International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.03, April 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

Design, Development and Manufacturing of Special Purpose Machine for Serration Operation

Prashant R.Kshirsagar[1], Mehul Shirke[2], Swapnil Tambe[3], Karyappa Tone[4], Sanket Toraskar[5]

[1]Assistant Professor, Mechanical Engineering Dept. Rajendra Mane College of Engineering And Technology Ambav, Devrukh, University of Mumbai (India)

2,3,4,5Final Year Students of Mechanical Engineering Department Rajendra Mane College of Engineering And Technology Ambav, Devrukh, University of Mumbai (India)

ABSTRACT

In this paper we discuss on serration operation on a component for gripping purpose. Special purpose machine are widely used for special kind of operations, which are not economical on conventional machines. It is design for getting higher accuracy at desired condition. A Special Purpose Machine introduced here can be operated semi-automatically as per the condition or a mechatronic based system can be developed that will work with different speed currently the operation is performed on a manual machine which is time consuming due to time required for loading and unloading of job, requiring total human efforts, results in less accuracy and less productivity, operational accuracy required. The manpower is required is more & skilled. In order to successfully come up with these problems we are going to design a Special Purpose Machine which is semi-automatic results in reduction of human efforts, high accuracy and high productivity and less time consuming. It will save production time and increase the production rate.

Keywords : Productivity, Quick Return Mechanism, Rotary Table, Semi-Automatic, Serration, Special Purpose Machine, Stepper Motor

1. INTRODUCTION

Production quality and low production cost are essential for the success of manufacturers in today's competitive market. SPMs are very useful for producing large quantities of high quality products at low costs. These machines can also be altered to produce similar components when necessary. High accuracy, uniform quality, and large production quantities are important characteristics of Special Purpose Machines.

The component for which SPM designed and developed is just similar like 'Single adjustable clamp'. Serration is required to be carried out on work piece to manufacture clamp.

In earlier process of manufacturing the clamps were machined by using conventional horizontal milling machine on which three jaw chuck is mounted on rotary table. By using conventional process all job setting and machining activities carried out manually. To rectify these drawbacks new Special Purpose Machine is designed

and developed by following automation and process improvement. New concept of automation is developed with focus on specialization of operation, simultaneous operation and increased flexibility strategies of automation. It will help to improve Productivity.

Quick-return mechanism design .The links displacement, velocity and acceleration were found. Computer-Aided Design and Analysis of the Quick Return Mechanism was studied. In the quick return mechanism, the velocity of cutting stroke and return stroke both change with the change in length of slotted link but the total velocity ratio remains constant. The velocity ratio and force output changes with the change in height of slider. The velocity ratio and force are found to be with their maximum value during the stroke.

2. WORKING PRINCIPLE

This Special Purpose Machine is constructed with a vertical column and a horizontal base. Column consists of tool arm which moves vertically along 'Y' axis. The tool holder is mounted at the free end of arm.

Rotary table carries a three-jaw chuck which holds the component. It is rotated by means of Stepper motor which are mounted on Work table having reciprocating movement along 'X' axis. Stepper motor fixes position of Rotary table at required angle. When position is locked, Work table moves horizontally against Single point cutting tool and a serration is obtained. Reciprocating motion of work table is performed by 'Quick Return Mechanism' which is fixed on the base.

Component is held manually in three-jaw chuck and then whole serration operation is done automatically. Finally, we get serrated component.

3. LITERATURE REVIEW

Mr. S. V. Shekhar (et al.), IJAERS, Vol. I, Issue IV, July-Sept., 2012/13-17, "Design and Development of SPM-A Case Study in Gang Milling Machine for Manufacturing of Conveyor Chain Bushes". It is concluded that new developed special purpose machine is technically and economically justified and proven its effectiveness over conventional manufacturing process. New concept of automation is developed with focus on specialization of operation, simultaneous operation and increased flexibility strategies of automation.

S. Ravindran M.E., Middle-East J. Sci. Res., 12 (12): 1710-1714, 2012, "Productivity Improvement and Energy Conservation With Modified Tool Heads of Shaper and Planer". The Quick Return mechanism of shaper and planer machines reduces the ineffective time and wastage of energy and improves productivity. Alternate tool changing time will be reduced in the case of mass production.

P. Parthiban (et al.), IJETER, Volume 4, Issue 6, June (2016), "Gear Shaping Attachment in a Shaper Machine". Use of shaping machine for high production of automatic gear cutting with auto indexing work piece. By this arrangement of the forward/reverse stroke is adjustable as compared with the conventional machines.

