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Design and Fabrication of Slotting Attachment in Drilling Machine

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Abstract: ***There are number of machine tools producing round and taper holes. But many engineering components require square and non-circular holes. At present square and other non- holes are produced using CNC machines or spark erosion or slotting machines. But there is no quality machine tool to produce square and polygon holes at minimum cost. Thus we made an attempt to design and fabricate an attachment for drilling machine which would produce square and polygon holes much more easily than the current method. This will be very useful to seat bolt heads etc.***
This attachment can be thought of an inversion of the "Cam and crank shaft mechanism. This attachment can be fitted either in drilling machine or vertical milling machine.
A complete design for this attachment for a size of ma*imum 20mm square and polygon holes has been successfully done and tested using an upright drilling machine. For different sizes of holes less than 20mm the tool can be changed. Similar designs can be made for any size and any number of sides to avoid lot of setting time and pre-machining procedures involved in current methods and very useful in case of mass production.
Keywords: Designing Attachment, Slotting & Drilling, Slotting Model

I. INTRODUCTION

Coimbatore is a highly industrial city. This is mainly due to entrepreneurship of local peoples. As there is no public sector undertaking. The small-scale industries though have lathe and other general-purpose machine tools; they find it difficult to get a good finished square and polygon shaping the components.
For producing square and polygon holes we have slotting and broaching machines. But it is slow process, the cost is high and setting time is more. A lot of time and manual work is involved in these methods. So this project **"**FABRICATION OF SLOTTING ATTACHMENT IN DRILLING MACHINE**"** is very much useful, if it is provided with good quality form tools of different shapes and sizes. Hence a need exists for attachment which can produce non-circular holes at minimum cost. Thus an attempt is made to design and fabricate such an attachment.

II. REVIEW OF STATE OF ART

A. Available Methods Of Producing Non-Circular Holes

All components which are produced do not have circular holes; they are non-circular holes also. Now-a-days most of the components having non circular holes are produced using broaching or slotting machines. By using our attachment such kind of jobs can be easily completed especially for small scale industries and for batch production where procurement and operation of machining and slotting machines would be uneconomical.

B. Disadvantages of Present Methods

1) It is a difficult
2) A possibility of injuries is more.
3) Labour cost and production cost is more.
4) More physical and metal fatigue.

III. TYPES OF SLOTTING MACHINE

The slotting machine fails under the category of reciprocating mechanism similar to the shaper and a planer.
There are two types of slotting machines. They are

1) Puncher Slotter
2) Precision Slotter

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A. Puncher Slotter

The Puncher Slotter is a heavy rigid machine designed to operating large quantity of metal from large forgings. The stroke length may be varied from 1800 to 2000 mm.

B. Precision Slotter

The precision slotting machine is lighter and operating at low speeds when compared to puncher slotting machine.
The machine is designed to finish the jobs in appropriate manner by using special jigs. The machine can handle the jobs of identical works due to increase the production. The precision slotting machine also used for general purpose work. The machine having quick return mechanism.

1) Slotter Size: The size of a general purpose or precision slotter usually from 80 to 900 mm.

C. Slotting Machine Parts

1) Base Bed: The Base is rigidly built to take all the cutting tools and the entire load of the machine. The bottom of the bed is smoothly finished to provide good seating on the work piece. The column is fitted to the Bed at the centre and tightly bolted. The column can be rotated in any direction.
2) Column: The column is a vertical member which is made of M.S. pipe. It is fitted to the centre of the base by two bolts.
3) Ram/Slider: The ram is a reciprocating member of the slotting machine. It mounted on the side ways between the top and bottom levels. It is supporting the tool. The cam and ram position is changed at the time of stroke.
4) Drive Mechanism: The slotter removes the metal during the downward cutting stroke. During the upward return stroke, the metal doesn't remove. The ram is driven by a cam wheel.
5) Holding Methods: The slotter can be fi*ed on the job itself while machining heavy jobs. If we want to machine smaller jobs they are held by vise, 'T' bolts, and clamps by special fixtures. The slotting machine is used to cut the job without touching the table.

