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Design and Fabrication of Attachments for Square Hole Drill

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Abstract - the mechanical design and of a square hole producing tool based on reuleaux 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 reuleaux triangle. Additionally, for this geometry to work like a rotating drive (such as a drill press) must force the reuleaux triangle to rotate inside a square, and that requires a square guide to constrain the reuleaux 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 humankinds intellective 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.

A. Problem statement

Material removal in electrical discharge machining which involves the generation of debris in the working gap that comprises eroded with electrode particles and by-products of dielectric decomposition. Uniformly distributed gap contamination of a certain thresholds is desirable in the interest of discharge.However excessive debris concentration confined to isolate domains in the gap because of insufficient flushing leads to repeated localization of the discharge in a particular location. This will have unfavorable ramifications on process strength, stability, geometry and integrity of the machined surface. Adequate gap flushing is therefore significant in terms of both machining productivity and the quality of the machining surface. Flushing could be accomplished by forced flow of the dielectric fluids through holes in the tool, but flushing holes leaves their footprints on the machined surface, as the work shape produced in EDM is complementary to that of the tool. Flushing could alternatively be through micro holes, which is specially fabricated in the tool. In the instance that it is infeasible to provide flushing holes in either of the electrodes, the dielectric could be directed and controlled at the gap in the form of a jet from outside the machining area. This technique is not effective when the machined depth or the frontal machining area is large.

In this context, the present works relates and directs to design and implementation of novel tool kinematics motivated by the concept of a RT. The technique utilizes rotating curvilinear tools for sinking regular and non-regular polygonal cavities with sharp corners, Wire EDM is also used if broaching is not practical and it gives good quality result with excellent surface finish, but every operations has its limitation and advantages. If the thickness criteria is not allowed to control the process and still the blind one take square hole is required, then this gives the limit of these operations. Thus there should be a tool which can directly provide the

required cutting and is attachable to present manufacturing equipment's with ease and accuracy. If such a tool is readily available and is economical to use, it will definitely affect directly or indirectly in a positive way for machining industries and also to the customers.

B. Scope

The scope of this paper is to machine the tool with three cutting edge and to select suitable material to machine all surfaces, by the connecting tool holder 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 broaching are better in different ways.

1) If the holes are drilled rather than broached or press worked then stronger and better components can be made.

2) Broaching is practical if huge quantities of components are required. So Drilling is advantageous as small quantities can be manufactured economically and efficiently. 3) There is no need of broaching undercuts and also the hole have a flat unimpeded ends.

C. Result expected

Other method, to generate square hole is quite time consumable and costly. With 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.

D. Working Principle

The main idea for manufacturing a special tool for fulfilling the laid objectives is to make a mechanism which will transform the rotational motion of a shaft about its longitudinal axis to revolving motion around the same axis in a given profile which is confined by four governing ellipses at each corner, having their center at the vertices of confining square which will guide the tool in confined profile keeping the rotation intact. This will lead to the cutting of the square geometry as required for the purpose. The rotation of tool with the same rpm as that of the chuck, which is necessary to overcome a large amount of force to cut a metallic component. Revolution becomes an integral part so the Reuleaux triangle center is not fixed and it has to move in a profile which is made by those four ellipses. After following the basic principles a need arises to put the components together without compromising the working of each components.

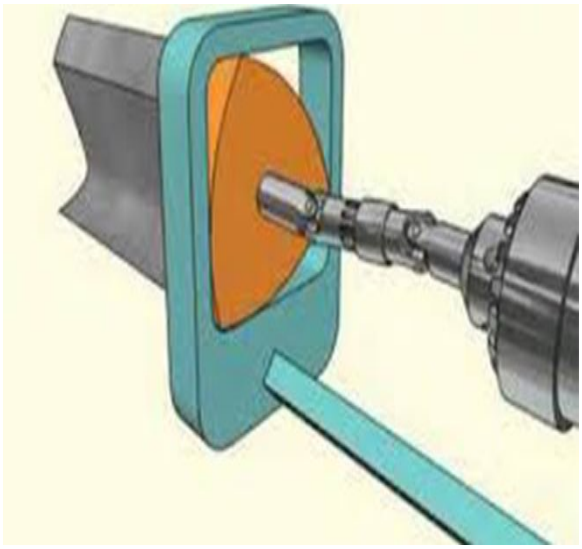

Fig.2 working principle of a square hole drill machine assembly.

II. DESIGN

The designing of the assembly needs the design and analysis of the main components of the machine such as the reuleaux triangle and the bracket holding and guiding it throughout the cutting. The selection of proper coupling for the operation is very essential as the design is concern and the vibrations created on the assembly are dependent upon the total load on the driving motor.

