

PLC Based Porcelain Insulator Cutting Machine

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Abstract - This paper represents the implementation of the programmable logic controller (PLC) based technology for cutting porcelain insulator. Currently most of the industries are approaching the manufacturing process with advanced automation tools to increase the productivity with lower cost and lesser time. A porcelain insulator is placed on the rotating shaft and the cutting blades are attached to a frame, these blades, rotating shaft and the frame all are connected to the motors. All these operate as per the ladder logic of PLC to which the commands are given from the push buttons.

Key words: Relay, Programmable logic controller, Insulators, Automation, Cutting machine

1. INTRODUCTION

At present the engineers are finding many ways so that the human efforts are reduce, which ultimately save the labor cost and valuable time. In this paper it has been innovated that how we can use the PLC for cutting process [1] of the porcelain insulator. During the manufacturing process of the porcelain insulator, after the grinding is done the next part involves the jig which is used for the assembly, here the metal parts made up of malleable cast iron is used. Next the cement injection process is used for joining the metal part with the insulator. Here the need of cutting the porcelain insulator arrives after the grinding process. During the grinding process the chuck of the lathe machine requires some extra length of the insulator to it firmly, after the grinding process is done that extra length of the insulator is to be cut. Using the advanced automation technology [2] the cutting process is done with the help of the programmable logic controller (PLC). The input to the PLC is given from the push buttons.

1.1 Relay based Technology

Before the development of the PLC based technology the cutting of the porcelain insulator was done by using the relay based technology. The input commands from the push buttons were given to the relay, after receiving the input commands the signal was given to the corresponding actuators for the further process. Here the relay was acting the mechanical switch. However there were many disadvantages in the relay logic based technology which led to develop the PLC based technology

Disadvantages of relay based porcelain insulator cutting machine are as follows:

1. For each of the control signals, it requires a separate relay
2. Due to this the circuit was more complicated
3. Overall size of the control panel increases
4. Difficulty in detecting the faults in the circuits
5. Less accurate

2. Automation

The word "automation" is most commonly used in various fields now a days, even in the manufacturing field also it is used more often.

The automated part of the production systems are separated into two different categories as:

1. Automation of manufacturing systems in the industry.
2. Computerization of manufacturing systems.

Automated manufacturing systems are classified into three basic types [1]:

1. Fixed automated systems
 2. Programmable automated systems
 3. Flexible automated systems
- 1) Fixed automated systems: These are the systems where the sequence of the processing operations, which is to be carried out is fixed by the configuration of the equipment.
 - 2) Programmable automated systems: In the programmable automation, the machine is designed with the ability to change the sequence of the operations to put up the different product configuration.
 - 3) Flexible automated systems: It is the next version of programmable automation. It is capable of producing a variety of products with ideally no lost production time while reprogramming the system and altering the physical set up.

3. INSULATORS

The porcelain insulators are prepared from the clay, quartz or alumina and feldspar, which are generally covered with smooth finish to shed the water. Insulators which are made from porcelain will be usually rich in alumina and are

used in the areas where high mechanical strength is required [5]

Generally the porcelain insulators are classified into six different major types:

- 1) Strain Insulator
- 2) Shackle Insulator
- 3) Suspension Insulator
- 4) Post-Insulator
- 5) Pin Insulator
- 6) Stay Insulator

Table -1: Ratings of insulators

Insulator	Voltage Capacity	Uses
Pin Insulator	< 11 kV	Distribution System
Suspension Insulator	11 kV to 765 kV	Transmission System
Strain Insulator	> 33 kV	Transmission System
Shackle Insulator	< 33 kV	Distribution System
Post Insulator	> 11 kV (High)	Substation System
Stay Insulator	< 11 kV	Distribution System

4. PROGRAMMABLE LOGIC CONTROLLER (PLC)

A programmable logic controller is a digital, industrial computer which is made up of integrated circuits. Logic in PLC is concerned with the implementation of switching operations [3]. Input devices like PLC is various sensors, limit switches, pushbuttons and output devices like alarms, solenoids, etc. are connected to the PLC.