IV. SLOTTING OPERATIONS

The followings are the various types of machining operations done slotters:

1) Machining of keyways
2) Machining of slots and slots
3) Cutting of internal and e*ternal gear tooth
4) Machining of angular portions
5) Cutting of grooves
6) Machining of inde*ed e*ternal dovetail slots
7) Forming the semi-circular portion of the locomotive driving bo*
8) Machining rectangular hollow portion of connecting rod end

A. Description

This attachment is intended for various shapes of non-circular holes. It consists of a rotating part and a reciprocating part held inside the two halves of the casing. The rotating part consists of a shaft screwed to a sleeve; the sleeve rotates with the shaft. The reason for screwing sleeve with shaft instead of providing a key is to prevent axial moment of sleeve.
At the other end of sleeve to suit the main shaft of 15 mm diameter. The reciprocating part consists of cam and crank shaft which act as guide for inner surface of sleeve. Bellow this part there is an e*tension to screw the tool holder. The reciprocating part is cam mechanism. Bottom casing and top casing are welded together. The casing is prevented from rotation by means of a bolt and nut.

V. PRINCIPLE OF OPERATION

To obtain a hole of desired shape, first the maximum size of hole that can be inscribed in it is drilled using a conventional drill bit. Now without changing the job and spindle settings, the taper shank of shaft is introduced into the spindle. When spindle rotates the shaft receives the drive and transmits it to the sleeve. The other end of the sleeve is connected to the main shaft which is made up of mild steel 15 mm shaft. The bevel gear and cam mechanism is used to transfer the rotary motion in to the reciprocating motion.

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Thus the stub reciprocates three times per revolution of the sleeve. The downward stroke is the cutting stroke. Thus the tool reciprocates with small amplitude and high frequency. The stroke length is equal to distance between the upward and downward movement of the crank shaft.

A. Design And Drawings

This "Drilling machine attachment for non-circular holes" consists of following parts.

1) Shaft
2) Bush
3) Bearing.
4) Sleeve.
5) Top casing.
6) Bolt.
7) Main shaft.
8) Bevel Gear
9) Cam and Crank Shaft
10) Bottom casing.
11) Key
12) Tool holder
13) Cutting Tool.

a) Shaft: Torque has been calculated, based on the assumed power.

Power Required (P) =650 W (Assumed) Mean Torque (T) = (P * 60 * 1000)/ (2 * 3.14 * N)

Speed (N) = 150 R.P.M (Assumed)

∴T= 9650 * 60 * 10000/ (2 * 3.14 * 150) = 41380.2 N-mm

Now we know,

$T = (3.14 * Fs * d^3)16$

Where,

T - Torque (N-mm)

Fs - Shear stress (N/mm^2)

= 37.5 N/mm^2 (from P.S.G Design data)

d = Diameter of shaft at bearing (mm)

$d^3 = (T * 16)/ (3.14 * Fs)$

$= (41380.2 * 16)/ (3.14 * 37.5)$

= 17.779 mm or 18 mm

b) Selection Of Bearing

Bearing has been selected with standard sizes-No. 6202

Inner Diameter (d) = 15 mm
Outer Diameter (D) = 35 mm
Height (H) = 15 mm

c) Selection Of Key: Key has been selected with standard dimensions. Keyway cross section

Width (b) = 8mm
Height (h) = 7mm
Keyway depth in stub = 4mm
Keyway depth in casing = 3.3mm
Clearance in depth = (4+3.3)-7
= 0.3mm length of key =Min.18 to Ma*. 90mm
Designation = parallel key 8*7*30

