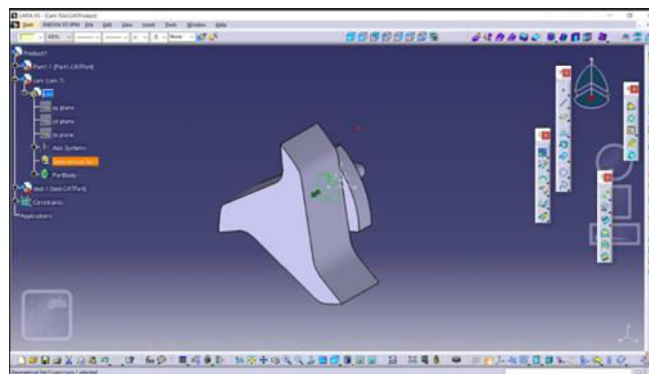


Fig. 3: Complete design results obtained in the CATIA simulation

## V. CONCLUSION

It was discovered that the square hole drilling machine could drill square holes in a variety of hardwood materials once it was built (pre-drilling is essential). Because of its modest size, the project is simple to put together and utilise. This setup can drill square holes with minimal installation cost and labour expertise, making it suitable for small-scale companies. Socket wrenches, spring collates, and feeding fingers may all be drilled using a square drill. When precision and time savings are the most important factors, a square drill is recommended. Instead of broaching, which is expensive, a square drill may be implemented to drill square holes.

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