

# Replacement of relay based system by programmable logic controller

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## ABSTRACT

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**Abstract-** Being in the world of technology it is necessary to develop each and every system so that it will be helpful for the operation of machines in every industry. Automation is the basic necessity now a days in production and manufacturing industry. Enhancing the growth in industry for the manufacturing the parts it became indeed to have a sustainable machine and fast production rate. Pastly, industries were operated on electrical contractors (high voltage relays) on the electrical panels replacing huge electrical relays in size. Approaches for making the electrical panel automatic has an great option inclining towards PLC (Programmable logic controller).

We are updating the number punching machine totally with an PLC operating system using ladder diagram programming so that there will be ease in making the system errors resolving. The system we are developing will also modify the product number punching time rate(reduction time for every single unit), size reduction of control panel, use of less wires(connecting wires), efficiency, reliability etc. The system will consists of the software providing the beneficial outcome of simple programming to interface Number Punching machine with PLC.

In number punching machine PLC and HMI plays an important role for the completion of numbering a particular job e.g. BF 17 0197

System will be contributing in elimination of complex contractors from the electrical control panel which will be replaced by the programmable logic.

**Keywords :** Automation , Numbering machine , Programming Logic Controller, Human Machine Interface.

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## I. INTRODUCTION

Bharat Forge Limited (BFL), is a Indian multinational company involved in automotive, Power, oil and gas, construction and mining, locomotive , marine and aerospace industries. At Mundhawa BFL industry there are various divisions which consists of forging, heat Treatment, machine division components (MCD), heat forge division (HFD), Forge modernization division (FMD). We were grateful to be working in one of the division named Machine Component Division (MCD I).In machine component division (MCD I), machining of crank shafts, automotive, locomotive is being done. Machining of front axles, knuckles and different types of auto parts are being carried out in this section. Number punching machine is basically used to mark on well fabricated job. It is the final step in the fabrication process of a job. It is basically performed for the identification of the job when used in cars and other applications. Identification of job required to find the faulty job or in correction incurred in the system because of the job. Marking is a process of striking series number of the job manufactured one example is BF 12 341. The different marking schemes used in the industry are QR code , dot peening, laser. In Bharat Forge QR Code and dot

peening are implemented largely. Relays are used to switch high power circuit which is connected to the load using a lower power circuit. In other words, it is an electrically powered device that mechanically switches electric circuits. It is an important part of any control system but it has some disadvantages like

Their parts wear out as switch contact become dirty

They cannot be switched ON and OFF at high speed because they have slow response

Relays maintenance becomes difficult from time to time and so on

To avoid these disadvantages we adopted the use of PLC

PLC that is Programming Logic Controller is digitally operating apparatus which uses a programmable memory for internal storage of instructions for implementing for specific function like sequencing, timing counting and arithmetic calculations to various types of machines or process through digital or analog input output modules

Mechanism tools:

### A.RELAY

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a

circuit by a separate low-power signal, or where several circuits must be controlled by one signal. Relays are switches that open and close circuits electromechanically or electronically. They control one electrical circuit by opening and closing contacts in another circuit. When a relay contact is normally open (NO), there is an open contact when the relay is not energized.

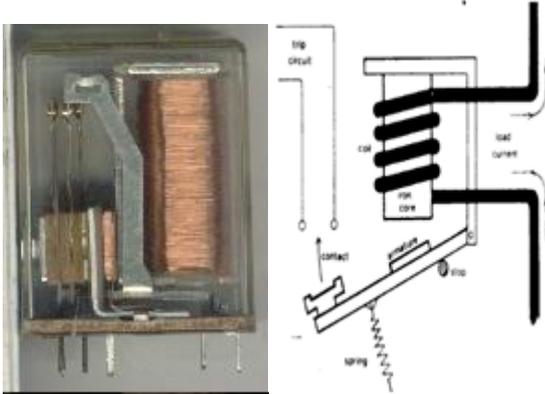


Figure 1. Relay and relay mechanism.

## B. CONTACTOR RELAYS

A contactor is an electrically controlled switch used for switching an electrical power circuit, similar to a relay except with higher current ratings. A contactor is controlled by a circuit which has a much lower power level than the switched circuit. Contactors come in many forms with varying capacities and features. Unlike a circuit breaker, a contactor is not intended to interrupt a short circuit current. Contactors range from those having a breaking current of several amperes to thousands of amperes and 24 V DC to many kilovolts. The physical size of contactors ranges from a device small enough to pick up with one hand, to large devices approximately a meter on a side. Contactors are used to control electric motors, lighting, heating, capacitor banks, thermal evaporators, and other electrical loads.

