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A NEED FOR DEVELOPMENT OF LOW COST PISTON RING FEEDER MECHANISM FOR SLIDE TYPE DUPLEX GRINDING MACHINE– A REVIEW STUDY

Joshi Guruprasad R.[1], Prof. (Dr.) Gujar A. J.[2],

Prof. (Dr.) Chapgaon A. N.[3],

[1]P.G.Student, [2]PG Head Studies Mechanical Engg., AMGOI,(India)

[3]Head of Mechanical Enggineering Department., AMGOI, (India)

ABSTRACT

In today's market there is need to manufacture the product with high quality, low cost and to survive in this competition company requires special skills and developed technology, which can reduce the cost of machining, time of machining, human interference etc. With the help of this, we can increase the profit of company to great extent. Generally Duplex Grinding machine is used for grinding both face of piston ring. When numbers of rings are to be grinded, it requires considerable time to feed the rings one by one. The fatigue of the worker to continuously feed the ring one by one and the sharp edges of the piston rings causes injuries to worker's hand which causes a major bottleneck in a mass production system, which leads to low production and decrease in productivity. Large cycle time and human fatigue problems can be reduced by making special modifications in existing grinding machines developed for mass production, developing dedicated type of automated manufacturing systems. In current work need for development of low cost piston ring feeder mechanism for duplex grinding machine for industry is studied and various research papers have been reviewed regarding new developments in grinding machine attachments (mechanism).

Keywords: Piston ring feeder mechanism, Duplex Grinding machine, Piston ring, Productivity, Automation etc.

I. INTRODUCTION

A modern manufacturing concept is more like a proactive kind and addresses the need for manufacturing organizations to produce efficiently and effectively [2]. In today's market there is need to manufacture the product with high quality, low cost. So to survive in this competition company requires special skills and developed technology such as automation [11], which can reduce the cost of machining, time of machining, human interference etc. With the help of this, we can increase the profit of company to great extent. The automotive industry is one of oldest industry. Piston rings are the crucial components of the IC engines. It is an open-ended ring that fits into a groove on the outer diameter of a piston in a reciprocating engine such as an

internal combustion engine or steam engine. The principal function of the piston rings is to form a seal between the combustion chamber and the crankcase of the engine. The goal is to prevent combustion gases from passing into the crankcase and oil from passing into the combustion chamber.

Abrasive machining [1] is a centuries-old technology; it continues to play an important role in industry. The extremely small scale of chips produced and the self-sharpening of grinding wheels are key advantages of abrasive machining. There is increase in quality demands for high-performance grinding technology, particularly in automotive, bearing and aerospace industries require enhanced processes that provide near-optimal yield with respect to productivity, precision and cost [3]. Piston rings are manufactured using casting followed by finishing and coating process. The grinding process is commonly used as finishing operation which makes the process distinguished from other machining processes [7,8,12]. In finishing process generally Duplex Grinding machine are used. Duplex grinding machines are classified as surface grinding machine consisting of two grinding wheels with horizontal axis faced apposite to each other. Duplex Grinding machine is used for grinding both faces of piston ring. Duplex grinding machine increases the dimensional accuracy such as thickness of piston ring, which is very important during assembling process of cylinder piston assembly.

II. PROBLEM STATEMENT

The automobile industry is one of the oldest industries and many industries in this sector are established in mid 60's and 70's so, there setup of machineries are also old one. There are many new advanced automatic machines such as CNC machines, CNC grinding machines are available in the market possessing higher accuracy and production qualities. The price of these machines ranges from several lakh up to crore. Many of the above mentioned industries come under small and medium scale segment of industries (MIDC Kolhapur) having limited financial capacity of investment. They cannot invest bigger amount to buy these higher end machines (CNC machines). One of the main problems about duplex grinder is the feeding of piston ring, which is done by operator manually [4]. When numbers of rings are to be grinded, it requires considerable time to feed the rings one by one. The fatigue of the worker to continuously feed the ring one by one and the sharp edges of the piston rings causes injuries to hands of worker which causes major bottleneck in a mass production system, which leads to low production and decrease in productivity.

So there is a need to develop low cost piston ring feeder mechanism (attachment) which can be mounted over the existing duplex grinder machines. Machine tool development [9,10] is an important topic considering today's requirements of cost reduction with high efficiency [5,6]. Due to the development of such low cost attachment, the need to replace the existing duplex machines and to invest higher amount to buy new higher end CNC machines becomes needless. Large cycle time and human fatigue problems can be reduced by making special modifications in existing duplex grinding machines for mass production giving a way to dedicated type of automated [11,13] manufacturing systems. The ring feeder automatically feeds rings one by one continuously in the grinding machine so there are less chances of fatigue of the worker hence fewer mistakes, which helps in increase of production of piston rings. Special ring feeder attachment does not require any physical appearance of worker. The aim of higher production with minimum involvement of workers becomes easily achievable.

