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Fabrication of Portable Pantograph for Wood Engraving

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Abstract: ***In study of theory of machine four bar mechanism is very important. Pantograph is one of the examples of four bar mechanism. Generally it is nothing but the parallelogram used for the copying the profile. A pantograph is a simple yet powerful tool which can broaden the scope of artwork and crafting. We can copy images to a reduced or enlarged scale with a pantograph depending on how the parts are measured and assembled .The pantograph in the illustration would produce a copy of the original. In this topic we "design, develop and analyze the portable pantograph for engraving required shapes or design on wood." Our pantograph is light weight and portable. Also copy with that different scaling of the letters is main work of this pantograph. This is low cost machine with compare to conventional pantograph. It may be old mechanism but still it has vast scope. In present days it has many beneficial uses. The physical model of pantograph consist of four links namely link A, link B, link C and link D. The links are connected with pins. The motor is mounted on link C at the centre. It is adjustable for which sliding slots are provided on link C. On link D, at the end point, Stylus is provided with curved bottom to ease the movement on the surface. The whole setup is clamped on a table. The stylus can only be used in 2D as one dimension is restricted. The engraving tool bit used is based on requirement. The experiments are performed on soft wood, engraved with good finish.***
Keywords-wood, stylus, link, letters, pantograph.

I. INTRODUCTION

Engraving is the machining process of using rotary cutters to remove material from a work piece advancing (or feeding) in a direction at an angle with the axis of the tool, It covers a wide variety of different operations and machines, on scales from small individual parts to large, heavy-duty engraving operations. It is one of the most commonly used processes in industry and machine shops today for machining parts to precise sizes and shapes. The pantograph is one of the most fascinating pieces of engineering equipment ever invented and in some form or other it should be part of every engineering shop's equipment. Engraving lettering in two dimensions is just one of its functions, more sophisticated versions work in three dimensions and will copy complicated three dimensional designs and engineered components, enlarging or reducing them in size as required. A pantograph is a simple yet powerful tool which can broaden the scope of artwork and crafting. We can enlarge or reduce images with a pantograph depending on how the parts are measured and assembled. The pantograph does the image resize calculating for us by using the distances between its pivot points as the "algorithm" for creating your finished copy. The pantograph in the illustration would produce a copy smaller than the original. By changing the distances between the pivot points you can change the percentage of enlargement your pantograph provides. By using Spirograph and pantograph mechanism together we are able to get complex shapes on wood and marble, such a complex shapes which are useful for decoration purpose. Spirograph is a mechanism in which kind of gear arrangement is used which gives perfect shapes with high precision and accuracy in our objective is to get the shapes so we are using this combination of mechanism as a part of our project. Tracing element can trace the shapes as per spirogragh and pen element gives the same shapes on the other hand of the pantograph machine.

II. LITERATURE REVIEW

Glass et al (1951) [1], the invention relates to reproducing devices or copying devices and particularly to pantographs other like. An object of the present invention is to provide pantograph for use with a heavy-duty metal-working or wood-working machine such as a milling machine. Zwicket al (1932) [2], his invention relates to engraving and copying machine of type in which a pantograph system is used, a cutting tool and tracing point or stylus being mounted on the pantograph system. An object of the invention is to provide a generally improved and more satisfactory machine of this character, and particularly one in which heavy cutting may be accomplished with little or no exertion on the part of the operator, irrespective of the direction of the cut. More et al (2016) [3] In engineering many process is required and different parts require different processes. But the properties of materials and other things change with the processes. Project is a mission of creating something new, which is innovative i.e. manufacturing of new product. This machine uses a high speed cutter that can be fed up or down to give depth of cut whereas the x- y axes table is given motion using a pantograph mechanism that copy or scale the template or shape that is to be produced on the job, this is an accurate method so also the first job will be same as the last job. Wallace, (1821) [4] invented the ideograph to improve upon the practical utility of the pantograph. The ideograph relocates the fixed point to the centre of the parallelogram and uses a narrow parallelogram to provide improved mechanical advantages. Benton et at(1884) [5] American typeface designer Linn Boyd Benton created the Benton

