PLC Installation on Inner Ring Bore SHG Grinding Machine

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***Abstract* —** To supply product of high quality in the market for maintaining the market requirements, machinery should be up to date. This project work is based on the upgradation of the inner ring track grinding machine on a production line. A grinding machine is a type of machine, which uses an abrasive wheel on cutting tool. Each grain of abrasive operation on the wheel's surface cuts a small chip from the work-piece via deformation. Grinding is used to finish work-pieces that must show high surface and high accuracy of shape and dimension.
The main objective is:-
1. To reduce the cycle time of machine.
2. To improve the quality of the bearing.
3. To reduce the maintenance cost of the grinding machine.
The aim of our system is to reduce the down time of the grinding machine i.e. to increase the productivity of bearings. Apart from down time, our objective is to improve the quality of the bearings. Quality defines the speed, precision and efficiency of bearings. Reduction of the cost of maintenance of the machine is also our prime objective. We meet our objectives with the help of Mitsubishi PLC and Servo System.

Keywords- *Grinding, Cycle time, Quality, Mitsubishi PLC, Servo System*

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I. INTRODUCTION

A bore grinding machine is one of the machines which is used for the purpose of grinding the inner bore of a bearing, during its manufacturing process. This machine consists of a grinding tool (made of silica), which is used for removing of scrap iron from the inner ring of the bearing. The project is to upgrade a bore grinding machine which works on the process of inner ring bore grinding in a tapper roller bearing. SHG is the machine name which performs the grinding process and the grinding is the process for giving proper finishing to bearing. The friction in grinding process is mainly done for finishing purpose and minimize extra unwanted burr in bearing. Electronic upgradation is based on PLC programming. The machine can be described from its name by:-

S : Surface
H : Inner
G : Grinding

Figure 1*: SHG grinding machine*

II. LITERATURE SURVEY

Initially we studied about the machine cycle of the system. We came across, "Gain scheduling controller for tool and cutter grinding machine and its comparison with fix gain control". Before upgrading the system used stepper motor and MTC (Machine Tool Controller) as its controlling element. There are various disadvantages of MTC and stepper motor like once motor is not controlled well, it can easily cause resonance vibration. The MTC panel is too large and its parts are outdated. Fault detection is also difficult in MTC .Servo motor is able to overcome this disadvantage of MTC also with the help of Mitsubishi controller we can overcome the difficulties of MTC. Considering the fact that the machines having older designs need more maintenance and hence the machines need upgradation in order to improve production, speed, quality of the product, reduce maintenance time and cost. The system uses stepper motor and MTC (Machine Tool Controller) as its controlling element.

Disadvantages of current system:-

1. System is currently operating on basis of MTC (Machine Tool Control) which is very complicated to replace and upgrade
2. As it is not cost efficient also, PLC is used for ease of controlling.
3. The system is also not up to the latest technology trending in the market.

Need of up gradation:-

1. This machine is currently controlled by with the help of discrete component cards.
2. Need for this arises because of basic reason of high complexity due to large number of discrete boards controlling the system. Thus fault detection and correction becomes difficult.
3. One of the reasons for up-gradation is to implement current system using PLC.

III. BLOCK DIAGRAM

Digital inputs are in the format of analog voltage values in the range of 0-24 V . These are converted into digital values using the A/D converter which is available in the PLC. The GOT 1000 series HMI is used as a I/O device which provides runtime parameters and also reports any errors in the system, which might occur during the manufacturing process. The high frequency drive is used to vary the speed of the motor which is used to drive the bearing. The digital outputs are in the form of analog voltages which are supplied to the motor. These analog values are obtained from the D/A converter which is present in the PLC. The output is given to the motor and the lamp for indication purposes.

