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LEONARDO DA VINCI'S INGENIOUS WAY OF CARVING ONE-FOURTH AREA OF A SEGMENT IN A CIRCLE

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ABSTRACT
Hippocrates of Chios (450 BC) has squared lunes, semicircle and full circle. Forgetting his squaring of circle, and 1. believing that 3.1415926 of polygon as Pi of the circle, 2. accepting wrong interpretation of Leonard Euler's equation of Pi radians and calling Pi constant as transcendental number by C.L.F. Lindemann, squaring of circle has become as an unsolved geometrical problem. S. Ramanujan has partially succeeded in squaring a circle. Leonardo da Vinci has carved out quarter area from a circle with the help of other circles. This paper is yet another attempt to prove that circle and its Pi are algebraic entities.

KEYWORDS: Algebraic number, circle, diameter, squaring.

INTRODUCTION
Circle and square are basic entities of geometry. Straightedge is associated with square. Whereas, circle is associated with compass, in addition to straightedge for its existence. From the beginning of human civilization till today, the circle has not been understood properly. The reason is that the circumference of circle is a curvature. The instrument compass can draw a circle but it can not measure its length. Unfortunately, we are yet to find out an instrument that can measure the length of a circumference, like the straightedge for the length of the side, diagonal of a square.

The age old method called Exhaustion method helps us to understand the circle only partially. Inspite of this deficiency, Hippocrates of Chios (450 B.C) has squared lunes, semi circle and full circle (Ref.9). The work that has been based on the value 3.1415926 of polygon of the Exhaustion method has **misled** the world. Thus, nearly 3000 years have gone by. The new branch **Calculus** too has supported polygon's value 3.1415926… as Pi of the circle (Ref. 11). It is too has failed to reveal the true Pi value of circle. In March 1998 Nature had been kind and revealed the **true Pi value** as $\frac{14-\sqrt{2}}{4}$ = 3.1464466… This value has survived next 17 years, fighting non-violently, submissively and politely and single handedly against the army of supporters of 3.1415926… of polygon, calling itself as Pi of the circle.

The new Pi value $\frac{14-\sqrt{2}}{4}$ has succeeded in convincing almost all members of the mathematics community and that Hippocrates had squared circle. Surprisingly, no Professor came out openly in opposing either the value 3.1415926… is Pi value and in opposing that squaring of circle is **not** an impossible geometrical problem and come out boldly in restoring **the golden throne** to the deserving Hippocrates of Chios because he was the first and the last mathematician who had squared a circle (Ref. 9).

Prof. Robert Burn of Exeter, U.K. has sent this author on 19.09.2015, ingenious construction of Leonardo da Vinci in carving out

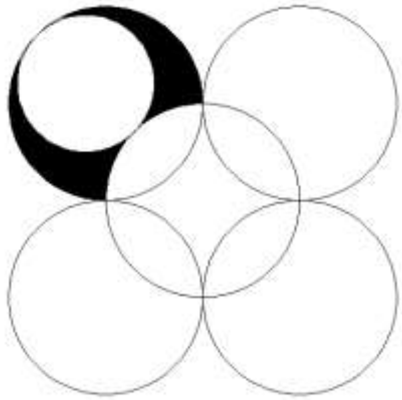

Diagram sent by Prof. Robert Burn

one-fourth area of a segment in a circle. It is explained and submitted to the world of mathematics that yet another evidence is here to show a circle or a group of circles **demarcate** a certain area equal to quarter magnitude in a circle. **Nobody has done before this great construction.** Now the mathematics community openly can come out in support of Hippocrates and Leonardo da Vinci that squaring of circle **was** done. And believing polygon's number 3.1415926… still as Pi of the circle will definitely can be taken as a disservice to mathematics and misleading the world and the **innocent student community** of the world in particular.

