A Review on Pantograph Based Applications

Saish Wadkar[1], Durvesh Sohani[1], Suraj Sawant[1], Sumedh Tambe[1], Mr. S. S. Kulkarni[2]
[1]*Student, Mechanical Engineering Department, S.S.P.M. College of Engineering, Kankavali, India.*
[2]*Professor, Mechanical Engineering Department, S.S.P.M. College of Engineering ,Kankavali, India*

Abstract **- This paper aims to give various applications where a pantograph mechanism can work as a machine with high accuracy. A pantograph is a linkage mechanism which is generally used in electrical locomotives to conduct electricity from trajectory lines. It is made of 5 linkages which forms a parallelogram where, each of the link is getting connected with the help of pin joint in such a manner to form a revolute pair. Its only function is to follow an enhanced or dwindle image of the geometry it traces. Due to this property, it can be applied with some improvements in various machines in order to minimize its complexity and cost. personalized modelling and motion analysis of these mechanism in solid works is also in the scope of this paper, but due to repetition of identical results only few results are shown. Analysis is done by using 3 types of pantographs, so that all three same outputs can verify for practicality of application.**

Index Terms **- pantograph , application of pantograph.**

1.INTRODUCTION

The pantograph is a simple and accurate tool which can be used in artwork and crafting industry. Pantograph mechanism is used for copying and scaling line drawing and complex images. The working principle of four bar mechanism in which one link is fixed and other are pivoted. The percentage of enlargement of the pantograph was provided by changing the distances between the pivot points. Using this principle, different types of pantographs arrangements are used in various areas such as sculpture, minting, engraving, and milling. Pantograph is mostly used in extension arms for wall-mounted mirrors, temporary fences, pantographic knives, scissor lifts, and other scissor mechanisms such as the pantograph used on electric locomotives and trains.

2.APPLICATIONS

Pantograph can be used for many applications in machining due to its ability to enhancing or dwindling the image it traces. Applications are:

1. Wood Carving machine
2. Transmission of electricity on Train
3. E-Highway - Future of Road Transportation:
4. Drafting
5. Relationship of pantograph with Flexoelectricity and piezoelectricity
6. Milling machines
7. OTHER USES

2.1. WOOD CARVING MACHINE

The Wood carving machine is a precision copy milling machine able to cut a wide variety of wooden joints. The wood carving machine uses a guide bearing to follow a template which moves the router bit to cut a pattern identical in shape but 1/2 the size. In addition to precision mortise and tenons, the wood carving machine will make box joints, dovetails, sliding dovetails and any number of unusual shapes or multiple mortises and tenon combinations on a single work piece. The concept of the wood carving machine is pretty simple - there's a guide bearing that follows a template.

The wood carving machine is made up of traditional cutting equipment along with a pantograph mechanism which is a mechanical linkage connected in a manner based on parallelogram and then it is used for copying and scaling line drawing and complex images. In four bar mechanism one link is fixed and other are pivoted. Another link follow the movement of the tracing link. Pantograph engraving machine is having low weight, portable and easy to handle for unskilled persons also than other complicated engraving machines.