III. METHODOLOGY

The ideas begins with searching the various papers presented on different mechanisms used for automation by different authors suggesting various solutions to the problems to be undertaken to increase productivity using automation techniques and finding their effectiveness in current problem.

- To collect various research papers that has made research regarding different automation techniques and mechanisms.
- To study these research paper and find solution to the current problem. If the solution is not found, then study different solutions that have been applied to different problems i.e., in our case study different attachments and there mechanisms.
- To study different attachments and there mechanisms and to understand its application.
- To list out the studied mechanisms as per the type of motion from one form to another and there utility for automating the mechanical system.
- Finally design and development of these mechanisms and use of computers wherever necessary.

IV. LITERATURE REVIEW

There are several research papers have been published regarding various topics related to grinding machines and piston ring manufacturing. They have been reviewed as follows.

I. Inasaki et al. (1993) explains that, abrasive machining is a centuries-old technology; it continues to play an important role in industry. The extremely small scale of chips produced and the self-sharpening of grinding wheels are key advantages of abrasive machining and should be taken advantage of in future efforts to develop abrasive machining technologies. The main differences between abrasive machining and cutting tool machining are the cutting edge geometry and relative scale of the chips produced. Because of the extremely thin chips produced in abrasive processes, it is possible to concentrate the machining stress at very local points on the work. It is this ability 'which makes machining of difficult-to machine materials possible.

Pramod A. K. et al. (2007) explains about machine utilization studies are very important in evaluating productivity and life of machines. Therefore critical factors such as setup time, tool life, machine break down time etc. must be thoroughly studied and monitored for carrying out improvement action in order to increase the productivity of the machines.

J. Kopac et al. (2006) explains about increasing quality demands for high-performance grinding technology, particularly in automotive, bearing and aerospace industries require enhanced processes that provide near-optimal yield with respect to productivity, precision and cost. In general, the goal is to maximize the production rate to the specified product quality bounds and to simultaneously reduce the production costs.

Rahul R. Gurpude (2013) explains that, in most of industries, it has been seen that the feeding of raw material is done manually. Nowadays some industries also use automation in feeding; still it has limitation that they are not fully automated. Some worker participation is always required. Because of this ‘degree of mechanization’ is not maintained. The technology of ‘degree of mechanization’ is decided upon the principles of minimization of cost , improved productivity ,both qualitative and quantitative, improved accuracy, better safety, etc. which

again is paused with higher initial investments, higher maintenance costs etc. Automation is one of the basic tools for improving the productivity. The same that is the necessity of automation and the various mechanisms are used for automation.

Gualtiero Fantoni et al. (2014) states that, in the last ten years several factors such as the increasing cost of human labour, the spread of automation and the decreasing cost of robotic systems have pushed both industry and academia towards the development of new grippers and robotic hands. The complexity of the grasping process is often underestimated since it looks very familiar for human beings. However the automation of this process creates many problems. In fact the design of a gripper does not depend only on the object characteristics but it is also affected by previous phases as feeding and the following phases such as handling, positioning and releasing. In general correctly fed parts require less versatile grippers with respect to a bin picking situation where the gripper has to face problems such as pieces with different orientation, part tangling, etc.

J.F.G. Oliveira et al. (2009) explains about some classical grinding problems require dedicated or specially designed processes. Well known examples are the grinding of long lengths and small diameters requiring the development of the centerless processes. Other is the low stiffness in (inner-diameter) ID grinding, requiring the use of a combined process where hard turning and grinding are performed in the same machine. Another is the need of grinding both flat surfaces in a spacer or a sealing component that requires a double disk process. The combination of critical part geometry and recent new developments in difficult to grind materials lead to very challenging problems that require newer processes concepts. New grinding processes are normally very much related to new tool or machine concepts. The solutions are normally complex and a good opportunity for the collaboration between industry and the research centers.

J.F.G. Oliveira et al. (2009) also explains about Machine tool development is an important topic considering today's requirements of cost reduction with high efficiency. Additionally, new grinding processes and new grinding tools are increasing the requirements for power, stiffness, stability and spindle rpm. Many present industrial challenges and new product demand is driving the development of machines for grinding.

Devarakonda Harish Kumar (2015) states that, in modern manufacturing and assembling, high dimensional accuracy and fine surface finish play an important role. The grinding process is commonly used as finishing operation which makes the process distinguished from other machining processes. One of the best low cost methods of producing such parts is by a cylindrical grinding attachment on a lathe machine. In the present study heavy duty lathe was retrofitted with a grinding attachment.

