International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 12 | Dec 2020 www.irjet.net p-ISSN: 2395-0072

DEVELOPMENT OF TRACER COUPLER MECHANISM

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ABSTRACT: In the present world various mechanical mechanisms are used in wide range of machines. The current paper talks about the development of a tracer coupler mechanism. With this mechanism one a trace a two-dimensional figure to the same scale oriented at an angle of 90^0 with respect to the original figure. This mechanism is designed and patented by Dr. S Mohan Kumar and the fabrication is done under his guidance. He holds all the rights of the mechanism. The mechanism is fabricated using aluminium as primary material. For the movement of links sliders are used which move inside the dovetail slots of the guideway bars. The tracing of two-dimensional figure is carried out efficiently. There is lot of scope in improvising the mechanism by eliminating the contact forces acting.

KEYWORDS

Tracer coupler mechanism, pantograph, dovetail slot, contact forces.

INTRODUCTION

The mechanical mechanism is a physical device used for transmitting forces and motion. With the help of a mechanism one can transform or modify the input motion and forces into a desired set of output motion and forces. The development of mechanisms has an ancient history which dates back to 3 century BC with the invention of simple lever by Archimedes. Presently there are hundred of mechanism finding its use in various machines and machine systems. Generally, the mechanisms consist of components such as frames, slotted levers, fasteners, bearings, springs, pins, keys etc... Mechanisms can be of various kinds namely, planar mechanism, spherical, complaint, spatial, cam & follower mechanism etc. In this paper we are going to talk about the development and fabrication of a tracer coupler mechanism. It is a planar mechanism which can be used for tracing purpose and also for the motion transmission. This is a patented mechanism designed by Dr. S Mohan Kumar. The primary unit of the mechanism consists of three rigid bars called three-way guide bar. These guideway bars are oriented at an angle of 45^0 to each other. These guide bars intersect at a point and id allowed to rotate freely at this point. A straight slotted link is mounted on the guideway. This link always moves perpendicular to the central guideway. This arrangement is represented in fig 1. The point P1 acts as the input link and the tracing occurs at point P2. The mechanism can be used for various industrial purposes, including tracing two-dimensional figures, sheet metal cutting, for transmitting motion across parallel axis of rotation. The work involves the fabrication of the given mechanism by selecting a suitable material. Optimal dimension should be designed and proper mechanism must be employed in order to achieve the required motion. A suitable moving pair is designed for fabrication and an effective method is used for holding the mechanism at the joints.

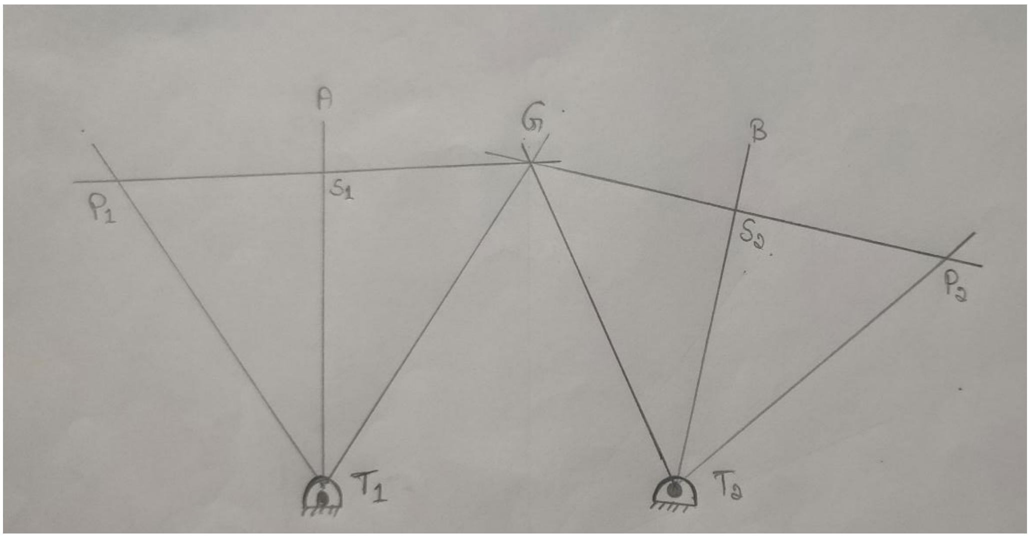

Fig.1 tracer coupler mechanism.

