DESIGN AND FABRICATION OF SPECIFIC TOOL TO PRODUCE HEXAGONAL HOLES

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ABSTRACT: The concept "Development and Fabrication of Specific Tool to Produce Hexagonal Holes" is by the use of the drill and based on the of reuleaux pentagon. The aim of this project is investigate how a circular motion can be converted into a hexagonal motion by purely a mechanical linkage, an application of which is to construct a special tool that drills exact hexagon holes. The practical importance of this enhancement is that the driving end can be placed in a standard drill press; the other end, when restricted to stay inside the ambient hexagon, will yield a perfectly hexagon locus and this can be turned into a working hexagon hole drill. The fabrication of the developed design in this paper has been done on Steel (EN8) that is ideal for soft surfaces but if harder materials are used, hard surfaces application is also possible. Additionally, for this geometry to work from a rotating drive one must force the Reuleaux pentagon to rotate inside a hexagon, and that requires a hexagon template to constrain the Reuleaux pentagon as well as a special coupling to address the fact that the center of rotation also moves.

Keywords: Reuleaux pentagon, Hexagonal holes, Oldham Coupling.

1. INTRODUCTION

The main idea behind manufacturing a special tool for fulfilling the laid objective is to make a mechanism which will transform the rotational motion of a shaft about its longitudinal axis to a revolving motion around the same axis in a given profile which is confined by six governing ellipse at each corner having their center at the vertices of a confining hexagon which will guide the tool in desired profile keeping the rotation intact. (4), (9), and (10) this will lead to the cutting of the hexagon geometry as needed for the purpose. The rotation of tool with the same rpm as that of the chuck in which it is placed is necessary as it has to overcome a large amount of force to cut a metallic component. (1) Revolution becomes an integral part as the Reuleaux center is not fixing and it has to move in a profile which is made by those six ellipses. (2) After following the basic principle, a need arises to put all the components together without compromising the working of each and the tool as a whole. This is explained with suitable diagrams and wherever necessary with block.

2. WORKING PRINCIPLE

Tool working has been laid on the above principle providing basic as well as advancement as and when applied. Additionally, for this geometry to work from a rotating drive one must force the Reuleaux pentagon to rotate inside a hexagon, (7) and that requires a hexagon template to constrain the Reuleaux pentagon as well as a special coupling to address the fact that the center of rotation also moves. (5)The practical importance of this enhancement is that the driving end can be placed in a standard drill press; the other end, when restricted to stay inside the ambient hexagon, (8) will yield a perfectly hexagon locus and this can be turned into a working hexagon hole drill. (3)

- The working involves different set of mechanisms

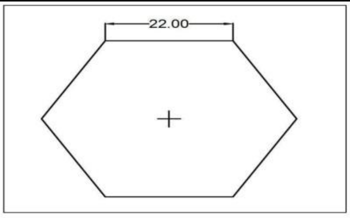
1) Oldham coupling (11)
2) Guiding mechanism
3) Cutting tool (6)
4) Connecting casing

3. METHODOLOGY

Point the way when ‘n’ is even, and hexagonal case, which presented design procedure and some unexpected difficulties. (5)

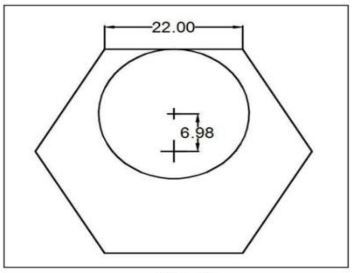
- Steps of design procedure of reuleaux pentagon are following below slides.

(1) First starting to draw the hexagon for a given size & decide the center of this hexagon at a point (0, 0) all dimension are in mm. (9)



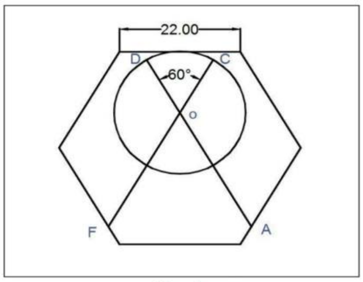
Step-1

(2) One starts with a circle of radius r centered at O (0, 6.98) the point that will trace out an exact hexagon. And align a unit hexagon with the circle's top. (10)



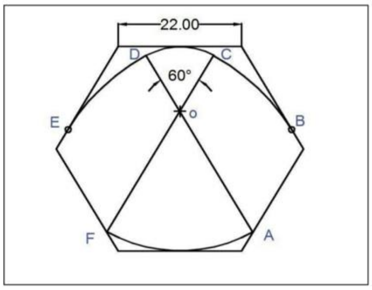
Step – 2

(3) Draw diagonals connecting O to C and D and spanning a 60angle and align a unit hexagon with the circle's top Draw the line extending from center O and it touches the bottom of the hexagon, again spanning 60 angle. We want this arc and the southeast side of the hexagon to meet at a point, call it point A and point F, along the diagonal from D & C respectively. (5)



