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Design and Fabrication of Multiple Tool Attachment for Lathe Machine

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Abstract: Every small scale industrialist wants to earn more profit with given limited resources in less period of time. Keeping these aspects in mind, there is a need to design an attachment that would result into increased rate of production at superior quality with low cost. The main purpose of this paper is to design and fabricate a multi-operational attachment to carry out various operations during manufacturing of a product. So the attempt has been made to design and fabricate the attachment in such a way that the number of operations can be carried out, without any need of shifting the work to next machine or station. The attachment is thoroughly designed in such a way that various operations such as Offset Drilling, Grinding, Slotting and Milling can be carried out on the same Lathe Machine. This will reduce plenty of time and on the other hand will reduce the human efforts.

Keywords: Multiple tool attachment, Lathe machine, Offset – drilling, Slotting, Milling.

I. INTRODUCTION

The upcoming and modern machining industries mainly focused towards the achievement of high quality, considering work piece factors such as dimensional accuracy, surface finish, high production rate, less wear of the cutting tools, economy of machining process in terms of cost saving and better performance of the product. In case of a rapidly developing industry, the operations performed and the parts or components manufactured should have least cost of production, then only the industry will run with enormous profits. In order to increase the number of operations on lathe machine there is a need to design and fabricate a 'multiple tool attachment' for a lathe machine. Lathe machine is also called as 'Mother of all Machine', so the approach has been made to perform various operations which is not performed by the simple lathe machine like Grinding, Offset Drilling, Plain Milling and Slotting etc.

The simple Lathe machine can perform limited operations such as Facing, Turning, Tapering, Knurling, Grooving etc. For further operations, such as grinding, milling, Offset drilling, Slotting etc., we have to shift the work pieces to another machine. Due to this, time required for manufacturing the product increases and also increases the cost of product. To overcome this problem, a multiple tool attachment plays an important role.

Various approaches are made in manufacturing industries to improve the performance and productivity [1] Provides the detailed implementation of multipurpose tool post attachment for drilling and grinding. [2] Has studied the Automation of Lathe Machine, where they have developed a conventional lathe machine by retrofitting stepper based method in which, the machine works as CNC trainer for teaching and learning of students [3] Shown regression analysis for achieving the accuracy and to decrease the time loss involved in the traditional grinding process. Grinding process is an abrasive cutting process where machining occurs with the help of geometrically unspecified cutting edges. Grinding interface involves material removal by contact between the grinding wheel and a random structured surface of the work piece. Surface quality is the main criterion in surface grinding and it is influenced by various parameters like work piece parameters, wheel parameters and process parameters.

II. LITERATURE REVIEW

Based on the review of literature, following are the various attempts which have made positive impact in manufacturing organisations.

[4] Conducted a research on Gear Manufacturing on conventional lathe machine by using milling cutter with the help of gear indexing mechanism to produce spur and worm and worm gear with more accuracy and also claimed that, duty centre lathe of standard power 2.5kw is capable of cutting spur gears and gears up to diameter of 30 mm and module between 1 to 2 can be generated.

[5] Designed the attachment of grinding wheel for lathe machine for grinding process. Grinding operation is the surface finish operation which is performed after all process. After machining of component, it is required to finish the burr and sharp corners of components on different machine. To avoid this type of situation it is easy to make an attachment for lathe machine which performed grinding without removing the component
[6]Constructed a Multi-Spindle Machine which is able to perform operations like drilling operation, buffing operation, Boring operation, Counter Boring operation without using separate machine for each operation and this machine is a separate unit which is not mounted on lathe as attachment. Bevel gear is used to transmit the rotating motion to the spindle.
[7] Provides information about how to perform the key-slot milling operation with the help of end milling cutter directed towards the centre of the shaft.
[8] Has shown the use of slotting attachment on lathe machine for slotting operation
[9] Claims that, 'The grinding wheel achieves speed up to 1440 RPM for external grinding and 550 RPM for internal grinding. With the help of this attachment, we can achieve accuracy up to 0.002mm'.