Here we are using “SIEMENS” PLC and the software used for developing the PLC logic is SIMATIC S7-1200. S7-1200 is a controller which provides the flexibility and also power to control a wide variety of devices in support of the automation needs. The flexible configuration, compact design and powerful instructions set are combined to make the S7-1200[4] a perfect solution for controlling a huge variety of applications.

5. METHODOLOGY

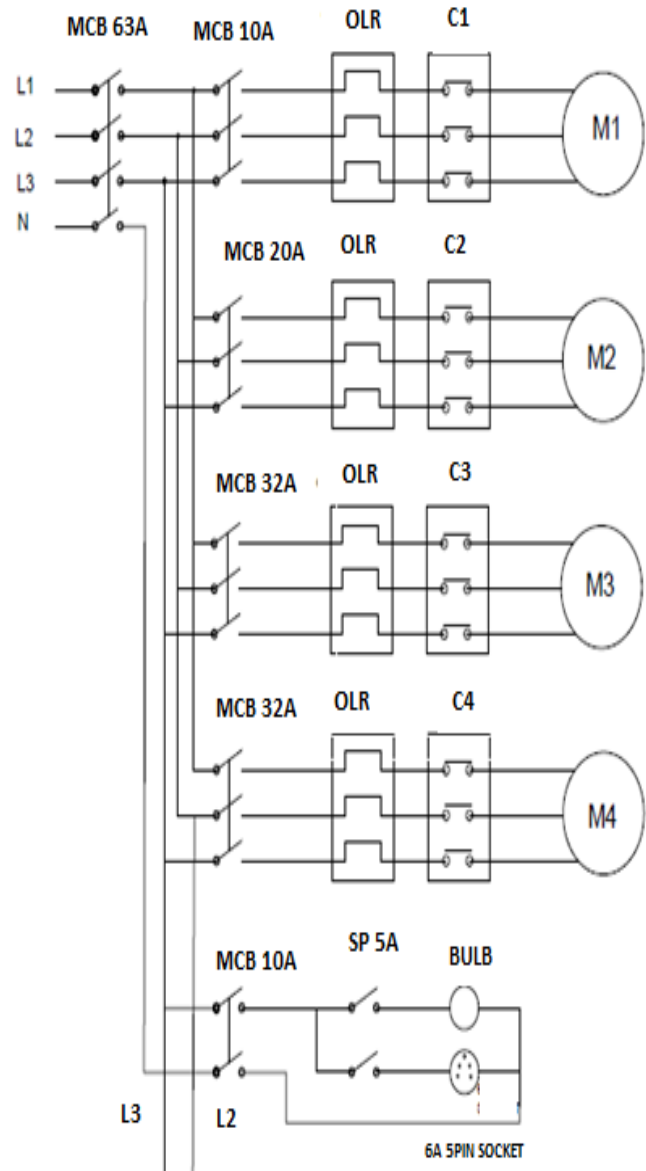


Fig -1: Control panel wiring diagram (part 1)

- OLR – Over load relay
- M1 – Hydraulic motor
- M2 – Wheel motor
- M3 – Right side cutting motor
- M4 – Left side cutting motor
- C1, C2, C3, C4 are the contactors