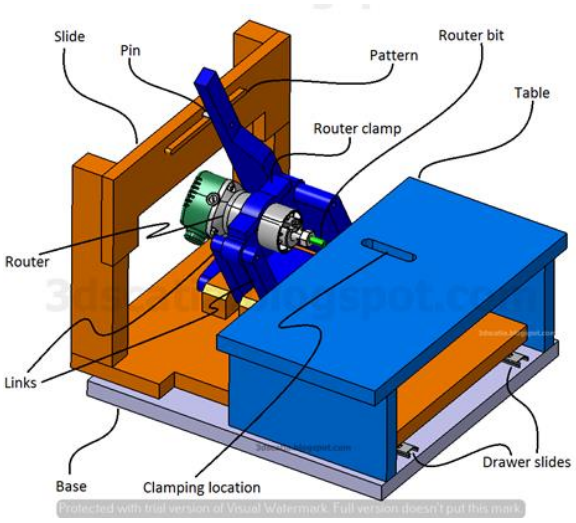

Fig 2.1. 1: Working of four bar mechanism

2.2. TRANSMISSION OF ELECTRICITY IN TRAINS

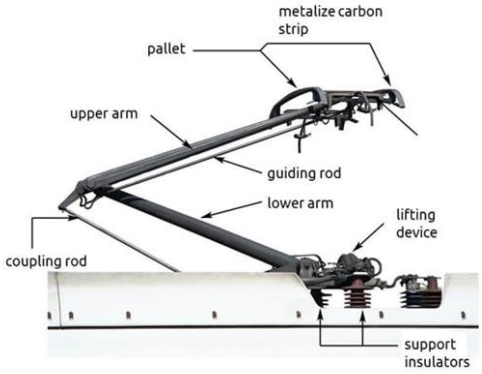

Fig.2.2. 2 Pantograph on locomotive

In electric locomotive the overhead current supply system plays an important role. The overhead line is called catenary system and the power is transmitted down to the motors via pantograph of the locomotive Pantograph is an apparatus which mounted on the roof of electric locomotive it unfolds and extends along a vertical axis, its role is to collect power through an overhead tension wire and send to the transformer. When a locomotive is to be started the pantograph is push up with the help of air pressure which is deliver by a small compressor delivering air at pressure of 7 kg/cm2 and some modern pantograph uses a piston cylinder. This pressure pushes the pantograph and until it touches the contact wire but if there is any disconnection for short duration. It won't affect power supply because the capacitor will be there after the rectifier which will ensure the energy supply all the time.

2.3. E-Highway - Future of Road Transportation:

Every nation aims at a future which doesn't need non-renewable sources of energy. As there is a presumed growth of demand for transport, the quantity of emission of carbon dioxide is more than that of country's economy. In order to reduce the adverse effect of the fossil fuel gases, a new, harmless and an efficient technique or system should be practiced. The E-Highway system is introduced with such a motto. ERS are principally, the electrified roads enable to the vehicles on the road to perform using power transfer. Generally, power source integrated into the road surface by externally driving energy to an electric engine. [14]

The main objective of present work is to carry out a research if there is a probability to substitute the major part of the transportation areas enslavement on fossil fuels by presenting a new system as Electrical Road Systems ERS. [14]

FIG 2.3.3. E-Highway

2.4. Drafting

The pantograph was first used for duplicating and scaling line drawings. Toy versions of modern versions are available.

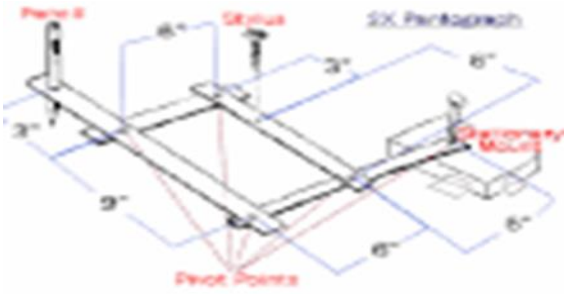

Fig 2.4.4 symatic of drafting

Fig 2.4.5 Actual drafting in process

2.5. Relationship of pantograph with Flexoelectricity and piezoelectricity

The pantographs are considered as a strain-gradient continuum if we take into account bending of the bending of bars constituting the pantograph. A pantographs have a greater surface-to-volume ratio so that's why surface-enhanced models may provide the increase of piezoelectric at the macroscale. At small scales the surface piezoelectricity and surface flexoelectricity may significantly improve the coupling between strain gradients and polarization[11]

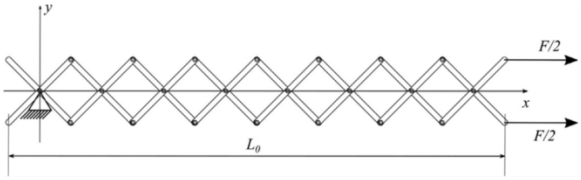

Fig.2.5.6. Pantographic bar loaded by a net force F . The number of cells is n = 8 .

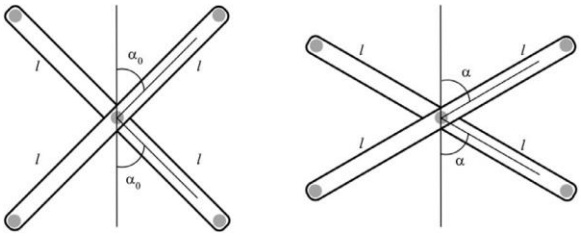

Fig.2.5.7. Deformation of a pantographic cell

A pantographic bar could be used as a working element of MEMS. Flexo-electricity for a beam-lattice with dominant bending or/and shear deformations may significantly improve a piezoelectric's response. In a certain sense the discussed effect is similar to surface-related phenomena for media with high surface-to-volume ratio.[11]

A pantographic metamaterial consists of two families of long elastic beams connected by pivots. Flexoelectricity of the pivots affects the effective properties of the pantographic bar.