III. PROBLEM IDENTIFICATION

A simple lathe machine can perform only limited operations like turning, facing, drilling, knurling and taper turning but for processes like grinding, offset drilling, plain milling and slotting we require different machines or special extra attachment on a lathe machine. For a small scale industrialist, it is difficult for him to buy separate machines for performing separate operations and also the cost of production increases. Different machine requires more space and also high maintenance.

IV. AIMS AND OBJECTIVE

The main objective of this attachment is to reduce the cost of production and production time. This attachment is attached on simple lathe machine in order to eliminate the need for an operator owning a milling machine, slotting machine, grinding machine and drilling machine. It is design to mount on carriage vertically by replacing tool post on lathe machine and to be used without disturbing setup in associated. It is able to perform multiple operations by using multiple tools for machining operations that normally require expensive single-purpose machines. It offers many solutions either as a separate tool or combined with other machine tools. It is economical and beneficial for job production, thus rapid production is achieve effectively. It is very useful to obtain job or batch production which deals with less material handling in single shop floor and reduce machine time for many operations.

V. EXPERIMENTAL SETUP

Fig. 1 Experimental Setup

A. OPERATIONS

1) *Milling square end keyways :* Conventional milling is recommended when using the attachment on a lathe as the lathe's feeds and bearings are not designed for upward pressure on the carriage. Cutting square end keyways can be accomplished with the project using a variety of different cutters and speeds. It is usually set on top of the compound rest with the spindle of the attachment parallel with the travel of the compound rest. Select and mount the cutter to the appropriate arbor.

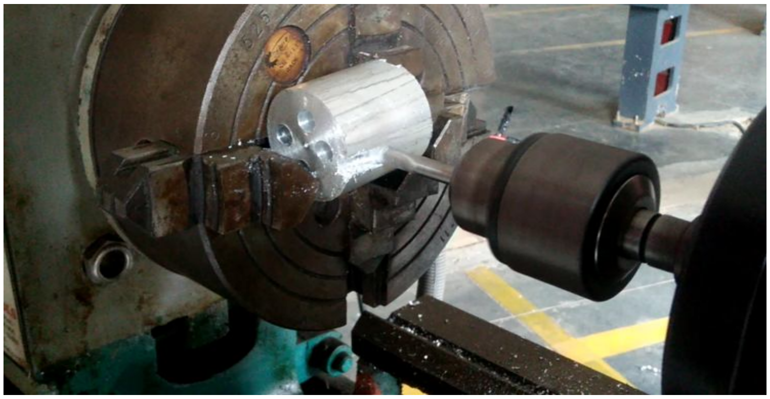

Fig.2 Square End keyways

2) *Off-Center Drilling :* Off-center drilling and boring may be performed by positioning the attachment spindle parallel with the lathe axis and set the drill by means of the cross slide and its lead screw. This allows the complete machining of irregularly-shaped items without removing them from the lathe chuck.

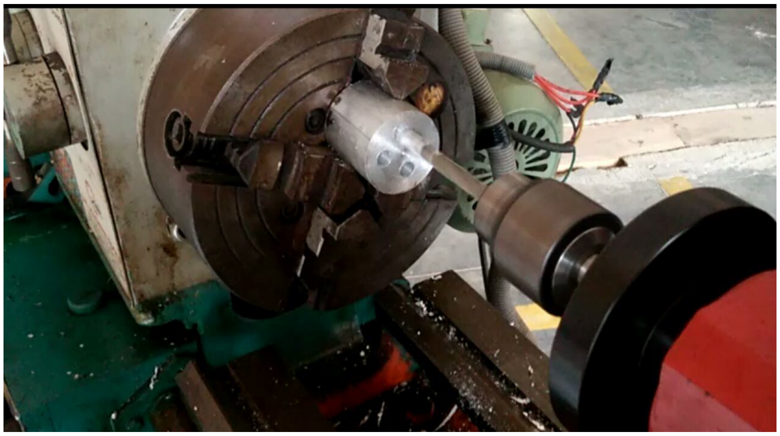

Fig.3 Offset Drilling

3) *Slotting:* Slotting with the attachment covers a wide variety of operations from milling long wide slots in material to cutting curved or thin slots. Work pieces may be mounted in the lathe chuck or between centers for slotting operation.