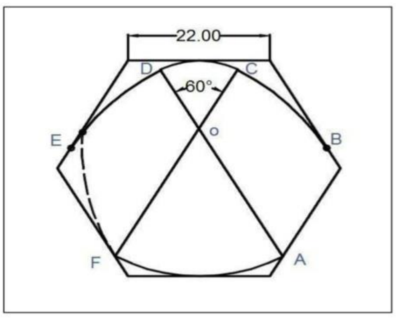
Step - 3

(4) Draw arc between point A & F with a radius from the center O. this arc is touch the lower face of hexagon, also another arc is draw from point F, is passing from point C and up to touch the face of hexagon at point B. similar method is apply for point A to give point E. (9)



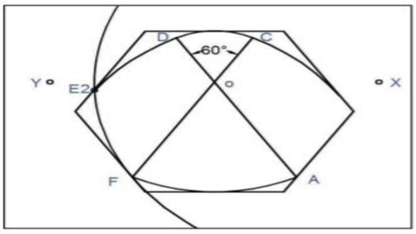
Step – 4

(5) Draw arc take a center point B and this arc is passing from point F and arc extending up to intersect arc ED. We want to arc is intersect at point E but this is coming nowhere near point E. (indicated by dotted circular arc). This is error in design of reuleaux pentagon, we try to overcome this error by the different method is illustrated in next step. (10)

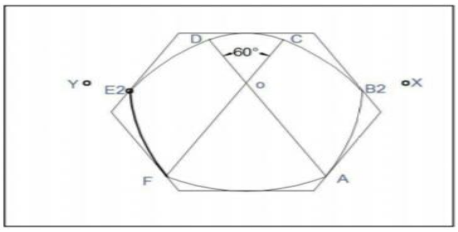


Step - 5

(6) Draw triangle by line extending of a three face (one upper & two lower side face) of hexagon to make a correct triangle. This triangle is rotate in clockwise direction of a small angular Displacement (make by ARRAY command in AUTOCAD).

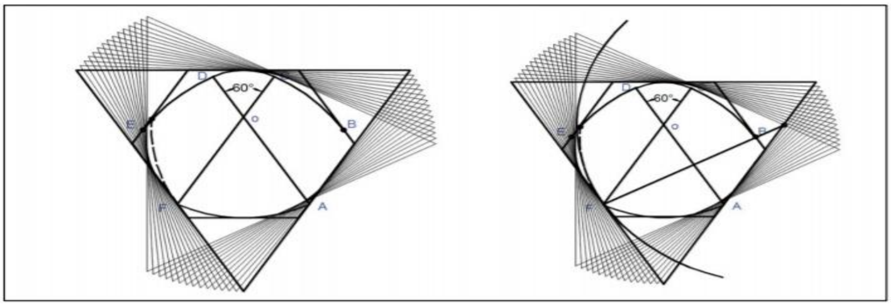


Step – 6



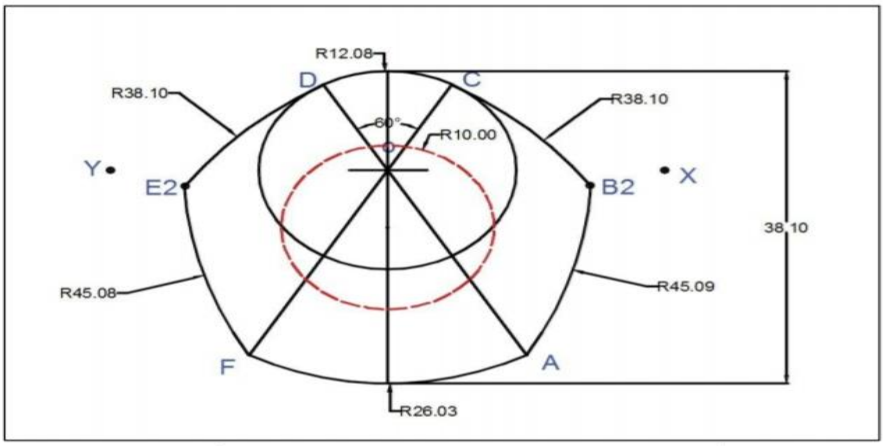
Step - 7

(7) Based on loci of point trace the curve. Perpendicular line draw from the point F (base face of point F), this line extending up to intersect the first triangle face is give base point X. after arc is draw from center point x, arc is passing from the point F and trace loci of point. This arc is intersect approximately near to point E to make correct reuleaux pentagon. (9)