PROCEDURE

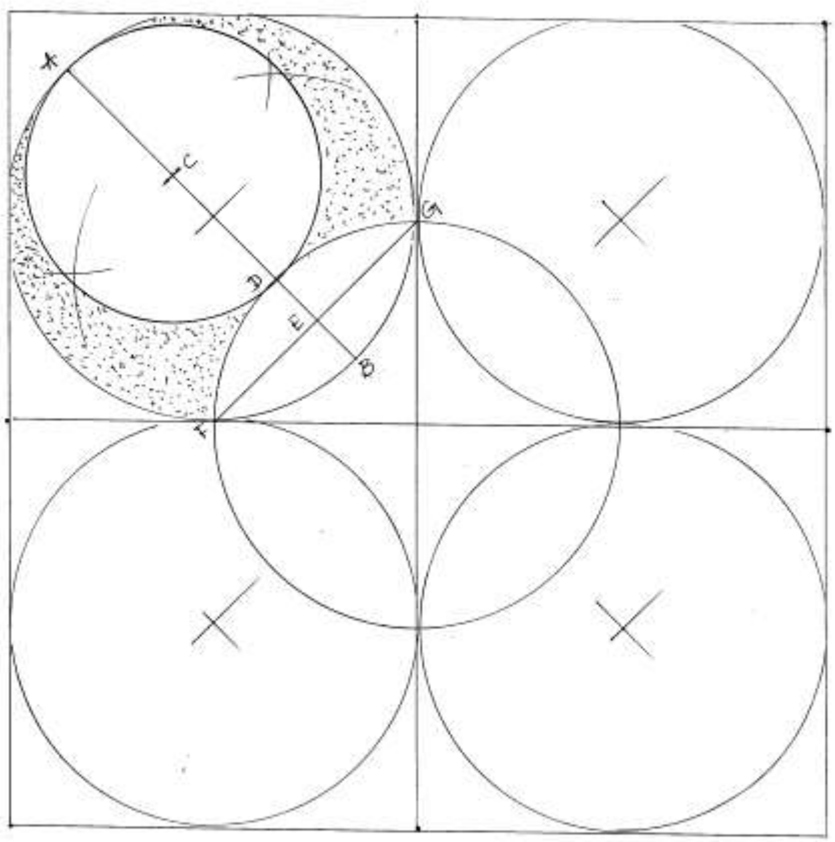

Diagram explained

Explanation of the diagram

1) AB = diameter of the larger circle = 1

2) AD = diameter of the smaller circle = $\frac{\sqrt{2}}{2}$

3) DE = EB = $\frac{2-\sqrt{2}}{4}$

4) From Siva method (Ref. 4)

Area of FED $= \left(\frac{\pi-2}{32}\right)d^2$ where d = 1

Area of 4 segments $= 4\left(\frac{\pi-2}{32}\right)d^2 = \frac{\pi-2}{8}$ where d = 1

5) Area of larger circle $= \frac{\pi d^2}{4} = \frac{\pi}{4}$ where d = 1

6) Area of smaller circle $= \frac{\pi d^2}{4} = \frac{\pi}{4} \times \frac{\sqrt{2}}{2} \times \frac{\sqrt{2}}{2} = \frac{\pi}{8}$ where d = $\frac{\sqrt{2}}{2}$

7) Area of shaded area =
Area of larger circle – (Area of smaller circle + Areas of 4 segments)
$= \frac{\pi}{4} - \left(\frac{\pi}{8} + \frac{\pi-2}{8}\right) = \frac{1}{4}$

So, the shaded area is equal to $\frac{1}{4}$. It means this area is squared.

CONCLUSION

Leonardo da Vinci has squared a segment of a circle with the help of other circles.