2. 6. Milling machines

Duplicate pieces milled on a milling machine could not have their outlines mapped out by moving the milling cutter in a "connect-the-dots" ("by-the-numbers") method until the development of control technologies such as numerical control (NC and CNC) and programmed logic control (PLC). The only means to control the cutting tool's movement was to dial the locations by hand using dexterous talent (with natural restrictions on a human's accuracy and precision) or to trace a cam, template, or model in some fashion and have the cutter mirror the movement of the tracing stylus. A duplicate part could be cut (at various magnification scales other than 1:1) simply by tracing a template if the milling head was mounted on a pantograph. (Milling by dialling was frequently followed by hand sculpting with files and/or die grinder points, and the template was normally manufactured by a tool and die maker utilising toolroom processes.) This was essentially the same idea as copying documents with a pantograph equipped with a pen, but it was adapted to the machining of hard materials like metal, wood, or plastic. Pantograph routing, which is similar to pantograph milling in concept, is also available (as does CNC routing). The Blanchard lathe, a copying lathe created by Thomas Blanchard, used the same basic principle.[1]

NC, CNC, PLC, and other control technologies established and spread throughout industry provided a new way to control milling cutter movement: by feeding information from a programme to actuators (servos, selsyns, leadscrews, machine slides, spindles, and so on) that would move the cutter as the information directed.[1] The majority of commercial machining is now done using computerised, programmable processes. Home machinists are more likely to use manual controls, but computerised control has made its way into the home shop as well (albeit not as much as its commercial equivalents). As a result, pantograph milling machines are largely obsolete. They are still used commercially, albeit at a much lower and diminishing rate. Machine tool companies no longer build them new, but there is still

a modest market for old equipment.[1] The magnification-and-reduction feature of a pantograph (with the scale specified by the movable arm lengths) is accomplished in CNC via mathematic computations that the computer applies almost instantly to the program information. Scaling (as well as mirroring) functions are incorporated into programming languages like G-code.

FIG 2.6. 8. Pantograph Milling Machine

2.7.OTHER USES

Sr. No.	Name	Uses
1	Extension arm	Pantograph extension arm is used for mounting a display screen and also for a flat television screen.
2	Pantograph engraving machine	The pantograph engraving machine is used mainly to cut mild steel, wood plastic to any shape with high accuracy. The pantograph engraving machine is used for the reproduction of maps and plans on enlarging or reduce the scale
3	Pantograph	Pantograph maintains electrical contact with the contact wire and transfers power from the wire to the traction unit, used in electric locomotives.
4	Windscreen wipers	Vechicle windscreen wipers on pantographs to allow the blade to cover more of the windscreen on each wipe
5	Ultra Hand	The Ultra Hand is made up of pantograph mechanism .It is used as toy grabber.
6	Guide frames	For heavy-duty applications like scissor lifts, material handling equipment, stage lifts and specialty hinges Pantograph mechanism is use as guide frame.

3. MERITS OF PANTOGRAPH

1. The main advantage is the pantograph is portable and it can move in 180 degree of rotation.
2. 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.
3. The design of the portable pantograph four bar mechanism such that, it reduces the weight up to 10times.
4. The cost is also reducing to a great extent.
5. The pantograph is cheap in price.
6. It works with accuracy.
7. It has highly effective mechanism.
8. It is economical.
9. Unskilled workers can do operation easily.

4. CONCLUSION

1. Pantograph has many beneficial uses, by doing some modification in parallelogram linkage of Pantograph it can be used in many applications.
2. The pantograph is portable and it can be move in 1800 of rotation.
3. 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.
4. The design of the portable pantograph four bar mechanism such that, it reduces the weight up to 10times.
5. It is an accurate system which works with precision.

REFERENCES

[1] M. Verma, A. Ahmad, N. S. Haque, S. L. Mallick, I. Mehta, and R. K. Tyagi, “The Mechanism and Kinematics of a Pantograph Milling Machine,” vol. 2, no. 3, pp. 1–5, 2013.