Mr. R.H. Aadekar (et al.), IJIERT, VOLUME 3, ISSUE 5, MAY-2016, "Evaluation of Tool Life in Face Serration Operation". The reliability of cutting tools influences the whole manufacturing effectiveness and stability of equipment. Tool wear monitoring is important in machining industries for controlling the quality of machined parts that helps to improve the productivity. It attempted to correlate the tool life and process parameter with productivity.

Haiyan Hu (et al.), ICAEES 2015, "The Design of DSP Controller Based DC Servo Motor Control System". Control system with DSP as its core controller for its great function of input and output (I/O) and capability of high speed digital signal processing.

4. PROBLEM STATEMENT

As per requirement of Adler Mediequip Pvt.Ltd, Sadavali, India, we developed the Special Purpose Machine for serration operation by using automation instead of manual operation to reduce cycle time and increase productivity.

5. OBJECTIVES OF THE PROJECT

1. To reduce cycle time.
2. To provide accuracy.
3. To make easy & vibration free for the purpose of serration operation, to increase productivity.

6. PROPOSED METHODOLOGY

1. Designing a SPM for required component considering following aspects :
    - Material of tool and components
    - Indexing of work piece
    - Reciprocating moment of work table
    - Rigidity of base
2. Providing suitable mechanism.

    Quick Return Mechanism

7. DESIGN CALCULATIONS:

7.1 Cutting Force

Cutting force depends upon workpiece material, machining parameters (speed, feed, and depth), wear of cutting tool, etc.

Normal force = F = kb (0.4a+c) kgf

P_z = k (a+0.4c) b kgf

Where Pz = force component in the direction of the cutting speed vector

k = Unit cutting force, kgf/mm^2, for steel k = 120 – 180 kgf/mm^2

b = width of undeformed clip, mm

a = thickness of undeformed clip, mm

c = mean width of flank wear land which is equal to half of the permissible flank wear

$c = \frac{0.5}{\tan(60)} = 0.28867$

b = 2c = 2 * 0.28867 = 0.5774 mm

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a = 0.5 mm

F = kb (0.4a+c) kgf

= 150 * 0.5774 (0.4 * 0.5 +0.2887)

= 42.33 kgf

F = 423.3 N

P_z = k (a+0.4c) b kgf

= 150 * 0.5774 (0.5 + 0.4 * 0.2887)

= 53.31 kgf = 533.1 N

7.2 Quick Return Mechanism

1) Length of AC = r / $\cos(90 - \alpha/2)$
2) Length of slotted liver AP = P_1Q / $\sin(90 - \alpha/2)$
3) Length of AR = AQ +QR