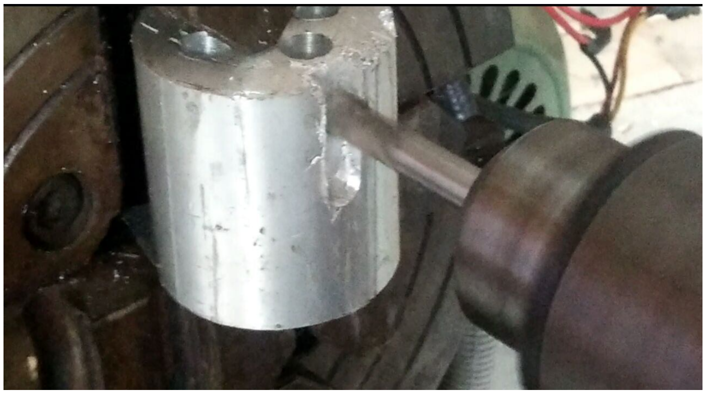

Fig.4 Slotting

4) *Grinding:* A wide range of grinding is made available by using this attachment. For maximum metal removal and minimum wheel wear, surface speeds of the grinding wheel should be near the highest allowable speed for the wheel size. Light cuts at full speed will remove metal faster than deep cuts at slow speeds. In general, rough cuts average 0.002 inch per pass, while finishing cuts average 0.0005 inch. The spindle rotation should be selected to throw wheel and metal debris away from the operator. When movement of the work is required during grinding, the work and the wheel should rotate in the same direction.

Fig.5 Internal Grinding

VI. DESIGN PROCEDURE

As per the design point of view, we selected the standard dimensions of block, head stopper and column. The dimension of base plate is selected as per the dimension of tool post mounted on carriage.

A. Specification

SR. NO.	COMPONENT NAME	MATERIAL	DIMENSIONS		
			DIAMETER	THICKNESS	HEIGHT
1.	COLUMN	Steel N-8, N-24	90 mm	5 mm	500 mm
2.	BASE PLATE	C.I.	210 mm	50 mm	-
3.	LEAD SCREW	Gun Metal	20 mm	-	450 mm
4.	ROTATING SHAFT	C.I.	30 mm	-	350 mm
5.	HEAD STOPPER	C.I.	105 mm	30 mm	-
6.	BLOCK	C.I.	Length*Breadth*Height 210*140*90 (mm)		
7.	PULLEY	C.I.	Diameter – 150 mm and 75 mm		
8.	V-BELT	RUBBER	Length – 812 mm		

Table 1: Specifications of Components

B. Motor Specification

SR NO.	PARAMETER	SPECIFICATION
1.	Type	3-Phase
2.	Rotating Speed	1440 rpm
3.	Power Developed	½ HP

Table 2: Motor Specification

The main part of Multiple Tool Attachment is spindle shaft from design point of view. The parts of the spindle are Quill, Quill cover, Front and back cover, etc. The dimensions of all the below parts are calculated from standard design data book and standard shaft size are selected from the design data book by B. D. Shiwalkar.

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C. Design Of Shaft

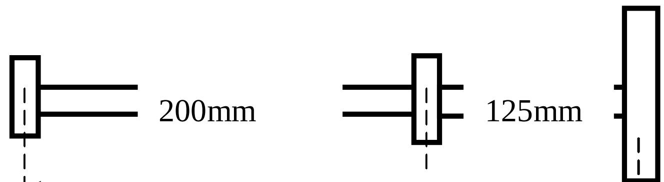


Fig.6 Line diagram of shaft

D. Assumption

1) Material is Homogenous and Isentropic.
2) Self- weight of pulley and shaft are neglected.
3) Shaft subjected gradually applied load.
4) Shaft is uniform.