ACKNOWLEDGEMENTS

Prof. Robert Burn of Sunnyside, Exeter, U.K. has been arguing with this author for the last more than a decade that 3.1415926… is the value of Pi implying further that squaring of circle is impossible too. This day i.e. Saturday, 19-9-2015 he has sent this diagram of Leonardo da Vinci to this author. This author was shocked at first but felt very happy that a **great soul** like Leonardo da Vinci (1452-1519), an Italian Renaissance Painter, sculptor, draftsman, architect, engineer and scientist could alone change **Prof. Robert Burn's** opinion that what is the true nature of Pi value. This author **congratulates** this Professor of U.K. and is highly indebted to him for bringing this **highly valuable construction of Leonardo da Vinci to the world unknown till now.**

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APPENDIX

THE SECOND GREAT CONSTRUCTION OF LEONARDO DA VINCI

A Study That Shows The Oneness Of Square And Circle From The Mathematical Configuration Of The Human Body

INTRODUCTION

Prof. Mario Livio (of **Is God a Mathematician**, a book of him, published by Simon & Schuster Paperbacks, New York, 2009, purchased by this author on 25-05-2015 and the next day this paper of **Pi of the Circle** (Page No. 195) Ref. www.rsjreddy.webnode.com has acquired a **new life** this way) says in Preface "*In this book I humbly try to clarify both some aspects of the essence of mathematics and, in particular the nature of the relation between mathematics and the world we observe*".

In page 1 **James Jeans** (1877-1946) a British Physicist quoted as saying by him *"The universe appears to have been designed by a pure mathematician"*.

So, it is very clear that here is one evidence, for the idea, of **God** as a mathematician, from ancient times, and as this figure has its origin in the intelligence of the past and understanding, of the right relation between this **Creation** and **Mathematics.**

This author, in one of his papers also said that **"The one that converts "Nothing" into Everything is Mathematics".**

If one starts at this angle, searching, innumerable evidences will be our mathematical truths.
This author has been struggling to drive to a point that there is no difference between square and circle. Both are one. Both are reversible in their origin. So, naturally, it implies that π exists both in circle and square. This paper shows that Human body also reflects the above concept of **oneness** of square and circle.