VI. 2D-DRAWINGS OF ATTACHMENTS

A. *Shaft*

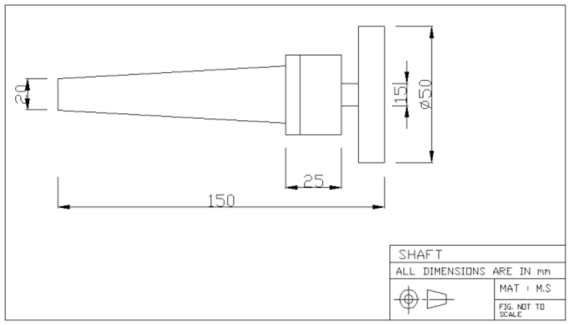

Fig.1.Shaft

B. *Bush*

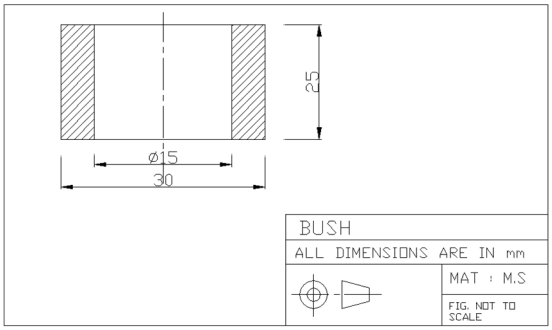

Fig.2.Bush

C. *Top And Bottom Plate*

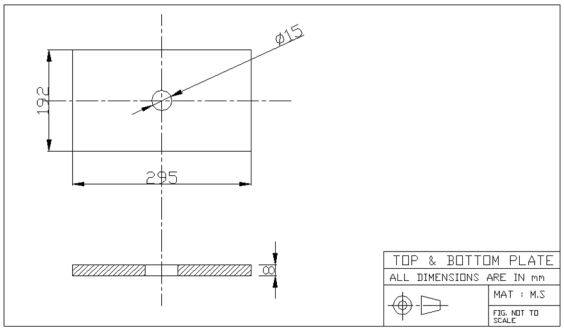

Fig.3.Top and Bottom Plate

D. *Tool Holder*

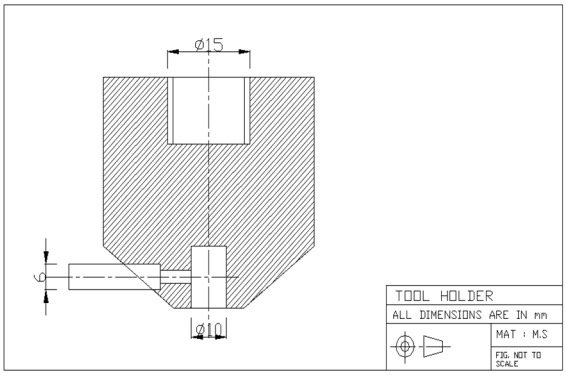

Fig.4.Tool holder

E. Bearing-6202

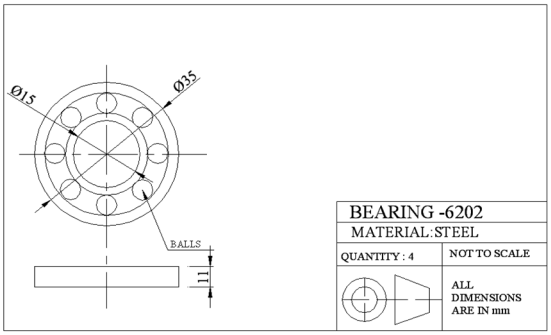

Fig.5.Bearing-6202

F. Bearing Cap

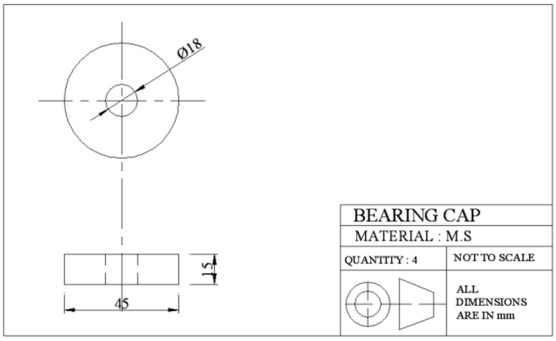

Fig.6.Bearing Cap

G. Crank Shaft

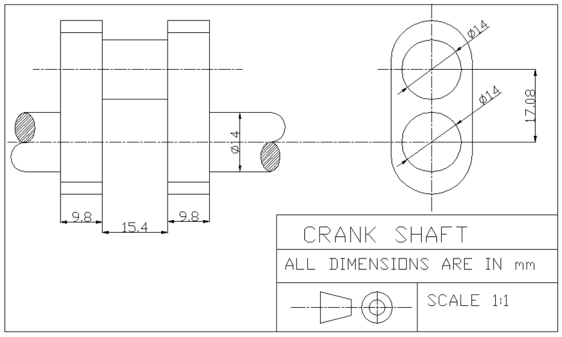

Fig.7.Crank shaft

VII. ASSEMBLY DIAGRAM IN 2D

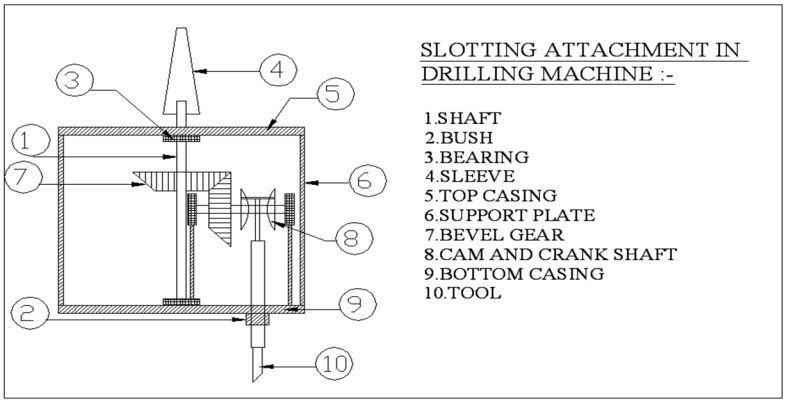

Fig.8.Assembly Diagram

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VIII. ASSEMBLY PROCEDURE

The procedure to assemble the drilling attachment is given below:

A. First the top casing is taken and a bearing is forced in it.
B. The shaft with a bush and sleeve screwed to it is passed into the bearing.
C. The bottom casing is taken and the guide bush is placed inside the casing against the tool holder with tool.
D. A bevel gear is provided between the two casings.
E. The cam and crank shaft is used to transfer rotary motion into reciprocating motion..
F. The tool holder is screwed to the bottom portion of the casing.
G. Finally the form tool (square in this case) is introduced in the tool holder and tightened using a bolt.

IX. MAINTENANCE

The attachment should be well maintained to ensure its long life. The following steps shall be followed.

1) Painting the casing to prevent rusting and corrosion.
2) Lubricating all the moving parts to avoid friction and reduce noise. This also gives good cleaning and cushioning effect.
3) Dust should be removed periodically.
4) Avoiding very hard materials as job materials.
5) Providing appropriate cutting angle and clearance angle to the tool.
6) Periodic regrinding of the tool.
7) Periodic inspection and tightening of all the threads.

A. Tool Economy

This is going to be very economical which has been illustrated below. For example assume an industry which makes 10 square holes in components using present methods of production at the expense of Rs.100 and if it makes 100 holes in the components per month, then the total cost is Rs.1000.

By using our attachment 10 holes can produced just for Rs.25 and the industry can produce 200 holes per month because the time taken is also tremendously less. Thus the industry spends only Rs.500 in one month. In this way approximately 75% of the expenses can be saved.

Hence the investment made on this project can be recovered in 3 or 4 months.

X. OTHER APPLICATIONS

This drilling machine attachment shall be utilised for other purposes other than machining form holes. This unit eliminates the presence of slotting machine in machine shop. Of course it may not be useful for all the jobs that a slotter can perform. This is because of lack of rigidity that a slotter has. But for small job works like machining a keyway etc can be very well performed by using a suitable tool bit fixed in the tool holder using a bar.