Pratik Chavan, et al. (2015) explains that, Lathe has always been the mother of all machines before the invention of CNC machines. The turning operation on lathe is most frequently performed, and then it's transferred to grinding machine for fine surface finish. The time required to do this is generally high and loading and unloading of job causes human fatigue. Thus combining these two operations on single machine would benefit and this led to think of grinding attachment on lathe machine.

Selveraj P. et al. (2006) explained about the technique of multitasking. An attempt has been made to compare between the multi-machines and multitasking machines in terms of time, cost, no. of setups involved, etc. for the manufacture of aircraft components.

Prof. W. B. Rowe et al. (1989) shows that, recent research and advances in technology have concentrated mainly on increasing removal rates, improving machine design, extending the range of materials to be ground and the application of adaptive computer numerical control including optimization and learning strategies. This trend is forecast to gather pace. As controller become more powerful and less expensive users will look to machines which can take care of themselves and do not require highly skilled operators.

M. Muthukkaruppan et al. (2007) Explains about the benefits of the automation such as improved productivity, improved repeatability and accuracy, less human intervention, less rejection, minimized production cost etc.

David A. Stephenson et al. (1997) in their book "Metal Cutting Theory and Practices" have detailed the basic theories of various metal removal practices including grinding. They have also provided updated information on machine tools, cutting tool material and work holding technologies.

Groover Mikell P. et al. (2003) in his book "Automation, Production Systems and Computer Integrated Manufacturing" has explained the automation related concepts for SPMs, its programming modules, use of sensors, actuators and overall economic importance of automation. The book clarifies the role of SPMs in the manufacturing environments like CIM, FMS.

V. DUPLEX GRINDER MACHINE SPECIFICATIONS

Fig.1 shows the MODEL: PM 350 of (Slide Type) Duplex grinding machine to which the new low cost piston ring feeder mechanism (attachment) will be developed.

Fig. 1 MODEL: PM 350 (Slide Type) Duplex grinding machine.

- Duplex Surface Grinder Machine Specially Used for All Types of Bearing Con, Connecting Rod, Ring Washers, Ceramic Washers, Sheet Metal Washers, Sir Clips, and Piston Rings etc.
- Job Grinding System by Through Feed Type.
- Wheel Size 350 x 55 x 25mm.
- Job Capacity Maximum 100mm.
- Job Feeding Attachment.
- Grinding wheel spindle mounted on 4 nos. precision bearings.
- Both Sides Roller Slide Guide ways Base for Emery Wheel Head Movements.

- Coolant supply Provision of through spindle bore.
- Sliding of both Wheels are operated by manually and Electric Motors.
- Rotary Arm Type Hydraulic Dresser System for both sides Grinding Wheel.
- Star Delta Electrical Panel with interlock system for safe operations of machine.
- Power requirement Approx 17.5hp

VI. FEED MECHANISMS USED IN THE ATTACHMENT

There are different types of parts feeding mechanisms used in different attachments. The three methods are described here briefly. Selection of the feeding mechanism for duplex grinding machine will be based upon the simplicity, applicability and low cost of the mechanism.

6.1 Oscillating Fixture

The oscillating type fixture as shown in Fig.2 is usually selected when production requirements are not too great but, where heavy stock removal and extreme accuracy is involved. A blade or work holding fixture is attached to a rugged pivoting arm, arranged to oscillate the work between the abrasive discs. A similar fixture is a reciprocating type which oscillates along a straight line as opposed to circular (pivoting) motion.

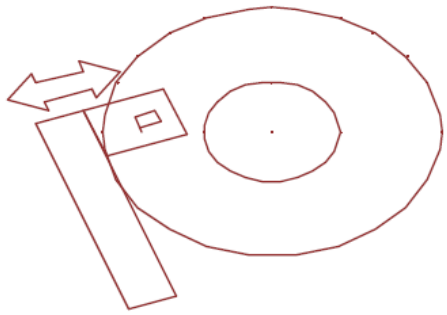

Fig.2 Oscillating Type Fixture

6.2 Rotary Fixture

The rotary type fixture as shown in Fig.3 is recommended for medium or small size parts where high production and accuracy are required. This type of fixture lends itself to automatic loading and unloading of parts such as bearing rollers, valve inserts, piston pins, pump vanes, snap rings, etc. A continuously rotating disc (feed wheel) provided with suitable openings is arranged to hold and carry the work between the abrasive discs.