MECHANISM

The mechanism developed may be used as an efficient coupling device and it finds major importance in tracing of two-dimensional figures to same scale which is a limitation of pantograph mechanism. In pantograph mechanism the traced figure is either enlarged or diminished in comparison with the original figure. Whereas in this tracer coupler mechanism we can obtain the traced figure of same scale. The primary unit linkage consists of three-way guide bars fixed at a point. This entire linkage is allowed to rotate freely. The three-way guide bars are slotted in order to allow the movement of sliders inside them. The guideway bars are oriented at an angle of 45^0 to each other. Another slotted straight link is mounted exactly perpendicular to the central guideway bar. This link is allowed to move in two direction only and other movements is constrained. This link always remains perpendicular to the central guideway and has linear motion only. The intersection of this slotted link with the other two guideway bars constitute the tracing points. The tracing input or output can be obtained at another end. If one of the intersection acts as input, the other becomes output end and vice versa. The traces figure is oriented at 90^0 to the original image. A diminished scale of trace is obtained at the central guideway bar intersection. From kinematic analysis it is found out that the figure traced is $1/\sqrt{2}$ times the original figure and is oriented at an angle of 45^0 to primary figure. The unit linkage can be coupled with any number of such units and can be used for various purposes. To increase the versatility of tracing it can be coupled with a pantograph mechanism. Apart from these, the linkages the linkage can be put to many other applications such as:

1) Transfer of constrained reciprocatory motion
   a) Along different axis oriented at 90^0 to each other
   b) Along axes kept at 45^0 to a reduced scale of $1/\sqrt{2}$ times the driving point.
2) Any number of traced reproductions can be made simultaneously by extending the mechanism with increased number of unit linkages. However, the figure will be,
   a) At 90^0 to the previous reproduction and to the same scale in one set.
   b) At 45^0 in another set at a scale of $1:1/\sqrt{2}$.
3) The mechanisms can be efficiently used for sheet metal cutting and marking operations.

DESIGN

Initially we designed the mechanism using CAD tool. The mechanism is developed in Solidworks software. For construction of mechanism, aluminium is selected. Aluminium possess good machinability and is available at much lower cost. It provides good surface finish which is very much essential for the smooth frictionless movement of sliders. For three-way guide bars dovetail slot is chosen because of its self-locking property. The sliders can be easily inserted and it allows only linear motion in two directions and all other motion is constrained. The aluminium sliders are designed according to the slot size. The effective connection between the links is formed by using connecting pins made out of steel. The three-way guide bars are mounted on a wooden base and a ball bearing is used for the frictionless rotation of the links. A pen marker or similar tool is used for tracing. The design of mechanism and its structure are shown in the fig.2 and fig.3.