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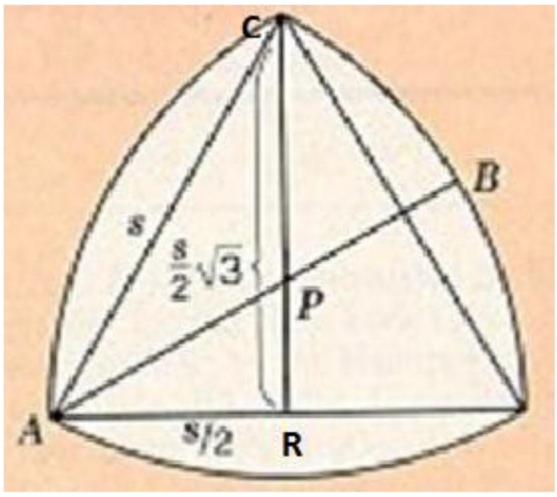
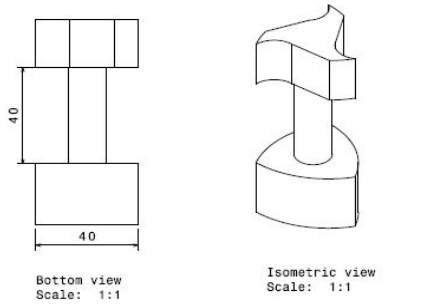
A. Reuleaux triangle



B. Tool Design:



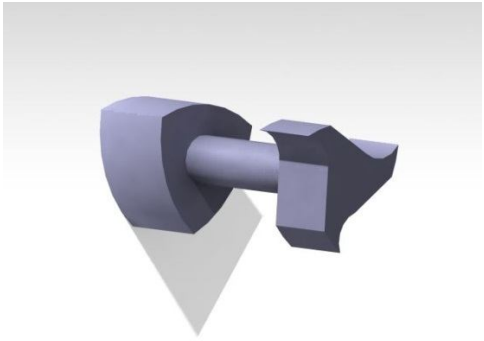


Fig.3.2 Design of tool with reuleaux triangle.

III. COMPONENTS

A. 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

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has high hardness strength. Predrilling is highly recommended, this reduces wear on tooling and the amount of swarf to be removed.it also relives some pressure on the tool and hence has greater tool life. The tool is mounted on a Reuleaux triangle of 25mm.

B. Bracket and supporting member

Fig.4.2 image of bracket ad supporting members fabricated.

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, and these rods are clamped to the drilling machine by using clampers. Clampers are provided to attach supporting member to portable drilling machine. In order to obtain the smooth running of RT inside the square guide, we made the square hole of size larger than the width of RT, hence we can ensure rotation of tool without jamming inside the square hole. Size of square hole =30cm Material: Mild Steel.

C. Universal joint

Fig.4.3 Image of universal coupling selected for the machine.

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Universal joint is used to connect two shafts at an angle for transmitting torque. The center 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 rotary motion. It consists of a pair of hinges located close together, oriented at 90° to each other, connected by a cross shaft. The universal joint is not a constant-velocity joint.

D. Drilling Machine

Fig.4.4 Standard drill machine selected.

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. This variation in cutting speed along the cutting edges is an important characteristic of drilling.

E. Specifications

1) Chunk size: 10 mm
2) Power: 350 W
3) Speed: 0 - 2600 rpm.
4) Current: 0 – 230 volts

IV. ASSEMBLY

A. The portable machine was connected with the bracket using four struts of steel bars to rigidly connect and hold the assembly in stable formation even in the case of huge vibrations and jerks generated by the rotations of the tool and coupling.

B. The supporting bracket was fastened over the machine with the help of fastening screws with the adjustment of removing the assembly from the machine.

C. The universal coupling is aligned with the square bracket and inserted into the chuck of the drill machine which has the chuck diameter equal to the diameter of the coupling i.e. 10 mm.

D. The outer shaft of the coupling is coupled with the tools reuleaux triangle with heat sink and press fit procedure so that it won’t sleep out in the case of high jerks and vibrations.

E. The whole assembly is then aligned and tested for the working of the machine.

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Fig.5 Experimental setup for the square hole drill machine.

V. ADVANTAGES AND LIMITATIONS

A. *Advantages*

1) The only conventional process to create a square hole within the desired parameters in minimum time possible

2) It is a compact and light in weight machine to operate without any fatigue to the operator.