Step -8

(8)On the arc ED new point E2 and point F is make correct arc FE2 (circular face of pentagon).Same method is applying for point A it gives the point B2 and base point Y, it makes arc AB2. Finally give a correct reuleaux pentagon it shown in below figure. (7)



4. DESIGNING OF COMPONENTS

Data which we have available:

- Mild steel EN8 solid shaft
- As per std. Diameter of shaft, d=20mm
- N=515rpm
- P=1KW

(1) $P = 2\pi NT/60000$
$1 = 2\times\pi\times515\times T/60000$
Torque Transmitted by Shaft
T =13.9 Nm = 13900 N mm

(2) $T = \pi/16\tau d^2$
$13900 = \pi/16\tau \times 20^2$
Shear stress on the Shaft
$\tau = 8.84\ N/mm^2$

For Mild Steel, Ultimate Shearing Strength σu =840 N/mm^2
Yield Strength σel =248 N/mm^2

- Shear Stress for M.S.

$\tau = 0.16\ \sigma u$
$= 0.16 \times 840$
$=151.2$ N/mm^2
$\tau = 0.3\ \sigma el$
$= 0.3 \times 248$
$= 74.4$ N/mm^2 (Take Min. Value of Shear Stress)
So, $\tau = 8.84$ N/mm^2 < 74.54 N/mm^2 ((therefore the shaft is safe)
Take, Factor of safety = 8

(3) Length of boss *l:*
$l = 0.45d$
$l = 0.45 \times 20$
$l = 9$ mm

(4) Thickness of flange t_1:
t1 = 0.7d
t1 = 0.7 × 20
t1 = 14 mm

(5) Width of tongue, t:
t = 0.4d
t = 0.4 × 20
t = 8 mm

(6) Height of tongue, h:
h = 0.5t
h= 0.5× 8
h = 4 mm

(7) Diameter of boss, d_1:
d1 = 1.5d
d1 = 1.5 × 2
d1 = 30 mm

(8) Diameter of Disc, D:
D = 2d
D = 2 × 20
D = 40 mm

(9) Length of shaft, L = 91 mm. (5)

- DESIGN OF MIDDLE PART:-

Data which we have available

Diameter of shaft, d =20mm
Diameter of disc, D =40mm

1). Width of slot
w =0.4d
=0.4*20
w=8mm

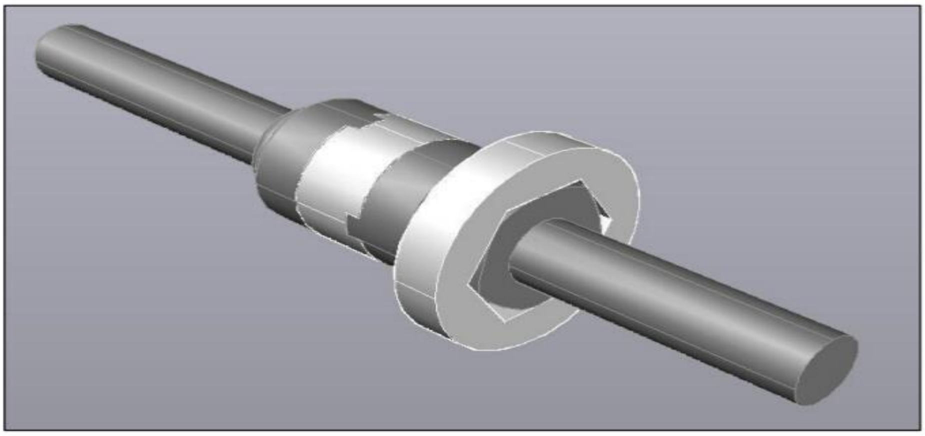
2).Depth slot, h_1
H_1=0.5t
H_1=0.5*8
H_1=4mm