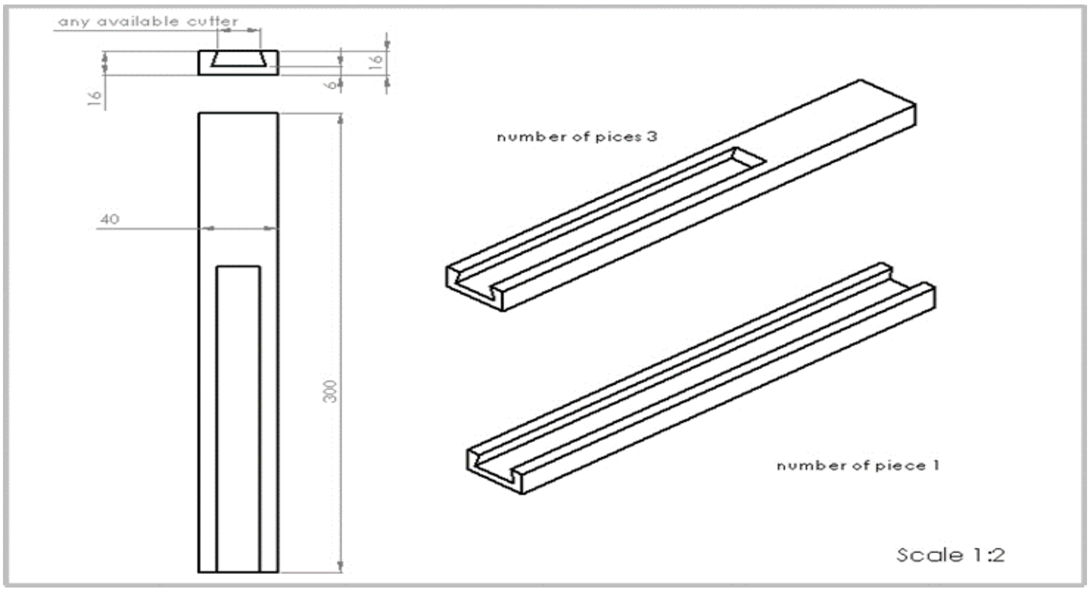

Fig.2 CAD drawing of tracer coupler mechanism.

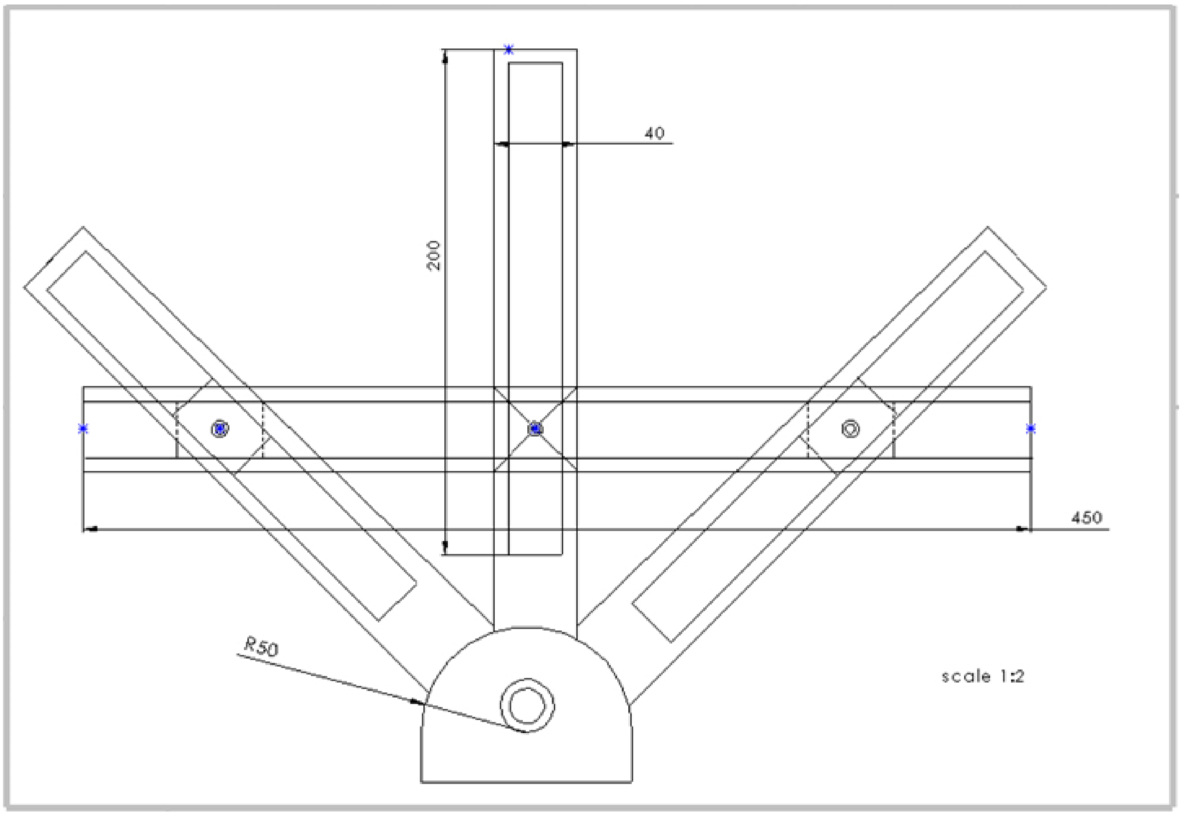

Fig.3 design of guideway bars.