[2] B. P. Nagaraj, R. Pandiyan, and A. Ghosal, “Kinematics of pantograph masts,” Mech. Mach. Theory, vol. 44, no. 4, pp. 822–834, 2009, doi: 10.1016/j.mechmachtheory.2008.04.004.

[3] M. V Patel, “FABRICATION OF PANTOGRAPH,” no. 3, pp. 3619–3626, 2017.

[4] M. D. D. Devardekar, M. A. J. Gudale, and M. R. R. Karande, “Wood Engraving Using 3 Axis CNC Machine,” pp. 382–387.

[5] V. Parmar, "Working Model of Garbage Collector and Load Transporting Carting Hoverboard Vehiclec," Int. J. Res. Appl. Sci. Eng. Technol., vol. 9, no. 3, pp. 710–712, 2021, doi: 10.22214/ijraset.2021.33334.

[6] S. Genna and C. Luigi, "Wood Laser machining using CO2 30W laser in CW and pulse regime," no. January 2009.

[7] N. Vilas, B. Shital, N. Thakur, P. Subhash, K. Purvi, and A. Wankhede, "Design and Development of a Portable Pantograph for Engraving Letters on Wood," vol. 4, no. 01, pp. 384–387, 2016.

[8] M. Jeste, "Mathematical Modeling and Simulation of Pantograph Mechanism in MATLAB," vol. 10, no. 07, pp. 547–551, 2021.

[9] IJSRD - International Journal for Scientific Research & Development| Vol. 4, Issue 01, 2016 | ISSN (online): 2321- 061

[10] Wang Hong gung, Zhao Mingyang, Fang Jilin, Li Shoji, Zhang Bo "The mechanism and kinematics of a 3 -DOF in-parallel actuator manipulator" in Proceedings of the 2003 IEEE, International Conference on Robotics intelligent Systems and Signal Processing, Changsha, China - October 2003.

[11] Eremeyev, V. A., Ganghoffer, J. F., Konopińska-Zmysłowska, V., & Uglov, N. S. (2020). Flexoelectricity and apparent piezoelectricity of a pantographic micro-bar. International Journal of Engineering Science, 149, 103213.

[12] D. Kulkarni, N. Pawar, "DEVELOPMENT AND PERFORMANCE TESTING OF PROTOTYPE WINDSCREEN WIPER, ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-5, ISSUE-2, 2018

[13] U.Tripathi, L.Shaikh, S.Giri, M.Singh, "PANTOGRAPH ENGRAVING MACHINE - A REVIEW", International Journal of Mechanical and Production Engineering, ISSN(p): 2320-2092, ISSN(e): 2321-2071 Volume- 6, Issue-3, Mar.-2018, http://iraj.in

[14] K.Chandra mouli, N.Pannirselvam, V. Anitha, D.V.V.Nagasai pardhu , "A Study on E-Highway - Future of Road Transportation" International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-8, Issue-2S2, January 2019

[15] Nikund R , R. Patel , "Design and fabrication of wood router machine using pantograph and four bar ", (IRJET) Volume: 07 Issue: 05 | May 2020

[16] Yavin, Y.,(1998),,The control of a motion of a pantograph' Mathematical computing Modelling, vol. 28,No.2, Machine Design by V.B. Bhandari.

[17] "Electrical Road Transportation System", by Waghmode D. S., Miss. Patole S. S, Gaikwad S.S, Kulkarni K.S., Sakat S .A, Raykar A.B., International Research Journal of Engineering and Technology, 4(4), 2017, pp. 2395-0072.

[18] "E-HIGHWAY [ISNS Green Zonal Area for Smart Greed Power Generation with Chargeble Electronic Roofway]" by Swapnil Narwade, Divyani Thorat, Snehal Kadam, prof.Shital Mahajan, 2017, 3(3), pp. 2395-4396.

[19] Barpate N., Thakur S., Kshetre P., Wankhede P., (2016) "Design and development of a Portable Pantograph for Engraving Letters" dInternational Journal for Scientific Research & Development. Vol. 4, Issue 01, p.2321-0613.

[20] Zwick K., (1932) "Pantograph Engraving and Copying Machine." Patent No. 2,067,962.