E. Specification of Motor

Power = 373 watt (½ HP)
N = 1440 rpm

1) *Step 1 - Material selection.*
   From design data book, Pg. No. 39, Table – II – 7
   Selecting, SAE 1030 (I.S. C-30 Soft) material for shaft.
   Sut = 527 MPa
   Syt = 296 MPa
   Sys = 183 MPa
2) *Step 2 - Permissible shear stress-:* For designing of transmission shaft we use the ASME code. According to this code the permissible shear stress τmax for the shaft without key ways is taken as 30% of yield strength in tension or 18% of the ultimate tensile strength of the material whichever is minimum.

$\tau max = 0.3 * Syt = 0.3 * 296 = 88.8$ MPa.
$\tau max = 0.18 * Sut = 0.18 * 527 = 94.86$ Mpa.
Since, $\underline{\tau max = 88.8 \text{ MPa}}$ is minimum. Therefore, selecting permissible shear stress.

3) *Step 3 - Torsional Moment*

$$P = \frac{2\pi NT}{60}$$

$$373 = \frac{2*\pi*1440*T}{60}$$

T = 2.47 N-m.
T = 2.47*10^3 N-mm.

4) *Step 4 – Calculation of belt tension.*

$T = (T1 – T2) * dp$
$2.47*10^3 = (T1 – T2) * 75$

From Design Data Book, Pg. No.161 TableNo. –(XV – 10)
Coefficient of Friction (μ) = 0.3 for V-belt.