Pantograph, an engraving machine capable not only of scaling font design patterns to a variety of sizes, but also condensing, extending and slanting the design. Mathematically, the pantograph works in affine transformation which is the fundamental geometric operation of most systems of digital typography today, including PostScript. Aesthetically the machine was incapable of replacing the punch cutter's intuitive balancing of line weights, counterpaces and proportion as the type was scaled. He has also invented a pantographic punch cutter, a router-like engraving machine for cutting the steel punches for type. That was the most important technical development in typography since Gutenberg‘s invention of variable-width type moulds in the 15th century.” "The machine age in the form of the pantograph and mechanical typesetting was beating against the door of hand-work. By the 1920's the whole process of type manufacture had been taken into mass production, and carried out under factory conditions. Feynman (1959) [6] used the analogy of a pantograph as a way of scaling down tools to the nanometre scale in his talk There's Plenty of Room at the Bottom. Numerous trade-show displays use 3-dimensional pantograph mechanisms to support backdrops for exhibit booths. The framework expands in 2 directions (vertical and horizontal) from a bundle of connected rods into a self-supporting structure on which a fabric backdrop is hung. Cheverton et al (1836) [7] Cheverton’s machine was fitted with a rotating cutting bit to carve reduced versions of well-known sculptures. Of course a three dimensional pantograph can also be used to enlarge sculpture by interchanging the position of the model and the copy. Another version is still very much in use to reduce the size of large relief designs for coins down to the required size of the coin. Leone et al (2009) **[8] “**Wood engraving by Q-switched diode-pumped frequency-doubled Nd:YAG green laser” Laser deep engraving is one of the most promising technologies to be used in wood carver operations. The aim of this work is to investigate the influence of the process parameters on the material removal rates by engraving panels made of different types of wood using a Q- switched diode-pumped Nd:YAG green laser working with a wavelength X = 532 nm. In this work, the features and the performances given by a 5W of nominal power switched diode-pumped frequency-doubled Nd: YAG green laser in the engraving of different kind of woods are discussed and the main conclusions are the following:

1) The surface carbonization depends on an incorrect selection of the process parameters and, for the adopted laser, it happens at beam speeds of up to 10mm/s.
2) For speed more than 40mm/s, the engraved depth is very low and multiple laser scanning are required to obtain deep engraving. The engraved depth is strongly affected by the mean power, the pulse frequency, the beam speed and the number of repetitions.
3) Increasing the speed is possible to obtaining engraving with a reduced frequency range around the value where the maximum output power is achieved. The maximum speed necessary to obtain engraving linearly depends on the mean power.

Iliescu, (2011) [9] “Study on Holograms Laser Engraving Process” Holograms and holography become more and more important for nowadays life, specially because of their role in security and protection. Some research results on holograms laser engraving process parameters are evidenced by this paper. Application of holography and holograms is very wide, covering: security and product authentication, packaging - consumer goods brand protection, art and interactive graphics, etc. This paper is a study on hologram marks, more specifically, on hologram laser engraving process parameters. In order to obtain high resolution engraving results low speed, high frequency and small pulse duration of the laser beam should be used. Diaci et at (2011) [10] “Rapid and flexible laser marking and engraving of tilted and curved surfaces” Author present a novel method for rapid and flexible laser marking and engraving of tilted, curved and freeform work-piece surfaces. A low power CW laser regime is used to measure the 3D shape of a work piece surface while a high-peak power- pulsed laser regime is used for processing. This paper discusses key issues concerning an implementation of the method and presents typical examples of markings and engravings. A novel method is presented that allows rapid and flexible laser marking and engraving of tilted, curved and freeform work- piece surfaces. The measurement phase takes typically less than 10 seconds. Wend land, (1901) [11] Deep engraving of metals for the automotive sector using high average power diode pumped solid state lasers” This author investigates deep engraving of steel and aluminium by laser. Material removal rates of up to 20 mm in 3 min for steel and 40 mm in 3min for aluminium are demonstrated up to a maximum engraved depth of 1mm. The material removal rates achieved, which is 90 mm in 3 min for aluminium alloy, 25 mm^3/min stainless steels are very attractive for industrial applications. This paper shows that it is possible to achieve good contrast which is needed for barcode marking on bare metals. Barpateet al (2016) [14] “Design, development and analysis the portable pantograph for engraving letters on wood” For design and fabricate an engraving machine we use pantograph mechanism. The engraving tool mounted on the pantograph should travel the same path given by stylus as an input. Stylus will trace the shape of already existing object. Using such kind of manipulator we can generate the rescaled replica of the object or we can say it to be a copying machine which can be employed in mass production with economical production, model of pantograph engraving machine is having low weight, portable and easy to handle for unskilled persons also than other complicated engraving machines. We designed such mechanism for engraving machine which is safe; hence there are no problems in manufacturing too.