3).Center distance between two shaft axes=8mm

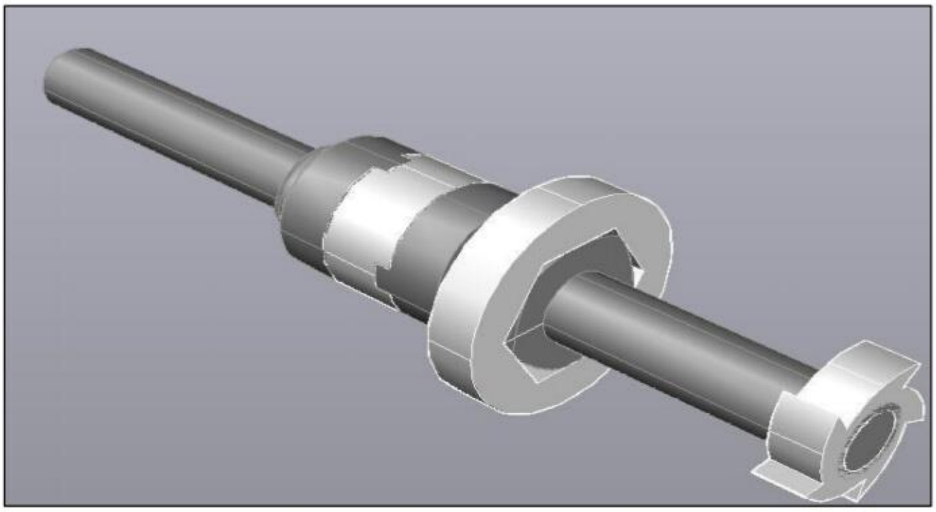
4).Diameter of middle part=40mm

5).Width of middle part=20mm

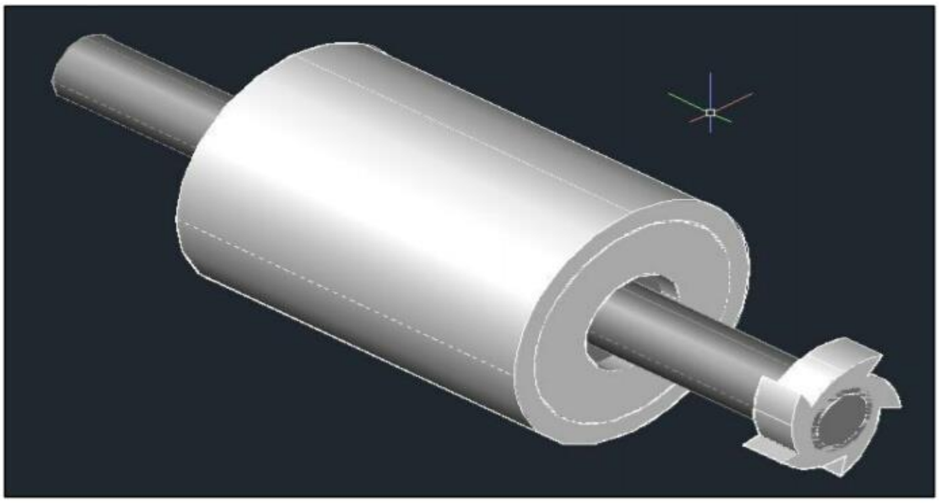
5. FINAL ASSEMBLY



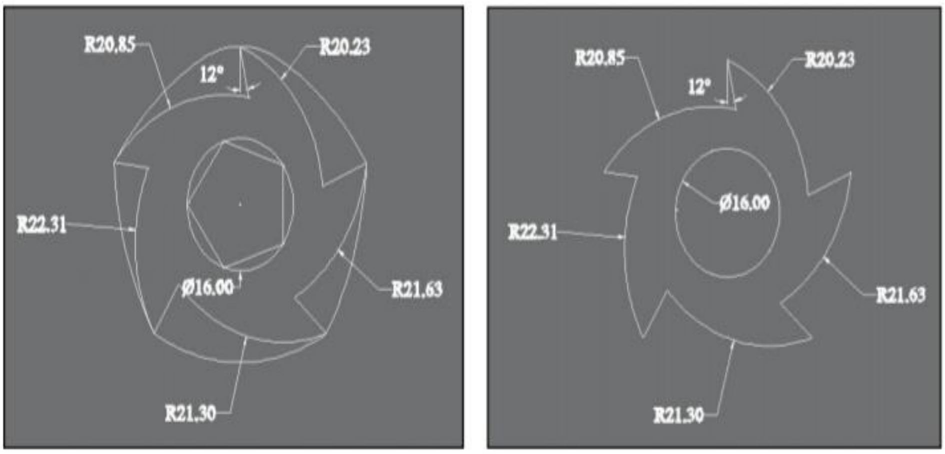
(Assembly of Part -1)



(Assembly of Part -2)



(Assembly of Part -3)



(Assembly of Cutter)

6. RESULT

The tool developed is approximately 228 mm in length and it is slightly heavy with approx. weight of 3kg. The cutting tool after proper assembly and installation is found to be nearly accurate Hexagon. That is, it is able to cut a hexagon profile with approximately 97 to 98% area of the original Hexagonal with same dimensions as that of the cutting tool .The remaining 2 to 3% which is not cut is present on the six corner of the hexagon in an arc form.

The main aim was to observe the feasibility of the mechanism in fulfilling the required motion and to check its employment with a cutting tool for producing the Hexagon of its size. This first aim has been fulfilled as desired and success of about 97 to 98% has been achieved in the secondary goal. In the future, the tool will be studied in detail and required modifications shall be provided, thus, there are certainly chances of 100% success rate. It can also be made of the cutting tool materials such as High speed steel, carbide etc., which can allow the manufacturing of the components as explained in the given project.

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