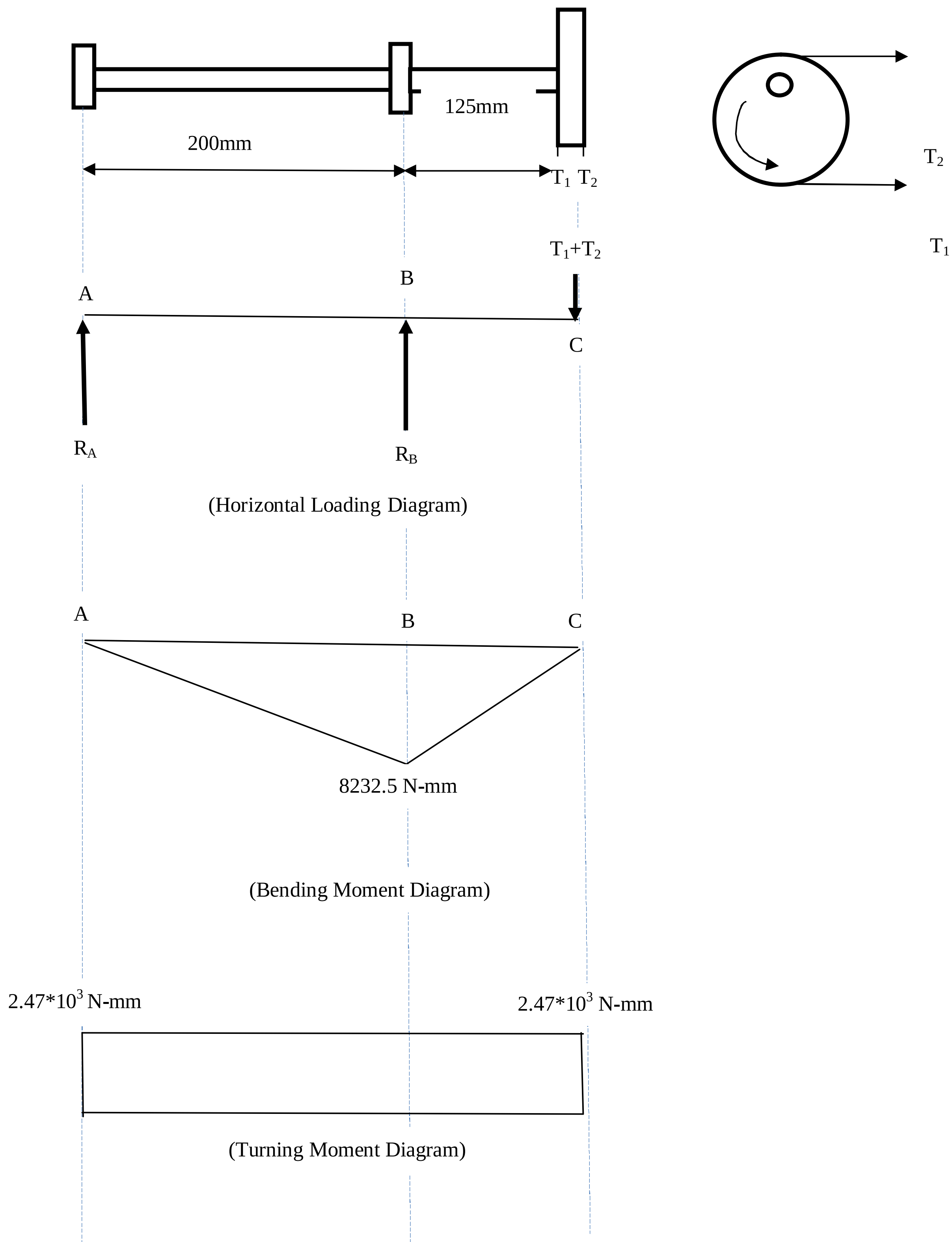
$$\frac{T1}{T2} = e^{\mu*\Theta}$$

Since, $\Theta = 210° = 210 * (\pi/180) = 3.665$ rad

$$\frac{T1}{T2} = e^{0.3*3.665} = 3.00$$

$T1 = 3*T2$
$2.47*10^3 = (3*T2 – T2)*75$
T2 = 16.46 N.
T1 = 3 * 16.46 = 44.4 N.

5) Step 5– Loading Diagram.



(Horizontal Loading Diagram)

(Bending Moment Diagram)

(Turning Moment Diagram)

$R_A + R_B = 65.86N \longrightarrow$ (i)

Taking moment about point (A)

$65.36*325 = R_B *200$

$R_B = 107.02N$

By putting the value of R_B in equation (i) we get,

$R_A + 107.02 = 65.86$

$R_A = 41.16N$

Bending moment calculations

$B.M._A = 0$

$B.M._B = -41.16*200 = -8232.5$ N-mm

$B.M._C = 0$

Step 6- Calculation of equivalent torque.

Equivalent torque moment.

$Te=\sqrt{(Kb*M)^2 + (Kt*T)^2}$

From Design and Machine Element Book, V.B. Bhandari (3rd edition), Pg. No. 334 and table no. 9.2,

Taking the value of shock and fatigue factor, for gradually applied load.

Kb = 1.5

Kt = 1

$Te = \sqrt{(1.5*8235.5)^2 + (1*2.47*10^3)^2}$

$Te = 12.593*10^3$ N-mm

Now,

$Te = (\pi/16)*\tau*d^3$

$12.593*103 = (\pi/16)*88.8*d^3$

d = 28.73mm

Standardizing the diameter of shaft,

d = 30mm

Hence, the diaeter of shaft is 30mm

VII. CONCLUSION

The development of multiple tool attachment is done by replacing or removing the tool post from conventional lathe machine. This attachment allows to perform offset drilling, grinding, milling and slotting easily by using different tools for each operations. This attachment has ability to produce good surface finish with grinding tool under 1440 rpm.

Mass production is possible on this attachment as different operations perform by single unit. This attachment also reduces cost required to pay the skilled operator for advance machine operations like milling, slotting, grinding etc.

This attachment gives a good solution to the small scale industries and workshops that cannot afford a separate machines for individual work and has limited space for performing advanced operations.