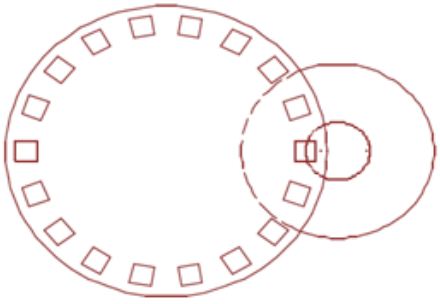

Fig.3 Rotary Type Fixture

6.3 Through Feed Fixture

The through feed type fixture as shown in Fig.4 is capable of producing accurately ground parts at the highest production rates. Work is fed in a continuous stream through the grinder by the feed mechanism locating at the front of the machine. A variety of feeding methods, including chain feed, belt feed, pusher feed, and others are available. A pair of guide bars retains the work pieces as they pass through the grinding zone, exiting at the rear of the machine.

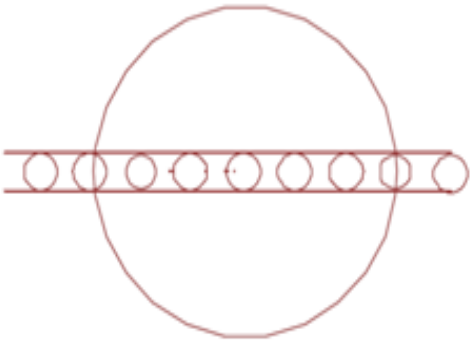

Fig.4 Through feed Type Fixture

6.4 Rotary and Through Feed

Rotary and through feed type fixture as shown in Fig.5 is used to convert rotary into linear feed or linear into rotary feed. In rotary and through feed the motion of the part to feed has two motions in combination .At start the part is passed in circular motion and after a specific distance the part is passed in linear motion with help of guide strips with various feeding methods

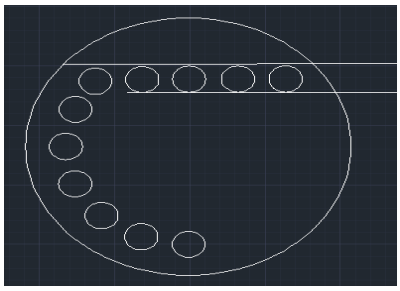

Fig.5 Rotary and Through Feed Type Fixture

6.5 Advantages of Rotary and Through Feed over Other Fixtures

In duplex grinding machine the feeding is done linearly. Advantages of rotary and through feed over other feeding methods are:-

- In oscillating fixture the type of feeding is pick and feed. This feed takes a lot of time to feed one by one and this feeding is not a smooth feeding process which may hamper the edges of piston rings
- In rotary fixture, the type of feeding is rotary and it is very complicated for low cost implementation as Duplex grinding machine requires simple linear feeding which is easy for implementation.
- In linear fixture, the type of feeding is linear and some modification must be done to for automation to minimize feeding fatigue of worker.

- In rotary and through feed the part to feed has combination of rotary and linear motion in which part is at start in rotary and after specific distance is converted into linear with help of guide strips.

So this mechanism is suited for development of low cost piston ring feeder mechanism for slide type duplex grinding machine.

VII. BLOCK DIAGRAM

Fig. 6 shows Proposed Block Diagram of Piston ring feeder mechanism attached to Duplex Grinding Machine.

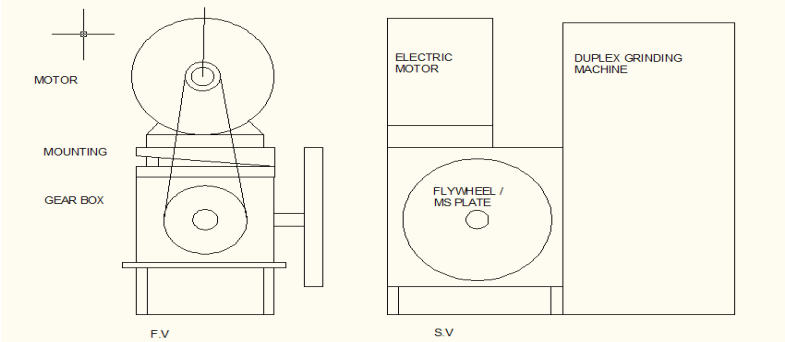

Fig. 6 Proposed Block Diagram of Piston ring feeder mechanism attached to Duplex Grinding Machine

VIII. CONCLUSION

This paper explored different sources of information on industrial challenges faced by industries while using duplex grinding machine to grind piston rings. From the gathered information, the main conclusions that can be drawn, which would represent a summary of relevant grinding hot research topics for industrial applications are:

- Several cases presented here on the diagnosis of grinding problems in industry shows that process productivity is an important issue and here automation plays an important role to increase the productivity with decease in labour fatigue.
- There is a need of future research to design and develop low cost piston ring feeder mechanism for duplex grinding machine.

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