International Journal of Recent Engineering Research and Development (IJRERD)
Volume No. 02 – Issue No. 05, ISSN: 2455-8761
www.ijrerd.com, PP. 26-30

Design and Fabrication of Reuleaux drilling machine

Mahesh Bhadane[#], Mayank Singh[#], Karan Ghare[#],
Abhishek Racheendran[#], Jagdish Chaudhary[#], Harshala Thakur[#]
[#]Mechanical Department, LTCE
Lokmanya Tilak College of Engineering, Koparkhairane, Navi Mumbai (India)

Abstract*:* In 21st century, there is huge expansion in the manufacturing industry and the need for economical methods for manufacturing. Square hole plays a vital role in the manufacturing sector. There are various mechanisms for square hole drilling by the use of Reuleaux triangle and Universal Coupling. In this paper the various machinery is been reviewed to achieve more efficient and economical method.
Keywords: Reuleaux triangle, Universal coupling, Drilling machine,Square hole, eccentric

I. Introduction

In the modern trends of manufacturing, there is a rise in demand for intricate shapes. Square hole find application in various machine guards, air conditioning guards and various architectural design.

Square hole has gained are importance in manufacturing and production sector. The design and construction of square hole drilling machine tends to b complex and efficiency to get proper square hole possess a challenge. Inorder to get proper square hole various methods are been used like Laser cutting, Square press, Broaching are being used over the years. Since the year 1875 the distinguished German Mechanical Engineer Franz Reuleaux, proposed the concept of curvy triangle it has been observed to be the most economical means to obtain a square hole. The setup of reuleaux triangle and universal coupling tends to provide efficient method to drill square hole.

II. Literature Review

Reuleaux triangle is a shape formed from an equilateral triangle by the intersection of three circular disc. Construction of reuleaux triangle, firstly considering an equilateral triangle of side 's' then taking the vertices as the centre and radius as 's' of the three circles. The arcs formed on the sides of the equilateral triangle in whole gives rise to reuleaux triangle.

$$x_P = \frac{s}{6}(-3 + \sqrt{3}\cos\propto + 3\sin\propto)$$

$$y_P = \frac{s}{6}(3 - 3\cos\propto - \sqrt{3}\sin\propto)$$

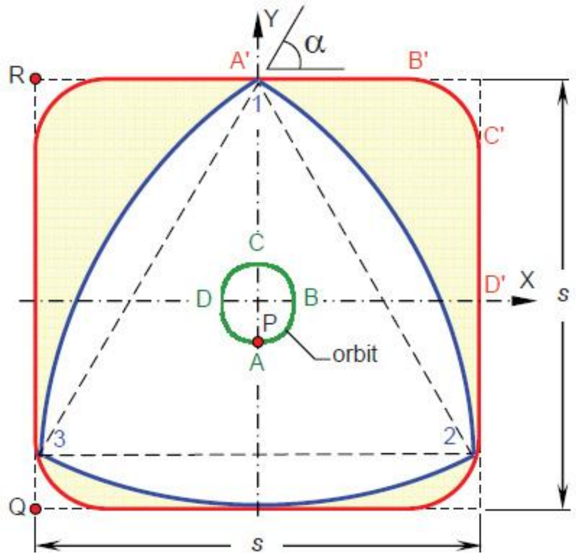

Fig1. Elements of RT Kinematics

For reuleaux triangle the centre of rotation is not fixed as the circular path of rotation is not followed. Thus, co-axial coupling that is universal coupling is used. Universal couplings are used for transmitting rotary motion in any direction irrespective whether the parts are aligned or not with each other.

Fig2. Universal coupling

The centroid of the triangle from which RT is made is not at the same distance from the three sides of reuleaux and this can be shown by simple geometrical analysis. 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,

AC= s
AR= s/2 CR= s/2*√3
Considering ▲ACD,
AP= 2/3 CR = 2/3*s/2*√3 = 0.577 s
Considering Reuleaux triangle,
BP= s-AP = s-0.577s = 0.423s

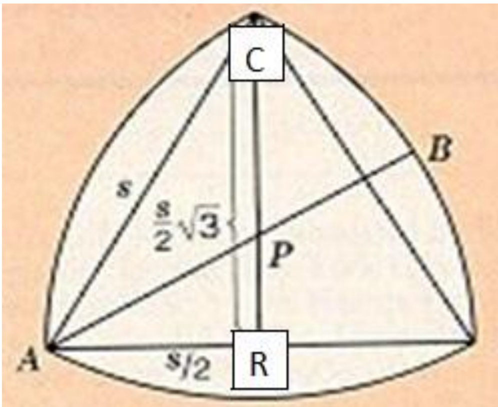

Fig3. Distance of centre from both sides

As, BP is not equal to AP, this shows that the centroid of triangle is not at equal distance from all points of Reuleaux. This also leads to a distinguished fact that if this figure is rotated inside a square then its centre of rotation will not be a fixed one instead it will also revolve around an invisible centre.

III. DESIGN OF PARTS

A. Design of shaft

This is the rear portion of the tool which is directly attached to the normal chuck in a drill press or lathe. It provides the base for the longitudinal placement of tool with accuracy as its axis would be the defining axis of the tool whose placement will confine the overall tool movement. It will take the rpm as given by the machine and drives the tool. The first part of the oldham coupling extruded in other direction, for providing place for the attachment of grooved part as shown in figure, is made complimentary to this shaft.