Calculation of material required:

Weight = volume x density

Volume of guideway bar = l x b x h

= 30cm x 4cm x 1.6cm

= 192 cm^3

Weight = 192 x 2.7 density of aluminium = 2.7 g/cm^3

= 518.4 g

Number of links = 3

∴ 518.4 x 3 = 1555.2 g

Volume of central link = l x b x h

= 45cm x 4cm x 1.6cm

= 777.6 g

Total weight = 1555.2 + 777.6

= 2332.8 g ~ 2500 g

∴ total aluminium required = 2.5 kg.

FABRICATION

The dovetail slot is cut using CNC machine. A dovetail tail cutting tool is used for this purpose. The aluminium sliders are machined using milling machine to appropriate dimensions. The connecting pins is machined using lathe machine. A wooden base of suitable shape is configured for the base in order to hold the mechanism properly. After machining all the components, they are assembled as per drawing. The central link is mounted on the guideway bars with the help of connecting pins. They are allowed through the holes provided in the sliders. All the sliders are inserted into the slots. The entire linkage is mounted to the wooden base and a ball bearing is used for frictionless movement. The model of the mechanism is shown in the fig.4.

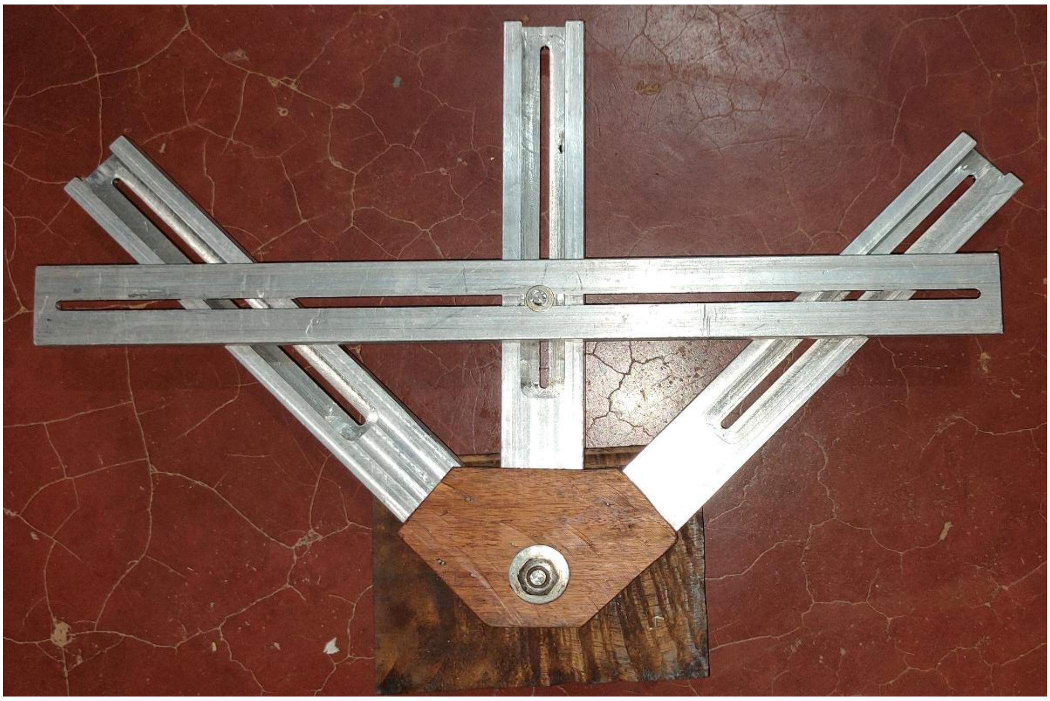

Fig.4 model of tracer coupler mechanism.