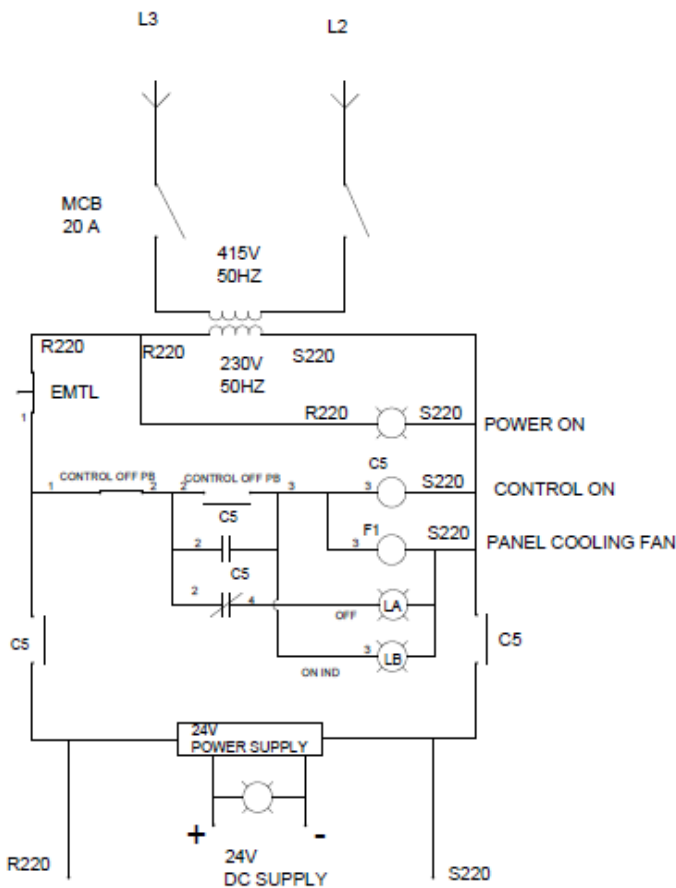


Fig -2: Control panel wiring diagram (part 2)

There are four different motors used in this project, which are named as follows:

1. Hydraulic motor
2. Wheel motor
3. Right side cutting motor
4. Left side cutting motor

Hydraulic motor is used for operating the frame upwards and downwards to which the right and left side cutting blades are attached. Wheel motor is used for operating the rotating shaft on which the work piece need to be cut is placed. Right and left cutting motors are used to operate the right and left cutting blades respectively.

The inputs to the PLC is given from the push buttons, these push buttons are placed on the door of the control panel. There is selector switch to select between the auto and manual operation of the cutting machine. The inputs from the push buttons are given to the PLC. In the PLC the required actions are taken based on the ladder logic developed according to the signals from the push buttons. The ladder logic consists of many interlocked logics, which finally produces the required output by considering the inputs given from the pushbuttons.

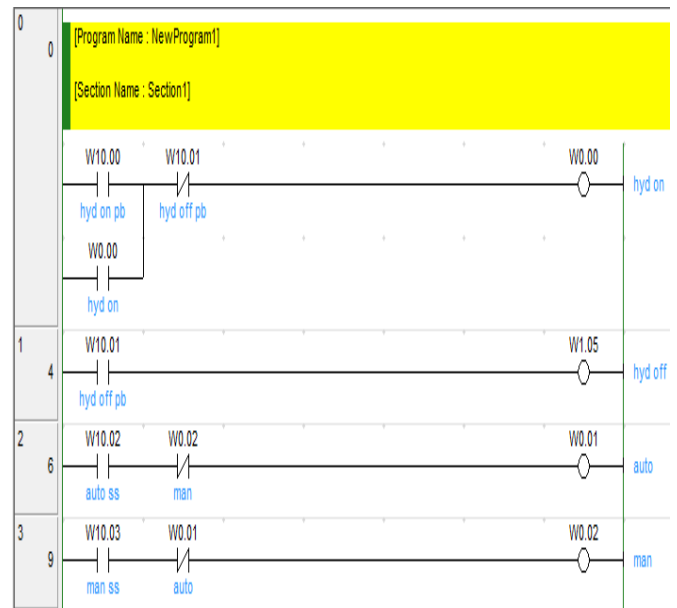


Fig -3: Ladder logic

Connections of the ladder logic:

1. In “network 0” the address W10.00 is the input from the “hydraulic motor on” push button and W0.00 is its corresponding reference output. There is NC block of “hydraulic motor off” in order to prevent the miscommunication between on and off buttons respectively
2. In “network 1” the address W10.01 is the input from the “hydraulic motor off” push button and W0.01 is its corresponding reference output

Similar to these networks there are many more networks in the ladder logic based upon the inputs from the push buttons

6. CONCLUSION

When PLC based technology was used instead of the relay based technology, due to the compact size of PLC, overall size of the control panel is reduced. Smooth cutting surface of the insulator is obtained when compared to that of the relay based technology. It is found that the operating time of the cutting machine is also decreased, which indicates the faster operation of the machine. The efficiency of the PLC based more than that of the relay based technology. No communication gap was found in the PLC based technology. Finally, by using the PLC based technology overall efficiency and productivity of the machine was increased when compared to that of relay based technology.

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