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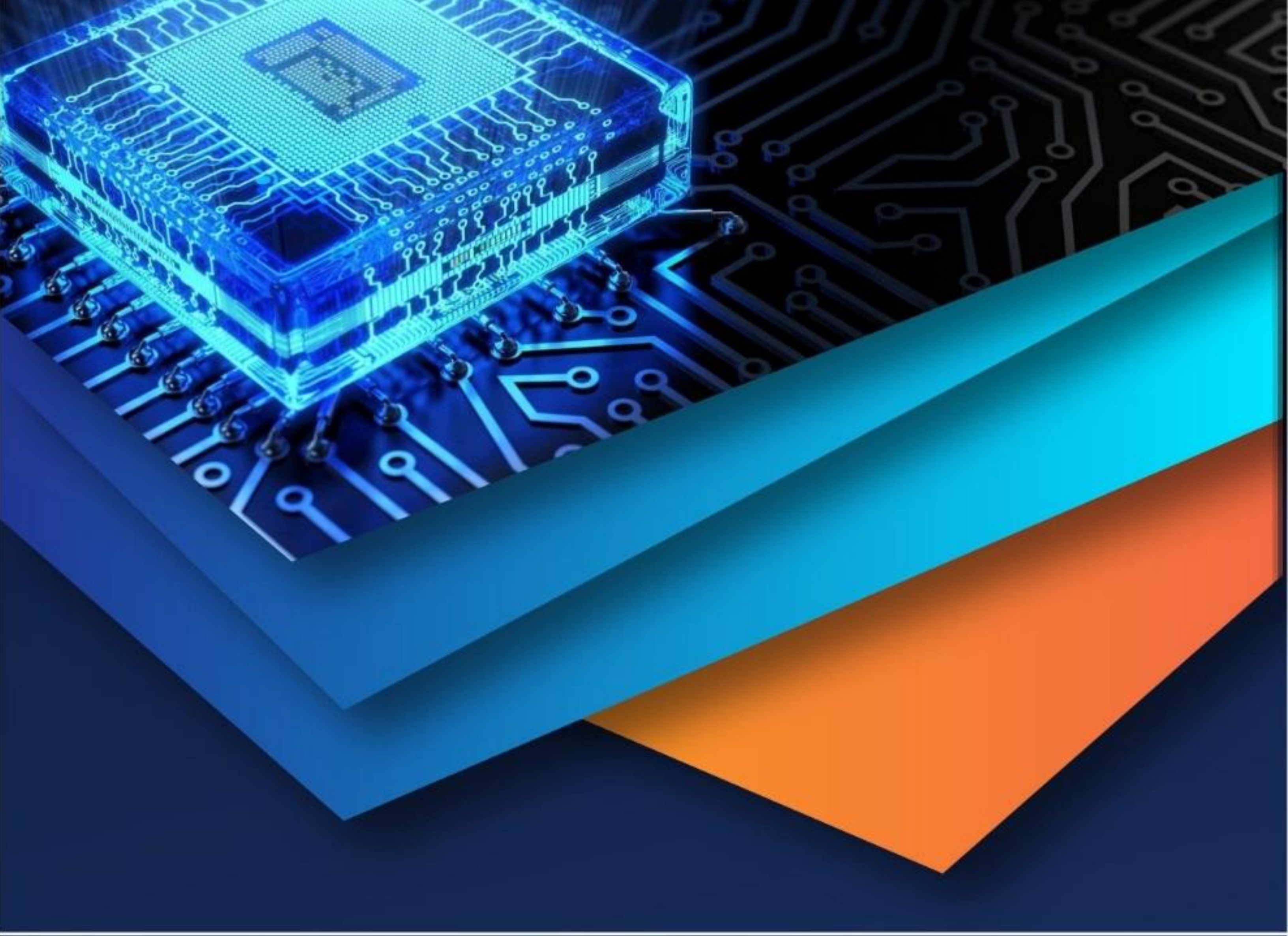

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