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III. PANTOGRAPH MECHANISM

Pantograph is a linkage constituting of five link connected with pin joints to form revolute pairs. It is connected in a manner based on parallelograms so that the movement of one point, in tracing an image, produces identical movements by second point. A pantograph is used to reproduce to an enlarged or a reduced scale and as exactly as possible the path described by a given point. If a line drawing is traced by the first point, an identical, enlarged, or miniaturized copy will be drawn by a pen fixed to the other. One of the revolute pair is fixed into the base, so that we can move this mechanism with respect to fixed point. Because of their effectiveness at translating motion in a controlled fashion, pantographs have come to be used as a type of motion guide for objects large and small. The point which traces the profile can be in any form e.g. Simple pin having conical point, rod having a bearing mounted at its end. And the point which gives the output can be in forms like router, pen, drilling machine etc. The pantograph is made up of five links. One end is hinged and at the other end is the stylus which we will be moving manually. The link will work in only X & Y direction and Z axis will be restricted. As the stylus will be moved the tool will also follow the same path. The scaling factor will be responsible for the change in size of the engraved profile.

A pantograph is a mechanical linkage connected in a manner based on parallelograms so that the movement of one pen, in tracing an image, produces identical movements in a second pen. If a line drawing is traced by the first point, an identical, enlarged, or miniaturized copy will be drawn by a pen fixed to the other. Using the same principle, different kinds of pantographs are used for other forms of duplication in areas such as sculpture, minting, engraving and milling. Because of the shape of the original device, a pantograph also refers to a kind of structure that can compress or extend like an accordion, forming a characteristic rhomboidal pattern. This can be found in extension arms for wall mounted mirrors, temporary fences, scissor lifts, and other scissor mechanisms such as the pantograph used in electric locomotives and trams. Before the advent of control technologies such as numerical control (NC and CNC) and programmable logic control (PLC), duplicate parts being milled on a milling machine could not have their contours mapped out by moving the milling cutter in a "connect-the-dots" ("by-the- numbers") fashion. The only ways to control the movement of the cutting tool were to dial the positions by hand using dexterous skill (with natural limits on a human's accuracy and precision) or to trace a cam, template, or model in some way, and have the cutter mimic the movement of the tracing stylus. If the milling head was mounted on a pantograph, a duplicate part could be cut (and at various scales of magnification besides 1:1) simply by tracing a template. (The template itself was usually made by a tool and die maker using tool room methods, including milling via dialing followed by hand sculpting with files and/or die grinder points.) This was essentially the same concept as reproducing documents with a pen-equipped pantograph, but applied to the machining of hard materials such as metal, wood, or plastic. Pantograph routing, which is conceptually identical to pantograph milling, also exists (as does CNC routing).The development and dissemination throughout industry of NC, CNC, PLC, and other control technologies provided a new way to control the movement of the milling cutter: via feeding information from a program to actuators (servos, lead screws, machine slides, spindles, and so on) that would move the cutter as the information directed. Today most commercial machining is done via such programmable, computerized methods. Home machinists are likely to work via manual control, but computerized control has reached the home-shop level as well (it's just not yet as pervasive as its commercial counterparts). Thus pantograph milling machines are largely a thing of the past. They are still in commercial use, but at a greatly reduced and ever-dwindling level. They are no longer built new by machine tool builders, but a small market for used machines still exists. As for the magnification-and reduction feature of a pantograph (with the scale determined by the adjustable arm lengths), it is achieved in CNC via mathematic calculations that the computer applies to the program information practically instantaneously. Scaling functions (as well as mirroring functions) are built into languages such as G-code.

A. Objective

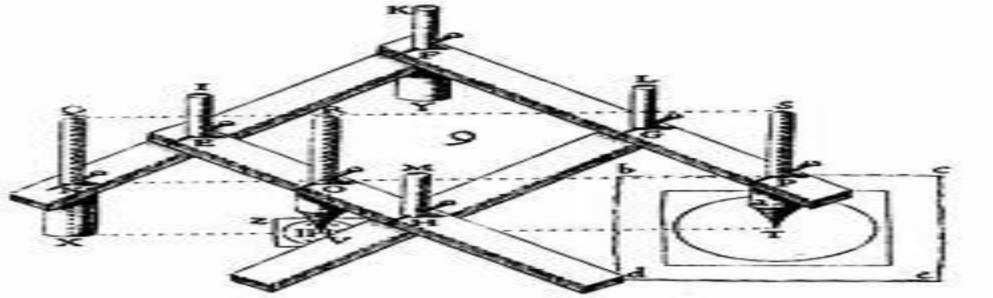

Figure 1; Pantograph Mechanism

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Construct a pantograph and used to draw similar figures (reduced or enlarged). A pantograph is an instrument used to copy line drawings or pictures, and enlarging or reducing them as you draw. The pantograph in this exercise will allow you to double the size of your picture.