Now moreover by giving a very high RPM and minimum feed the frequency of reciprocation can be increased. When this high frequency reciprocation are applied on the job through an abrasive slurry, a hammering effect takes place on the work piece and any complicated shape in the tool can be produced in the job as a female part of the tool. The abrasive slurry consists of mixture of water and abrasive particles. This slurry and work piece is enclosed in a container.

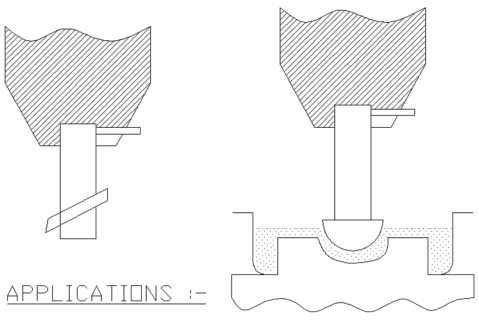

Fig.9.Application

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1) *Alternative Tool Designs:* When tool as described above is employed approximately a cut of 4mm has to be taken by each corner. This gives heavy shock loads to the attachment and heavy vibrations reach to the operator who gives the feed. In order to overcome the above difficulty the following two tool designs may be employed.
2) *Stepped Tool:* A tool similar to broach tool shall be used. Instead of having only one cutting point there may be three or four cutting points. The bottom one being smaller in size and the size gradually increases to the required size and the size gradually increases to the required size at the top.
3) *Adjustable Tool:* This tool size can be changed according to the requirements by using a screw. This unit may be designed similar to a drill chuck. Using this kind of tool first a light cut may be taken and then full depth of cut shall be given. The size alteration may be assisted by a micrometres dial.

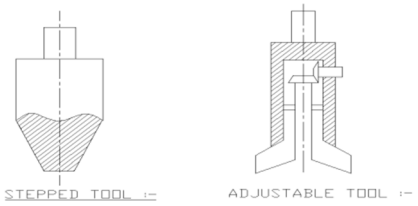

Fig.10.Alternate tool

A. List Of Materials

Table.1.List of materials

Sl.no.	Components	Material	Quantity
1	Shaft	M.S	1
2	Bush	M.S	1
3	Bearing	Steel	2
4	Bottom Plate	M.S	1
5	Top Plate	M.S	1
6	Steel rib	Steel	4
7	Inner Plate	M.S	2
8	Outer Casing	M.S	1
9	Tool Holder	M.S	1
10	Tool	H.S.S	1
11	Spring	C.I	1
12	Bolt and Nut	M.S	-

B. Photography

C. 3-Dimensional Daigram

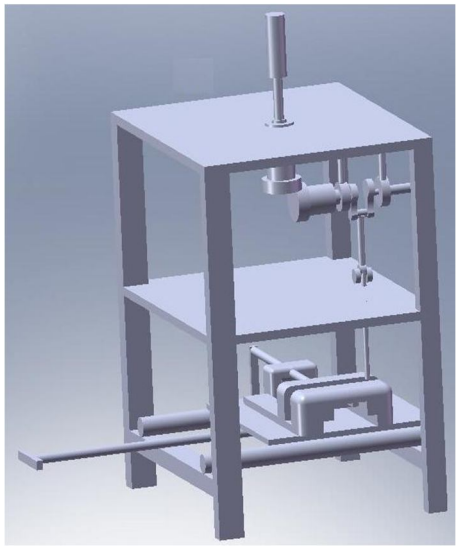

Fig.11.Assembly Diagram

XI. CONCLUSION

This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, computing and machining while doing this project work. We feel that the project work is a good solution to bridge the gates between institution and industries.

We are proud that we have completed the work with the limited time successfully. The Solar Air dryer is working with satisfactory conditions. We are able to understand the difficulties in maintaining the tolerances and also quality. We have done to our ability and skill making maximum use of available facilities.

In conclusion remarks of our project work, let us add a few more lines about our impression project work.