PROCEDURE

1. Square = ABCD, Side = AB = a
2. Inscribe a circle. Diameter = GF = Side = AB = a
3. Diagonals = AC = BD = $\sqrt{2}a$

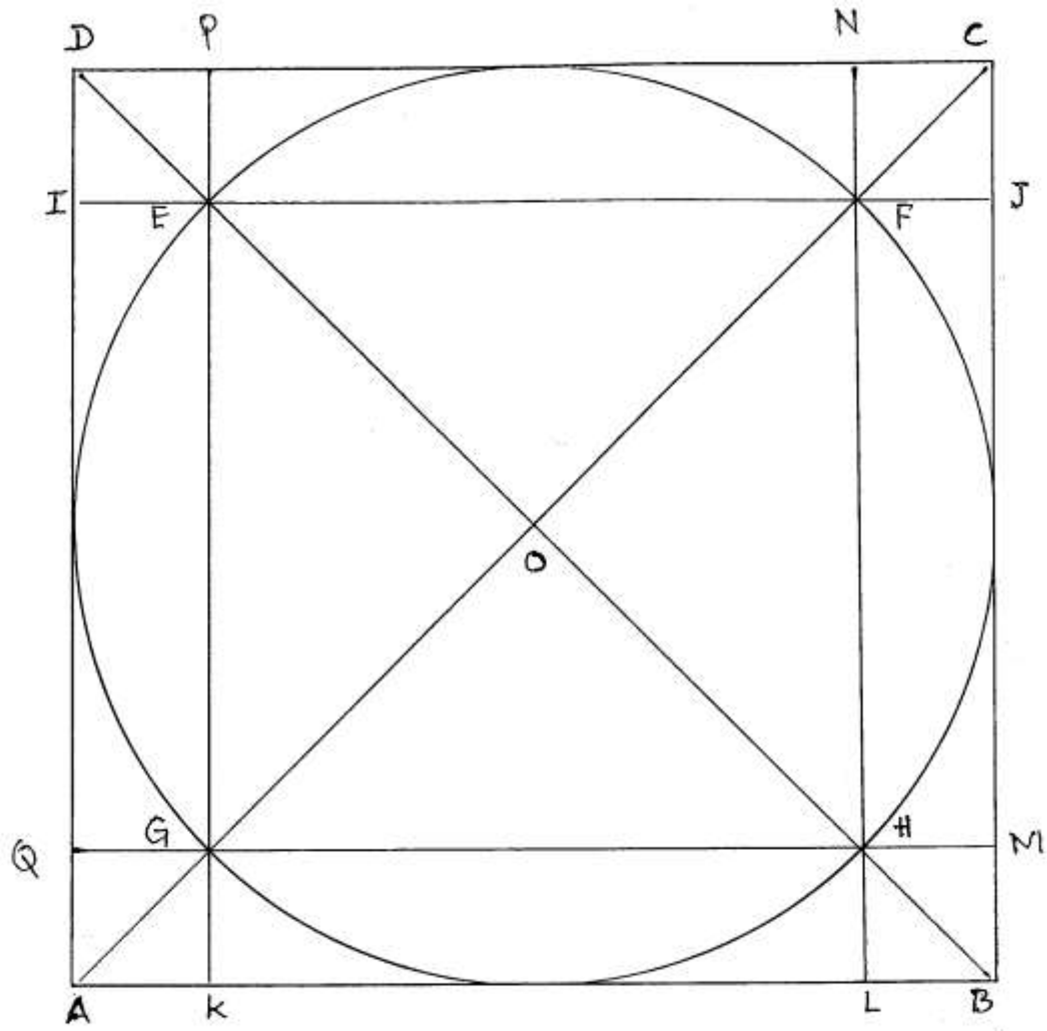

Fig-1

4. Two diagonals intersect the circumference at four points E, F, G and H, creating smaller square EGHF, whose side is equal to $\frac{\sqrt{2}a}{2}$ = OE = OF = Radius = $\frac{a}{2} \times \sqrt{2} = \frac{\sqrt{2}a}{2}$.
5. As a result of the formation of smaller EGHF square, four more **third squares** have formed. They are QAKG, LHMB, FJCN and DIEP.
6. Let us find out the side of four third squares. For example

   IJ = Parallel side = a

   EF side = $\frac{\sqrt{2}a}{2}$ (S.No. 4)

   IE = $\frac{\text{IJ side} - \text{EF side}}{2}$ = FJ

   $= \left(a - \frac{\sqrt{2}a}{2}\right)\frac{1}{2} = \left(\frac{2-\sqrt{2}}{4}\right)a$

   = IE = CJ = $\left(\frac{2-\sqrt{2}}{4}\right)a$ = ID = DP = PE = NF = NC = FJ = CJ
7. AB + AD + DC + CJ

   $= a + a + a + \left(\frac{2-\sqrt{2}}{4}\right)a = 3a + \left(\frac{2-\sqrt{2}}{4}\right)a = \left(\frac{14-\sqrt{2}}{4}\right)a$
8. $\left(\frac{14-\sqrt{2}}{4}\right)a$ is equal to the circumference of the inscribed circle.
9. The length of the circumference can be obtained from the following way **also**

   $$\frac{14\ \text{AB sides} - \text{AC diagonal}}{4} = \frac{14a - \sqrt{2}a}{4} = \left(\frac{14-\sqrt{2}}{4}\right)a$$
10. **One fourth** of the circumference of the inscribed circle can be obtained by the following process.
11. HF **arc** is equal to one fourth of the inscribed circle.

    BC side of ABCD square also gives the exact length of HF arc. How?
12. BC = side = a

    CJ = side = $\left(\frac{2-\sqrt{2}}{4}\right)a$

    JB = BC – CJ = $a - \left(\frac{2-\sqrt{2}}{4}\right)a = \left(\frac{2+\sqrt{2}}{4}\right)a$