B. Working Principal

The working principle of pantograph wood engraver is mainly based on the four bar mechanism in which one link is fixed and other links are pivoted and these other links moves according to movement of stylus it is shown in fig. 2 In figure, Point B is fixed, Point A, C, D and E are pivot points, Point P2 is cutting point, point p1 is stylus point.

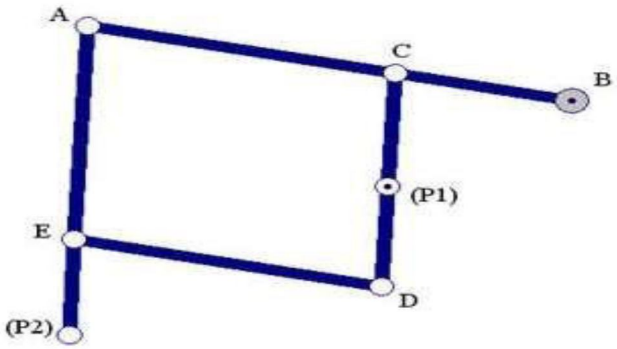

Figure 2; Four Bar Mechanism

Fabrication of Portable Pantograph

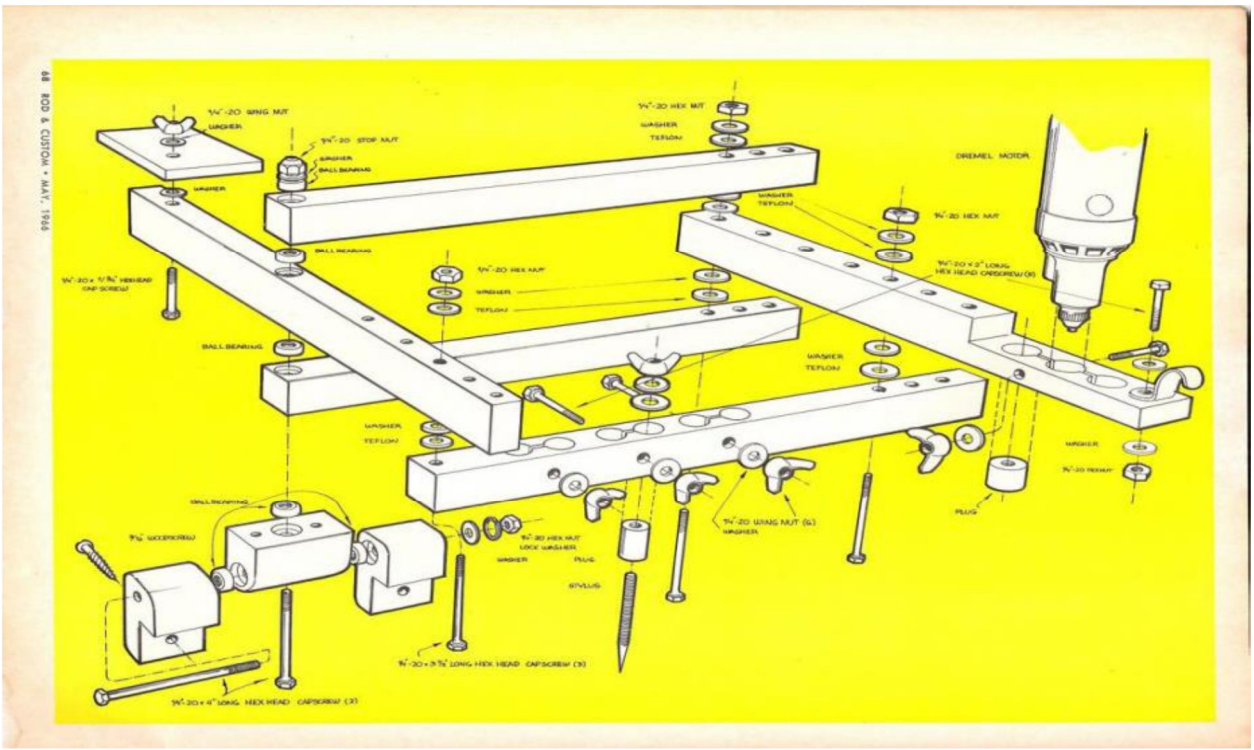

Figure 3; Design Plan

Motor specification	
Rated power input	350W
No-load speed	30000r/min
Collect chuck capacity	6.35mm
Net weight	1.8kg