3) The square hole created by other alternate methods is time consuming and non-economical when done for small scale production.

4) High speed cutting of the square hole can be done where the exact square is not required, avoiding the finishing operations.

5) It is found to be the simplest design of a square hole drill machine with minimum initial investment.

B. *Limitations*

1) To create the hole of different shapes and sizes the bracket and tool of the machine is to be replaced with the desired size of the hole.

2) The vibrations and noise created in the machine due to more number of moving components is hard to be damped due to the design limitations, such as weight and size of machine.

3) The combined cost for the number of tools and bracket required for the variation in size and shape is not economical for the small scale production.

VI. RESULT & DISCUSSION

The tool developed is approximately 250 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.

VII. 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.

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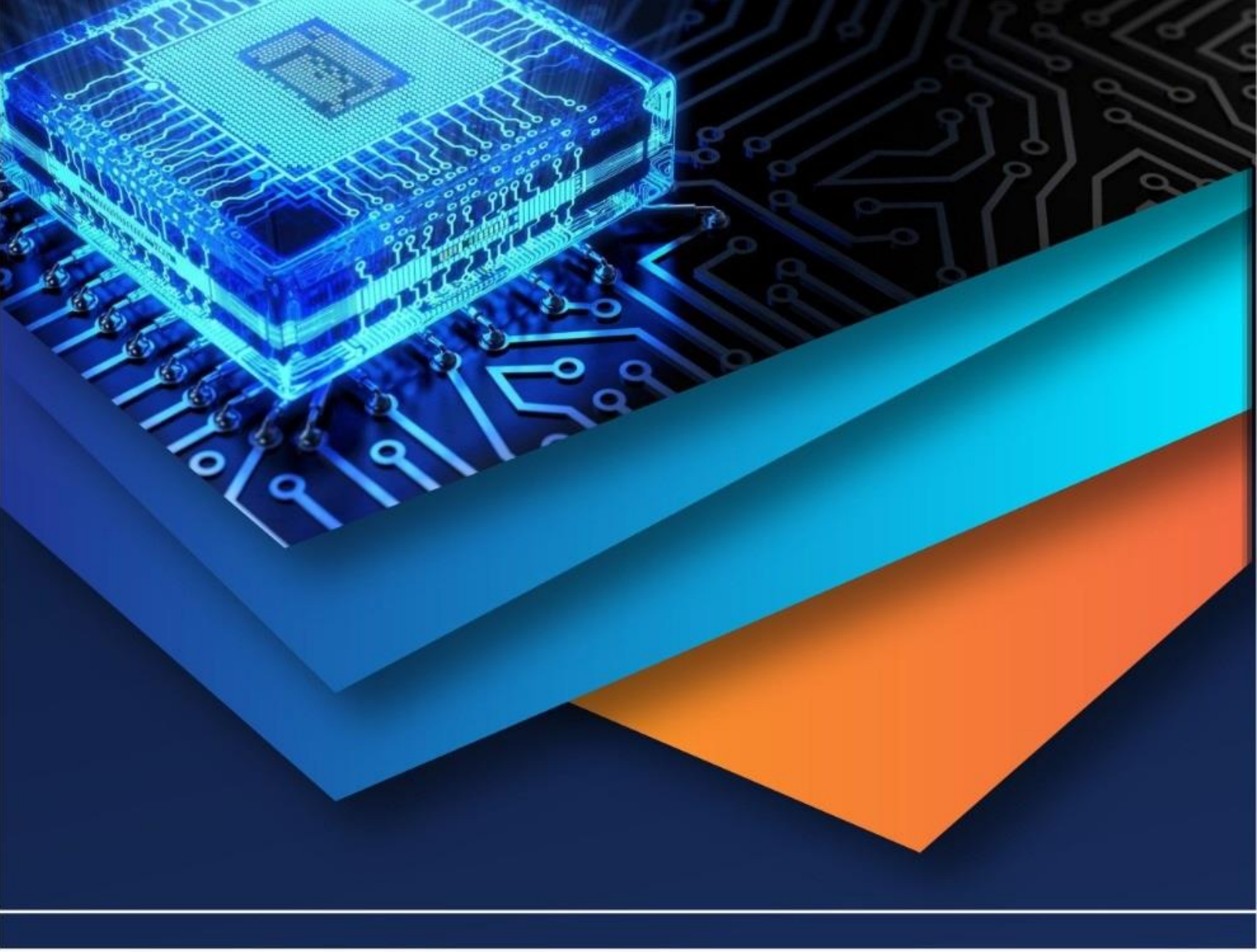

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