The chief advantage of our system is that, simple portable type low cost slotting attachment in drilling machine when compared to other machines which are available in market. Operating principle of this machine is also very easy.

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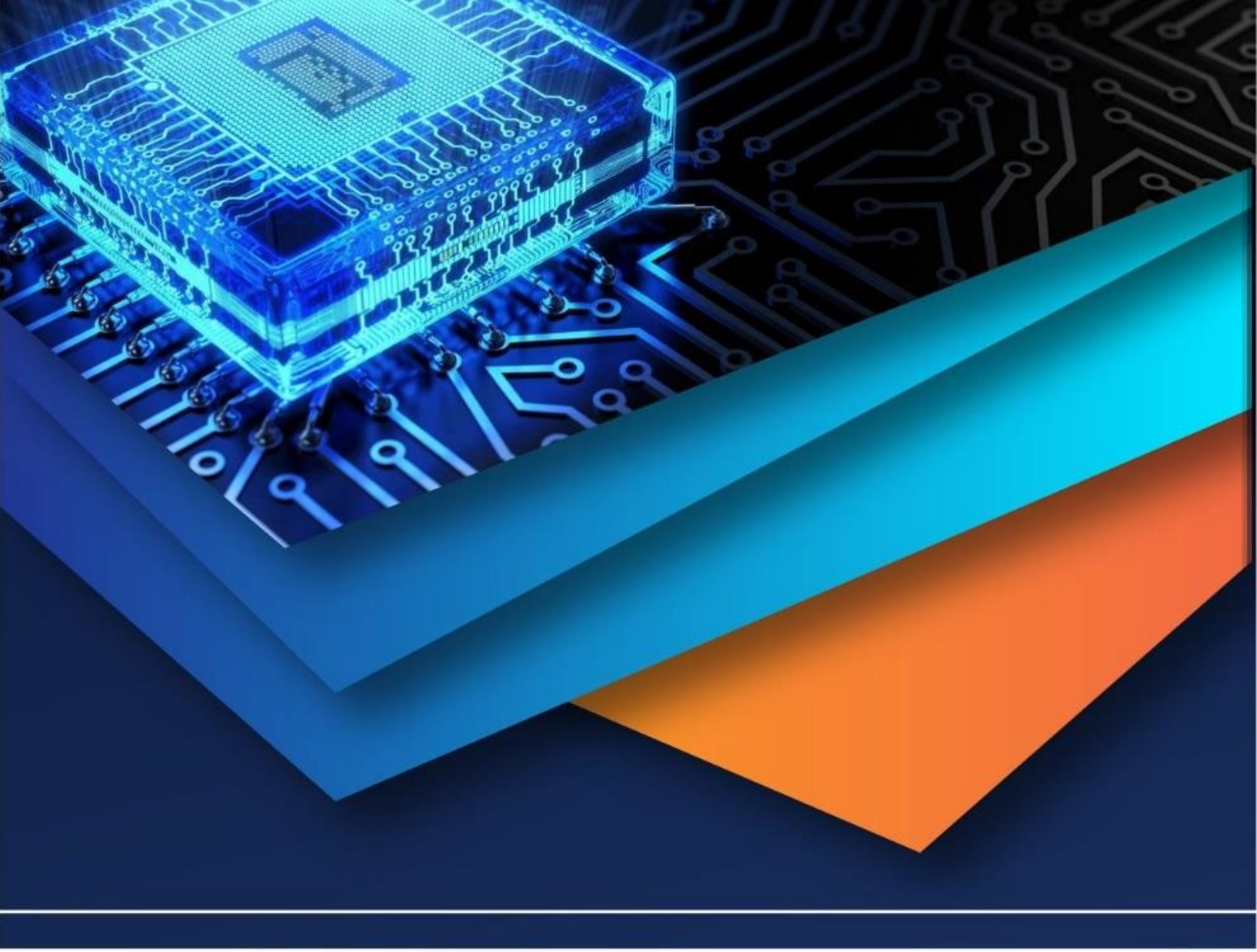

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