= AP $\cos(90 - \alpha/2)$ + PR $\sin(90 - \alpha/2)$

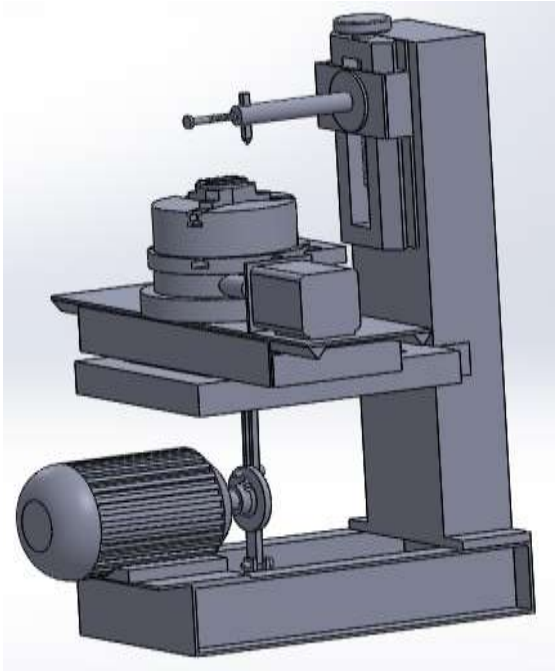

Fig. 1 CAD model

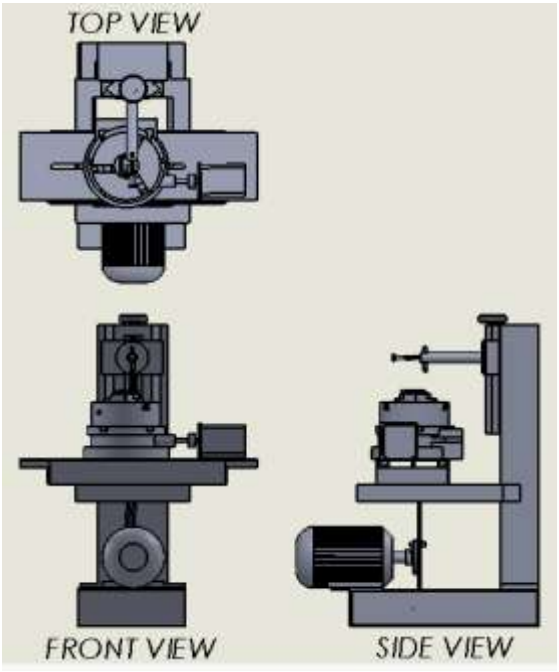

Fig. 2 orthographic view

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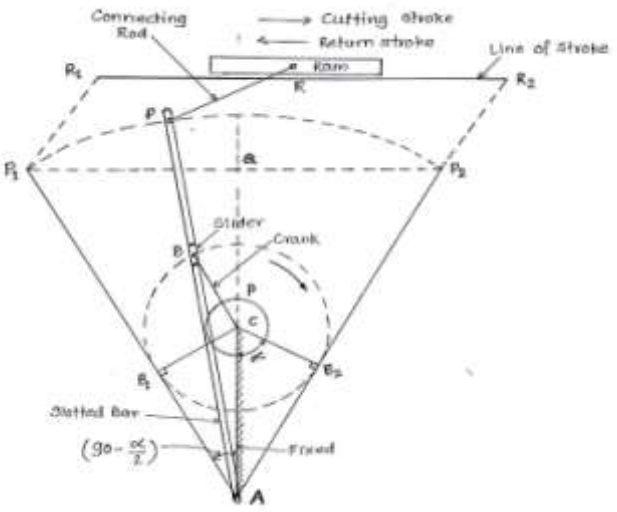

Fig. 3 line diagram of connecting rod

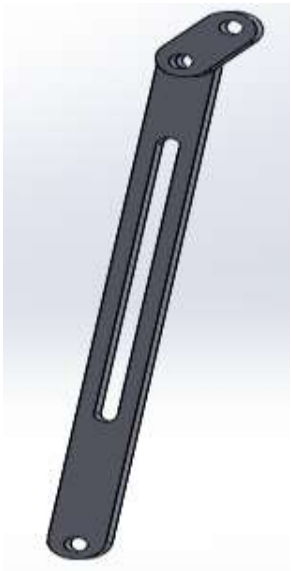

Fig. 4 CAD model of connecting rod

Fig. 5 Actual working model of SPM designed and manufactured.

8. RESULTS

In manufactured machine we use a 20RPM Three Phase Motor.

JOB SPECIFICATIONS

- Material:- SS 304
- Total number of Serrations:- 120
- Indexing Angle:- 3 degree
- Flange Angle:- 60 degree
- Depth of Serrations:- 0.5 mm

Fig. 6 CAD model of serrated component

So for completing a job with 120 serrations our machine take up to 8 – 9 minutes that means in one shift of 8 hours we can complete up to 50 components.

9. CONCLUSION

From the overall procedure we followed in designing a Special Purpose Machine, we conclude that design is safe , accordingly the design could be brought into practice while designing we have successive in keeping the cost factor to minimum total net savings. In quick return mechanism, velocity of cutting stroke and return stroke both change with the change in length of slotted link and crank length. Due to its lower rpm reciprocating motion of work table requires more for cutting and return stroke.

Productivity has improved in both ways that is qualitative and quantitative. Special purpose machine is necessary for improving the production. It has improved the repeatability, accuracy and less rejection, due to accurate automation. Special Purpose Machine causes less human interaction, drastic reduction in work load through Special Purpose Machine which directly helps in less operator fatigue. This reduces the labour cost. Hence Special Purpose Machine increases the production rate, reduced production cost, and reduced labour cost which minimizes the production cost.

If we use 40RPM motor instead of 20RPM the productivity will increases up to 30% - 35% that means we can complete up to 80 components so productivity more increase.

10. ACKNOWLEDGEMENTS

Authors of this paper are thankful to Mr.Prakash Kale HR Generalist, Mr.Milind More Production Engineer for giving opportunity and prove our technical potential, Mr.Kshirsagar Prashant R. for valuable guidance and encouragement, Principal Dr. M. M. Bhagwat for constant support and motivation. We thank deeply to invaluable guidance rendered to us all occasion by all others to directly or indirectly contribute to our humble performance.

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