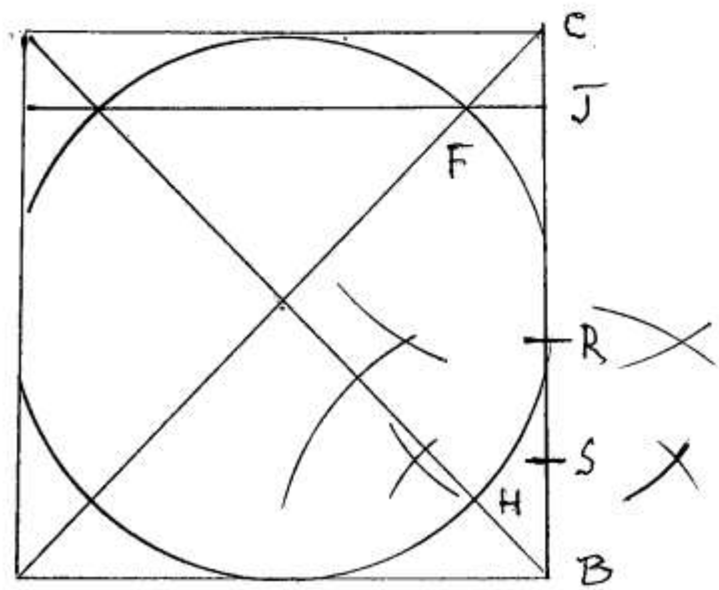

Fig-2

13. Bisect JB **twice**

$$\left(\frac{2+\sqrt{2}}{4}\right)a \rightarrow \left(\frac{2+\sqrt{2}}{8}\right)a \rightarrow \left(\frac{2+\sqrt{2}}{16}\right)a$$

14. Now **deduct** one fourth of JB side of $\left(\frac{2+\sqrt{2}}{4}\right)a$ from the side BC=a

JB → JR + RB → RS + SB

$\frac{1}{4}$ of JB side = $\left(\frac{2+\sqrt{2}}{4}\right)a \rightarrow \left(\frac{2+\sqrt{2}}{16}\right)a$

So, SB = $\left(\frac{2+\sqrt{2}}{16}\right)a$

$$a-\left(\frac{2+\sqrt{2}}{16}\right)a=\left(\frac{14-\sqrt{2}}{16}\right)a$$

which is equal to quarter length of the circumference = FRH arc.

15. This way the **full** length of the circumference of the inscribed circle can be **earmarked** in the perimeter of the ABCD square as BA + AD + DC + CJ = 3a + $\left(\frac{2-\sqrt{2}}{4}\right)a$ = $\left(\frac{14-\sqrt{2}}{4}\right)a$ of S.No. 7 and an Arc of circumference say one quarter of it FRH can also be **earmarked** as follows

$$CJ=\left(\frac{2-\sqrt{2}}{4}\right)a$$

$$JR=\left(\frac{2+\sqrt{2}}{8}\right)a=BR$$

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$$SB = \left(\frac{2+\sqrt{2}}{16}\right)a = RS$$

Let us verify Side CB = CJ + JR + RS + SB = a

$$\left(\frac{2-\sqrt{2}}{4}\right)a + \left(\frac{2+\sqrt{2}}{8}\right)a + \left(\frac{2+\sqrt{2}}{16}\right)a + \left(\frac{2+\sqrt{2}}{16}\right)a = a$$

$\frac{1}{4}$ of circumference = arc FRH which **is equal to** = CS =

= CJ+JR+RS = $\left(\frac{2-\sqrt{2}}{4}\right)a + \left(\frac{2+\sqrt{2}}{8}\right)a + \left(\frac{2+\sqrt{2}}{16}\right)a = \left(\frac{14-\sqrt{2}}{16}\right)a$