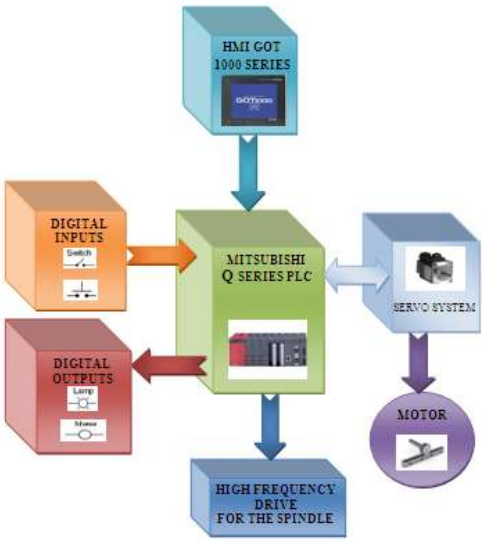

Figure 2: *Block diagram of the system*

1) **MMI GOT Series**: Man machine interfaces are panels mounted devices that provide effective dialogue between the operator and machine .Equipped with programmable display and keys, MMI allows easy operation and monitoring in the production area. MMIs display operational and fault messages.MMI keeps the operator fully informed of the current status of operations of all times.GOT1000 MMI can be directly connected to the MITSUBHISHI PLC via serial interface resulting in easy and quick installation.

Features:
1. High resolution quality with touch screen facility
2. 64 bit high speed RISC processor
3. Serial port connection.

Figure 3: *GOT 1000 MMI Front panel*

2) **DIGITAL INUTS**: There are various digital inputs like output from float sensors, inductive proximity switch, push button, selector switch.

Proximity Sensor: Proximity Sensors are available in models using high-frequency oscillation to detect ferrous and non-ferrous metal objects and in capacitive models to

detect non-metal objects. Models are available with environment resistance, heat resistance, resistance to chemicals, and resistance to water. Proximity Sensors convert information on the movement or presence of an object into an electrical signal.

Figure 4: Proximity Sensor

3) **DIGITAL OUTPUTS:** Digital output to the Grinding wheel, Dressing wheel, servo motor.

4) **MITSUBISHI Q01 PLC**: CPU is the heart of programming logic control. MITSUBISTHI is the manufacture of PLC based machine which placed worldwide.

Features:

1. Expandable from 16 to 4096 I/O s
2. PLC-CPU cycle period/log instruction up to 34 ns
3. High speed counters.

Figure 5: *Mitsubishi PLC*

5) **SERVO SYSTEM:** A servo amplifier reads position data directly to perform operation. Data from a command unit is given to the servo amplifier which then controls the speed and rotation direction of servo motor and executes precision positioning. Also conveys the data back from the motor to the corresponding module. Servo motor used id KF HP 40B

Figure 6: *Servo motor*

6) **SERVO AMPLIFIER:** A servo drive is a special electronic amplifier used to power electric servomechanisms. A servo drive monitors the feedback signal from the servomechanism and continually adjusts for deviation from expected behavior. Servo drive receives a command signal from a control system, amplifies the signal, and transmits electric current to a servo motor in order to produce motion proportional to the command signal. Typically the command signal represents a desired velocity, but can also represent a desired torque or position. The process of adjusting these parameters is called performance tuning. Servo amplifier used is MR J3 40B.

Figure 7: *Servo amplifier*

IV. CYCLE TRACK

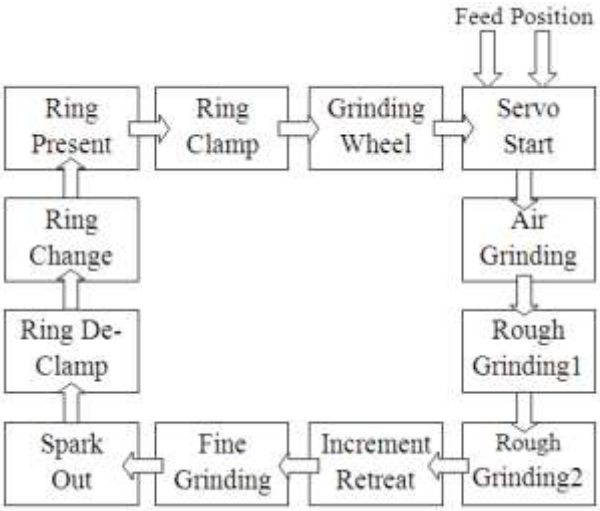

Figure 8: *Flow of cycle*

V. SOFTWARE IMPLEMENTATION

1) **PLC LADDER LANGUAGE:**

Ladder logic has evolved into a programming language that represents a program by a graphical diagram based on the circuit diagrams of relay logic hardware. Ladder logic is used to develop software for programmable logic controllers (PLCs) used in industrial control applications. Ladder logic

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2189 - 2193

is widely used to program PLCs, where sequential control of a process or manufacturing operation is required.While ladder diagrams were once the only available notation for recording programmable controller programs, today other forms are standardized in IEC 61131-3. IEC 1131-3 is the international standard for programmable controller programming languages. Often the ladder logic program is used in conjunction with an HMI program operating on a computer workstation.

