Design and Development of a Portable Pantograph for Engraving Letters on Wood

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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 letters 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.

Key words: Engraving Letters on Wood, Portable 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.

II. PROBLEM STATEMENT

Traditional engraving machine are bulky and are difficult to transfer from one place to another. This kind of machine has large workspace, high weight and good maneuverability; it is most important in field of wood or metal engraving. Here, we designed a pantograph for engraving letters on wood which having easy handling, portable, low cost and low weight as compare with traditional engraving machine.

III. OBJECTIVE

Our paper topic is titled as “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 de-scaled replica of the object or we can say it to be a copying machine which can be employed in mass production with economical production. So we can enlist the objectives of our project such as-

1) Design an engraving machine by using pantograph mechanism.
2) For engraving machine using various scaling factor for descaling purpose.
3) Machine should be compact in size and light weight.
4) Total cost for production of an engraving machine remains low.
5) Machine should be easy for handling for unskilled workers.
6) Engraving machine should be portable.

The three degree of freedom in this manipulator adds a feature to increase or decrease the depth of engrave and thus can be used in metal engraving industries or wood carving industries to copy the engraved design.

IV. METHODOLOGY

Pantograph is a geometrical instrument used in drawing offices for reproducing given geometrical figures or plane areas of any shape, on an enlarged or reduced scale. It is also used for guiding cutting tools. We use the same pantograph mechanism for designing our engraving machine.

V. LITERATURE REVIEW

The history of Pantograph falls far behind in 1603.
Christopher Scheiner, (1603): The pantograph was originally invented as a means to trace original art and then scale it up or down in size. “One arm of the pantograph contained a small pointer, while the other held a drawing implement, and by moving the pointer over a diagram, a copy of the diagram was drawn on another piece of paper. By changing the positions of the arms in the linkage between the pointer arm and drawing arm, the scale of the image produced can be changed.

Benton Pantograph 1884: American typeface designer Linn Boyd Benton created the Benton Pantograph, an engraving machine capable not only of scaling fonts in 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 punchcutter's intuitive balancing of line weights, counterweights and proportion as the type was scaled. Beatrice Warde remarked on the invention of the pantograph, "The operator, by the way, is likely to be a young woman, as the work requires a combination of manual dexterity and almost hypnotic concentration, to which any flash of creative, independent thoughts would be a positive handicap. The Huge Impact of the Typographic Pantograph In an interview by Mark Solsburg, Mathew Carter remarked on the repercussions of the pantograph on the typographic community. "A Milwaukee engineer named Linn Boyd Benton put the first 'nail in the coffin' of local foundries in 1884 when he 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.

VI. WHAT IS PANTOGRAPH?

Pantograph is a geometrical instrument used in drawing offices for reproducing given geometrical figures or plane areas of any shape, on an enlarged or reduced scale. It is also used for guiding cutting tools. Its mechanism is utilized as an indicator rig for reproducing the displacement of cross-head of a reciprocating engine which, in effect, gives the position of displacement. 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 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 of the original. By reversing the positions of the pencil and stylus, we would get a copy smaller than the original.

This could be a handy tool if we want to get into painting small wall murals.

VII. WHAT IS ENGRAVING?

The practice of incising a design onto a hard, usually flat surface, by cutting grooves into it. 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.

There are three basic types of mechanical engraving:

1) Diamond Drag (Scratch) engraving.

2) Burnishing.

3) Rotary engraving.

VIII. CUTTERS

The cutter is the most vital single item on the engraving machine and must always have the best possible cutting edge. Relate it to a cook's knife, a carpenter's chisel, a hand graver. It must be sharp at all times, there is no substitute. Any engraving instruction should begin with the cutter, the most basic and essential piece of your equipment. I shall be emphasizing this over and over again.

Inexperienced engravers, for some reason have a terror of using a cutter grinding machine, imagining that they have to be an engineer before they can attempt to use such a device. Not so, in fact it's quite.

Fig. 1: Typical engraving cutter

IX. WORKING 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. The schematic diagram of our portable pantograph is shown in fig.3.

A. Model

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.5. The motor is mounted on link C at the
center. It is adjustable for which sliding slots are provided on link C. The motor has specification as follow:

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.

B. Scale Factor
It refers to the magnification of the object. Scale factor can be found by knowing the distances from the fixed point to input point and to output point. The scale factor is given by:

\[ \text{Scale Factor} = \frac{\text{Distance from fixed point to output point}}{\text{Distance from fixed point to tracing point}} = \frac{\text{Length of link A}}{\text{Length of link D}} \]

We can copy objects with varying scales, this one of the advantage of pantograph.

X. EXPERIMENTATIONS

A. Experiment no.1
Aim: To observe proper cutting of wood.
Objective: To cut wood smoothly.
The following experiment was performed with the Pantograph.

Firstly, to ensure that the tool is capable of cutting the wood, this experiment is performed. The stylus is moved freely without any reference. Tool follows the stylus in reduced scale. The wood is cut successfully.

Conclusion: Hence wood is cut successfully without any difficulty.

B. Experiment no.2
Aim: Straight Line Tracing
Objective: To trace a straight line.
The stylus is moved along a straight line. The cutter follows the path exactly as the stylus. A straight line is traced successfully.

Conclusion: Hence the straight line is traced successfully without any difficulty.

C. Experiment no.3
Aim: Curve Tracing
Objective: To trace a curve.
The Pantograph is clamped to the table. The stylus was moved along a circle. The wood used is a soft wood. The cutter cuts the wood exactly as the circle. The circle is traced successfully.

Conclusion: Hence the curve is traced successfully without any difficulty.

D. Experiment no.4
Aim: Letter Tracing
Objective: To trace letters.
The stylus is moved freely in a shape of letter A. The letter was traced but not accurately. It says that a stencil is necessary for accurate tracing.

Conclusion: Hence the letters are traced successfully without any difficulty.

XI. FIGURE

![A Portable Pantograph](image1)

![Schematic diagram of Linkages of Pantograph](image2)

XII. ADVANTAGES

The main advantage is that the Pantograph is Portable. The Pantographs that are available in the market are bulky and very expensive. The design of the portable Pantograph is such that, it reduces the weight up to 10 times. The cost is also reduced to a great extent. The Pantograph is cheap in price. The Scaling factor can be adjusted according to the need with slight changes in the design depending on if the scale has to be reduced or enlarge. It works with accuracy. The template that has to be copied can be done with precision. It has a highly effective working mechanism.

XIII. DISADVANTAGES

The Pantograph has a poor Damping factor. While working it creates noise and vibration which are difficult to avoid. The mechanism is very easy to copy by anyone. So commercially, it is non-profitable. It can have many copyright issues.

XIV. FUTURE SCOPE

Automatic system can be incurred. Automatic path follower Stylus can be installed. By changing the tool only, various operations can be performed. Rigidity of the structure can be increased for cutting metals.

XV. CONCLUSION

Pantograph may be old mechanism, but still in present days it has many beneficial uses. Pantograph is parallelogram linkage which is used in our paper engraving purpose on material like wood. 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.

REFERENCES