i.e., CS = $\left(\frac{14-\sqrt{2}}{16}\right)a$ of S.No. 14

16. So, arc FRH = CS

Part-II

Square – Circle – Human Body

LEONARDO DA VAINCI'S CONSTRUCTION

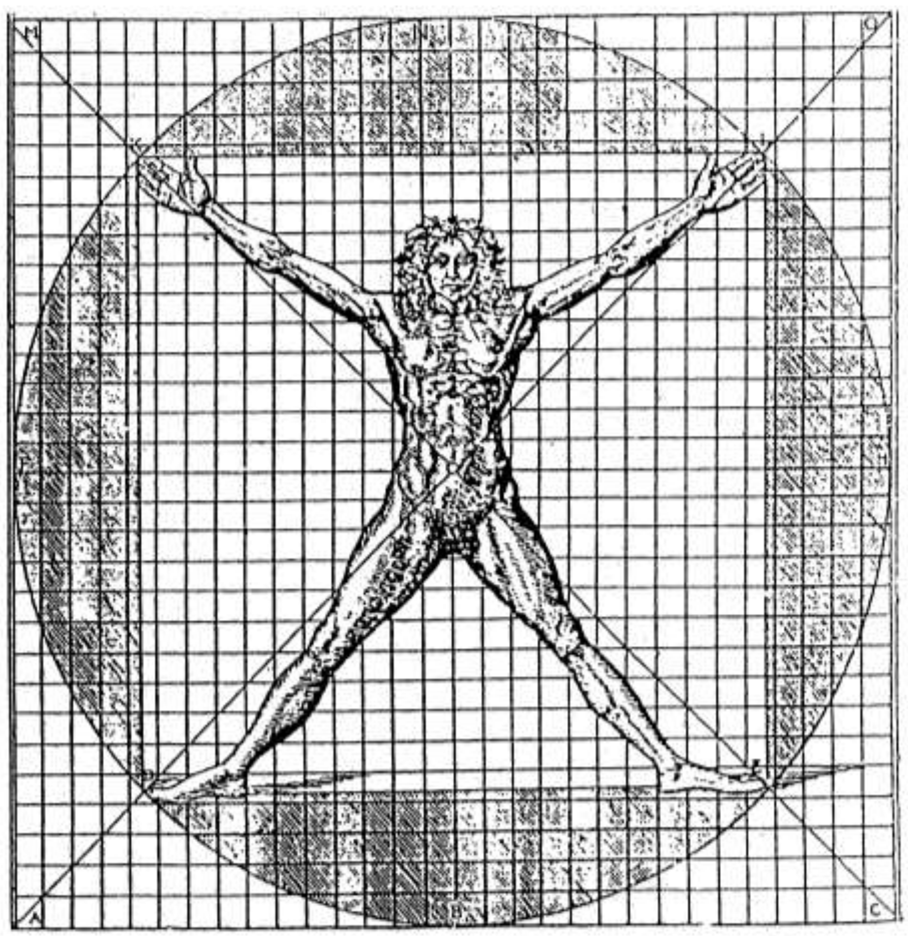

Fig-3: Human body in the circle – square nexus

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Of Fig-1 = Of Fig.3

17. Centre O = Belly-button of the Human body.
18. E = Tip of the Right Fore Limb
19. F = Tip of the Left Fore Limb
    G = Tip of the Right Hind Limb
    H = Tip of the Left Hind Limb
20. Human body has a **bilateral symmetry** (which means "A type of arrangement of the parts and organs of an animal in which the body can be divided into two halves that are mirror images of each other along one plane only (usually passing through the midline at right angles to the dorsal and ventral surfaces). Bi-laterally symmetrical animals are characterized by a type of movement in which one end of the body always leads").
21. In the human body when both the limbs are stretched they create a square equal to EGHF of Fig.1.
22. This EGHF square can be an inscribed square of ABCD larger square, when a circle of diameter equal to side AB is inscribed in it.
23. The EGHF square has formed because of intersection of two diagonals of the larger ABCD square, at four points of the inscribed circle.
24. Further, four tips of **both** the fore limbs and the hind limbs have created the four corners of EGHF.
25. Thus, it is clear that the smaller square EGHF in which human body's configuration fits in cent per cent exactly.
26. When four equi-distant tangents are drawn it creates ABCD square.
27. To conclude, the human body has mathematically been designed by **The Nature**. This is one clear example for the belief that

GOD IS A MATHEMATICIAN And Mathematics is **not** thus a human creation, as **Everything is God** & **God is Everything.**