2) **MITSUBISHI GX DEVELOPER:**
GX Developer is the standard programming software for all MELSEC PLC series and combines all functions of MELSEC with the user guidance of Microsoft windows. With this software we can comfortably create PLC programs alternatively in the form of ladder diagrams or instruction lists. Common software GX Developer can create the data of the Q series, Qn A series, a series (including the motion controller (SCPU)) and FX series, with their setting operations common, and is abbreviated to GPPA. Wide range of programming languages GX Developer is compatible with various programming languages and includes the relevant functions such as relay symbol language, logicsymbolic language, MELSAP3(SFC), MELSAP-L and function block.

V. ALGORITH/M

Figure 9: Algorithm cycle

1. Checking initial condition:
-If lubrication and oil flow is good, cycle starts.
- Else cycle interrupt and emergency return.
- If any error is present servo will not get enable
- Else servo will get started.

2. Mode selection:
- Auto dressing selection with auto mode.
- Dressing cycle on.
- Length slide-in condition.
- Cross slide jump-in condition.

3. Start grinding cycle:
- Grind Start.
- When gap eliminator position achieved rough grind 1 start.
-Gauge in (unit measurement)
-Rough grinding 2 starts.
-Increment retreat1.
-Marposs signal check (SQ28)
-Fine grinding starts
-Increment retreat2.
-Spark out grinding start.
-Marposs signal check (SQ30)
-Ring size finished.
-Slide out and ring change.
-Cycle repeats.

5. Start the dressing cycle:
-Select the mode of dressing cycle.
-Set dressing compensation
-Cross slide at dressing position.
-Dressing arm length slide-in.
-Next dressing step executed.

V. RESULTS

Before upgradation:-

Figure 10: MTC panel

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System was operating on basis of MTC (Machine Tool Control) which is very complicated to replace.The cycle time taken by machine was high.

After upgradation:-

Figure 11: (a) PLC **Figure 11:** (b) GOT panel

The PLC is a solid sate device and hence extremely compact as compared to hard wired controller. The cycle time is reduced from a value of 20 seconds to 12 seconds and also the quality of the product is improved by inclusion of another grinding cycle. Using this PLC, the batch production of the product has increased per hour.

Advantages of up gradation:-

1. Cycle time is reduced.
2. Quality of the product is improved.
3. Cost is reduced.

VI. ADVANTAGES

1. Reduced space: PLC is a solid state device and hence extremely compact compared to hard wired controller.
2. Energy saving: Power required by PLC is less as compared to the equivalent relay logic board.
3. Re-programmability: PLC can be re-programmed by using programming device.
4. Re-usability: PLC can be re-used for other applications.
5. Easy troubleshooting: Indicator lights are used provided at major diagnostic points to simplify trouble shooting.
6. Greater reliability and lifetime: PLC consists of static devices hence less
number of parts reduces wear and tear and hence less down time of machine.

VII. APPLICATIONS

1. The purpose of the PLC is to control and implement the grinding of the face of inner ring which is further used as a part in bearings.
2. PLC can be used in batch processing system, where the same product is to be manufactured over and over again in the same cycle.

VIII. CONCLUSION

PLC provides a robust modular platform for automating complex machines and processes. The MITSUBISHI PLC from the leading automation companies offer high performance, flexibility and advanced feature. Scanning time and maintenance time of the system is thus reduced by using PLC. Thus leading in mass production of bearings.The compactness required in the system is achieved by upgrading the grinding machine with the MITSUBISHI PLC. Thus the cycle time is reduced. The selection of the MITSUBISHI PLC helped us in up gradation of the old MTC system. Hence performance of the system is improved.

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