RESULT

After completing the fabrication, the mechanism is tested for the working. The simple shapes like S, C, W and other geometric shapes like square, triangle, etc are traced successfully to the same scale. The traced figures are oriented at an angle of 90◦ to the original figure. The shape S traced using this mechanism is shown in the fig. 5.

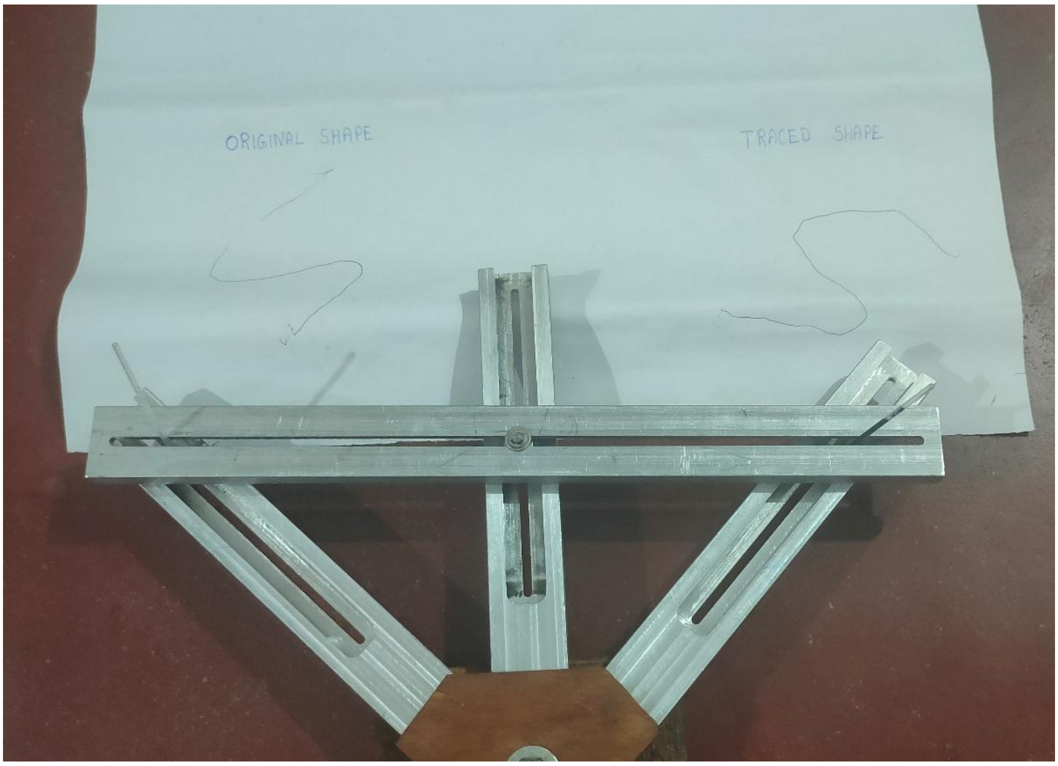

Fig.5 shape 'S' traced by the mechanism.

It is observed that the shapes traced are satisfactory. The lines traced are quite abrupt and smooth curves are not obtained. This is due to friction offered by the walls of the slotted link on the sliders. It is found that there is lot of contact forces acting on the sliders and walls of the slotted levers. And due to these contact forces, there is no smooth movement of the sliders and hence the tracing is affected. It is very difficult to achieve this movement with the help of present slider mechanism. The tracing can be improvised or greatly achieved if the fabrication mechanism is altered and suitable linkage system is employed. With the help of improved movement system, the working of mechanism can be achieved greatly. There is huge scope for improving this mechanism and it may find many modern uses. The mechanism can be effectively used for sheet metal cutting and marking operation when coupled with a robotic arm and can also be controlled using NC programming.

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