IV. MATERIAL SPECIFICATION

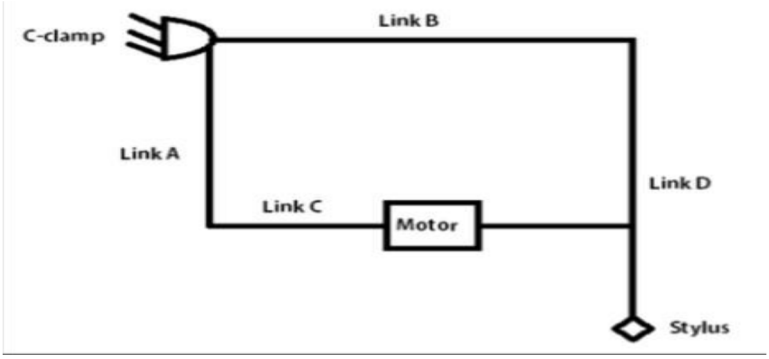

Figure 4; Schematic diagram of Linkages of Pantograph

A. Specifications

Materia: 1 inch 14 gauge Mild steel square tubing inches, MS Pins, MS stylus with curved end.
Dimension: Link A=500MM, LINK B=1000MM, LINK C=1000MM, LINK D=500MM
Motor: 220 V, 50 Hz, 3000 rpm, 350W Trimmer Router

The physical model consist of four links namely link A, link B, link C and link D. The links are connected with pins as shown in fig 9. The motor is mounted on link C at the center. It is adjustable for which sliding slots are provided on link C. On link D, at the end point, Stylus is provided with curved bottom to ease the movement on the surface. The whole setup is clamped on a table. The stylus can only be used in 2D as one dimension is restricted. The engraving tool bit used is of 4 mm diameter. The experiments are performed on soft wood. Letters are engraved on wood with good finish and accurately.

Figure 5; Fabrication of Portable Pantograph

B. Results

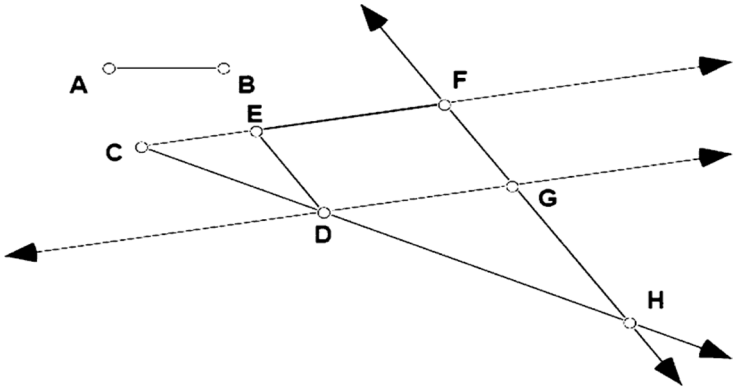

Figure 6; Construction using pantograph

Hide the circles.
Construct *EF*- on *CE*.
Construct a line through point F- parallel to *DE*.
Construct a line through point 0 parallel to *CE*.
Construct point *G* where these lines intersect.
Construct point *H* at the intersection of *FG* and *CD*.
Hide *CE*, *CD*, *FG*, and *DG*.
Construct CE, FG, DG, and GH. This is something like what a real pantograph looks like.

V. CONCLUSION

Pantograph may be old mechanism, but still in present days it has many beneficial uses and many other advantages. Pantograph is parallelogram linkage which is used in our paper engraving purpose on material like wood, steel, plastic etc. Our model of pantograph engraving machine is having low weight, portable and easy to handle for unskilled persons also than other complicated engraving machines. We designed such mechanism for engraving machine which is safe; hence there are no problems in manufacturing too. It works with accuracy. It has a highly effective working mechanism. Hence the letters are traced successfully without any difficult.