Material used - C45
FOS = 2
$\sigma_{ut} = 320$ N/mm^2
$\sigma_t = \sigma_b = \sigma_{ultimate}$ / FOS = 320/2 = 160 N/mm^2

International Journal of Recent Engineering Research and Development (IJRERD)
Volume No. 02 – Issue No. 05, ISSN: 2455-8761
www.ijrerd.com, PP. 26-30

$\sigma_s = \sigma_t / 2 = 160/2 = 80$ N/mm^2

Torque calculation

POWER of motor = 1 hp= 746 watt

Consider 85% motor efficiency =746 x 0.85 = 634.1 watts,

And taking motor rpm as 100

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

$634.1 = 2 X 3.14 X 100 X T / 60$

T = 60.552 N-m = 60552 N-mm

$T_{max} = T x 1.3T$

Torque transmitted by shaft,

$T_{max} = 78717.71$ N-mm

$T_{max} = \pi/16 x \tau x d^3$

Therefore, $77620 = \pi /16 x d^3 x 80$

$d^3 = 5011.32$ mm^3

d = 17 .11 mm ≈ 20mm

taking 20mm shaft, so our design is safe.

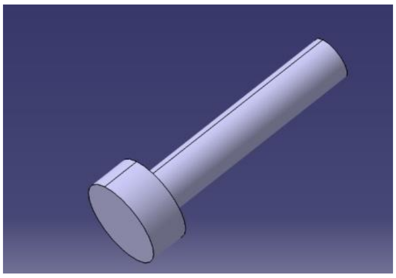

Fig4. CAD model of shaft

B. CAD model of frame

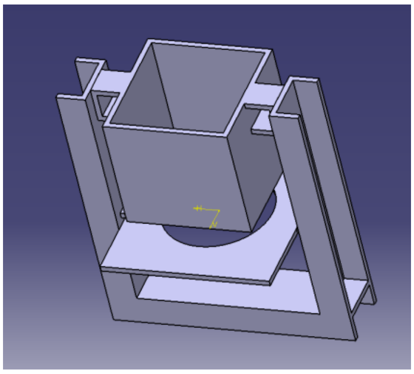

Fig5. CAD model of frame

IV. ACTUAL VIEW OF MACHINE

Fig6. Experimental setup

IV. PRINCIPLE AND WORKING:

The main principle of working is conversion of rotating motion of shaft to the coupling which provides eccentrical rotation of reuleaux shape tool in a square shape which produces a square profile with curved edges.

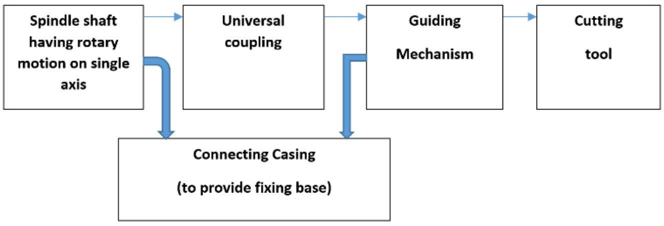

Fig7. Block diagram of whole mechanism

The shaft is connected to universal coupling , which is connected to drilling socket.The drilling socket is inserted in the drilling machine and it transmit the rotatory motion to the shaft.In the bottom part of shaft there is reuleaux triangle which is made to rotate in square guide. This gives the eccentric motion to the cutting tool attached to the bottom of reuleaux triangle. As the reuleaux triangle rotates, due to universal coupling the motion is free, but only restricted due to the square guide. The square guide gives the eccentricity which makes the tool follow square path and drill square holes.

V. RESULT

The cutting tool should theoretically cut square hole with the accuracy of 97.72%. The remaining 2.28% is not cut due to the motion of the reuleaux triangle in square guide. The path traced by the reuleaux triangle in square guide has curved edges , which is responsible for the remaining 2.28% of square not traced. But due to curved corners it reduce the stress concentration in the drilled geometry.

The square hole drilled with experimental setup has the accuracy of the around 90-95%. This variation from the theoretical result is due to several factor altering the drilling process. One of the major obstacle was vibrations, due to eccentric motion ,vibrations produced are high , which in turn distort the geometry being drilled. Below is the figure of the drilled hole in the acrylic material. And other figure shows the variation of drilled hole geometry to the theoretical geometry.

Fig8. Actual square hole drilled on acrylic

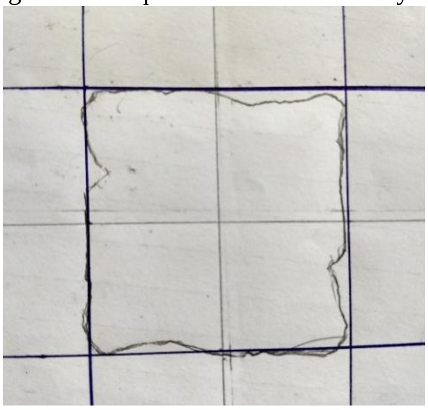

Fig9. Comparison of ideal hole with actual hole

VI. REFERENCES

[1]. S. Besicovitch.,1963. Minimum area of a set of constant width, *in* Proceedings of Symposia in Pure mathematics. Vol. 7, pp. 13-14, Convexity, Amer. Math. Soc., Providence, RI.
[2]. Rajurkar, K.P., Yu, Z.Y., 2000, 3D Micro-EDM using CAD/CAM, Annals of the CIRP, 49/1:127-130.
[3]. http://en.wikipedia.org/wiki/Coupling
[4]. Watts Brothers Tool Works., 1996. How to Drill Square, Hexagon, Octagon, Pentagon Holes. Wilmerding, Penn.
[5]. IJSRD - International Journal for Scientific Research & Development| Vol. 4, Issue 01, 2016 | ISSN (online): 2321-0613
[6]. ScienceDirect Procedia Materials Science 6 (2014) 1823 – 1836 .3rd International Conference on Materials Processing and Characterisation (ICMPC 2014)