A. Scope Of A Project

In the present era of production and manufacturing a large variety of components there should be the necessity for large industries with highly qualified personnel. Now days the competitors are increased and to stand among the competitor requires some ideas in the production and manufacturing facilities that leads the company to earn more profit with less effort. Pantograph engraving machine is manually operated and is used for wood engraving in a short duration with variety of geometries and shapes. Also the cost of operation is less which leads to more economical. This kind of machine can also be used in almost all fabrication industries where there is a need to cut the M.S plate which may be require for various production purposes. The project has been innovated by means of initiating the various ideas from our project which makes us to design and fabricate the machine in a right manner.
In modern times, the word pantograph has taken additional meanings. Due to its resemblance to the drafting tool, the diamond shaped framework on the roof of an electric train or trolley that connects to the overhead power lines is also called a pantograph.

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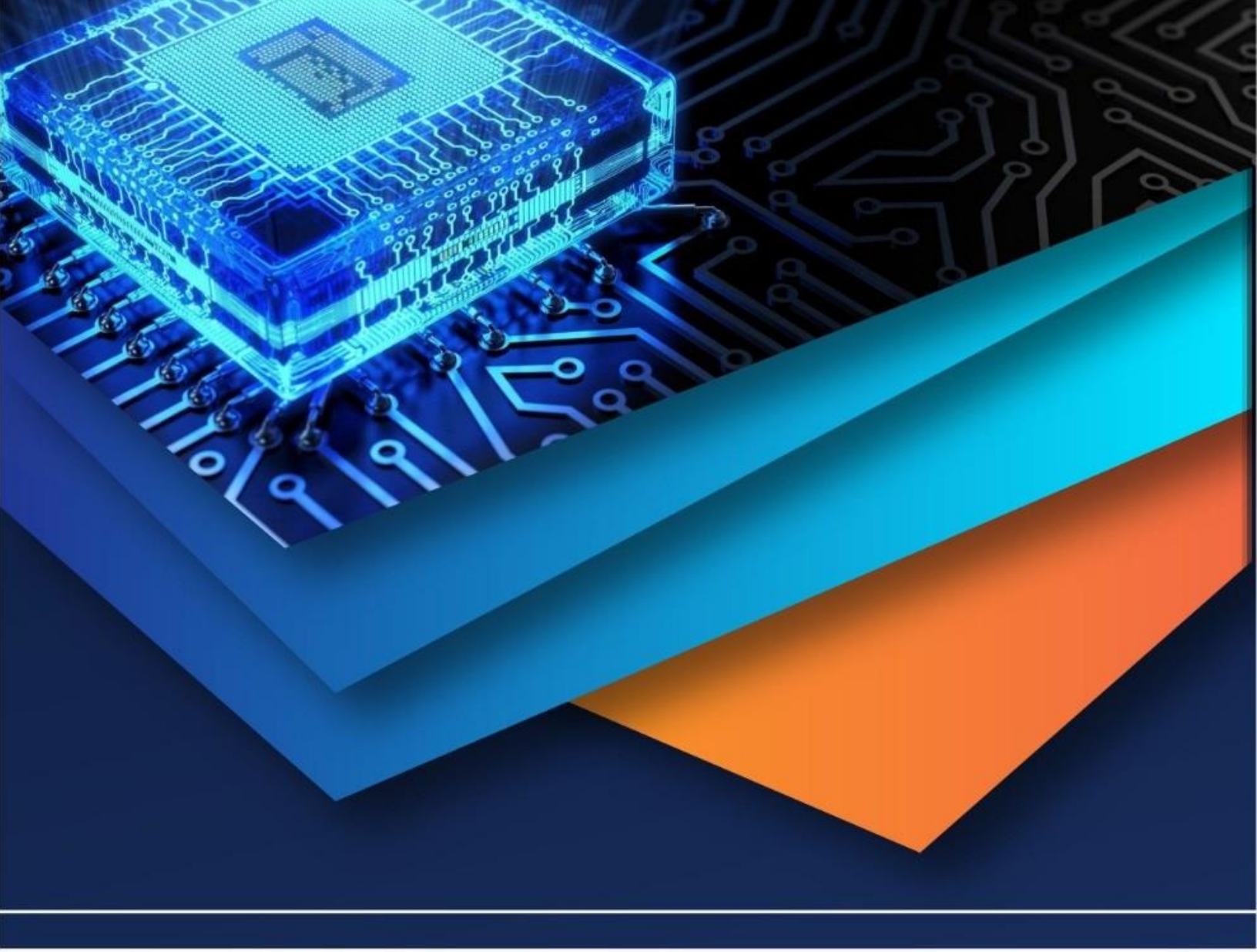

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