## C. PROGRAMMABLE LOGIC CONTROLLER

The PLC is a microcontroller based device with input/output circuitry that monitors the status of field connected sensor (inputs) and controls the attached (output) actuators (motor -starters, Solenoids, Speed drives, Valves etc.) according to a user created logic program stored in the memory. It is digitally operating digital apparatus which uses a programmable memory for internal storage of instructions for implementing for specific function like sequencing, timing, counter and arithmetic calculations to various types of machine or process through digital or analog I/O modules

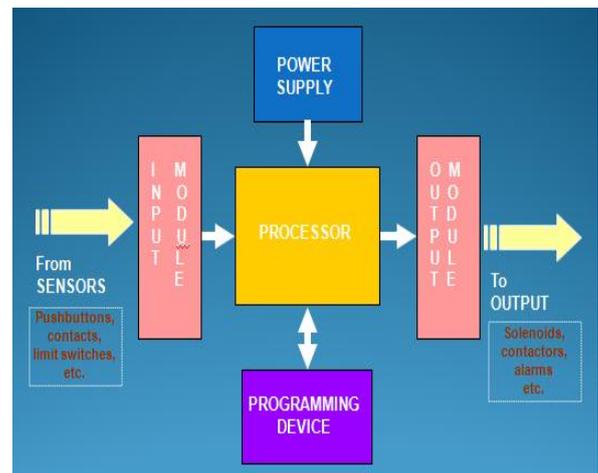


Figure . Block diagram of PLC.

The input/output arrangements may be built into a simple PLC, or the PLC may have external I/O modules attached to a computer network that plugs into the PLC. PLCs were invented as replacements for automated systems that would use hundreds or thousands of relays, cam timers, and drum sequencers. Often, a single PLC can be programmed to replace thousands of relays. Programmable controllers were initially adopted by the automotive manufacturing industry, where software revision replaced the re-wiring of hardwired control panels when production models changed.

## D. PNEUMATIC MARKING MACHINE

A pneumatic punching machine is always a better choice for punching machine for the production of similar products if it is suited for the method. It is comparatively more economical for production of large quantities of products as it uses compressed air. A pneumatic punching machine uses compressed air to generate high pressure to be applied on the piston. A solenoid valve controls the directional flow of air into and out of the cylinder. Polyurethane tubes are used for pressure transmission from the pneumatic cylinder to the punch assembly. The high pressure air fed to the punch, forces it on the material and as the punch descends upon the sheet, the pressure exerted by the punch first cause the plastic deformation of the sheet. Since the clearance between the punch and the die is very small, the plastic deformation takes place in a localized area and the sheet material adjacent to the cutting edges of the punch & die edges becomes highly stressed, which causes the fracture to start on both sides of the sheet as the deformation progresses.

## II. PAST WORK

Many research papers from reputed national journals were surveyed and few are presented here :

1 .Gavali Amit Bhimrao, 2.Patil Mahadev S. describes how the present automation system comes in to existence through its various stages. In the past, automation is done through relays and contactor logics. Since the human intervention is more, the scope of errors was also more. But with the advent of microprocessors & microcontrollers several new tools as PLCs (Programmable Logic controllers) come in to use.

1 .Prof.Mrs.Sharada Dhavale, 2.Mr.akhil Nair, 3.Ms.Komal Mandape, Ms.Meena Lawate discuss the replacement of Contactor Logic Circuit (CLC) in Die Casting machine (LK-12T) with Mitsubishi PLC and Graphics Operator Terminal (GOT1000) controller.

1. P.Goyal, 2.G.Srivastava,3. R.Singh, 4. N.Singh describes the project work which deals with the design of pneumatically controlled small scale punching machine to carry out piercing operation

Material List for Modification			
Sr. No	Material Description	Qty	Status
1	Schneider Electric PLC SR3B261 BD	1	Purchased
2	SMPS 230V/ 24 V DC ,5 Amp , VINIT Make	1	Purchased
3	Relay Board (8 Relay Module)	1	Purchased
4	MCB 2 Pole , 6Amp	2	Old one to be used
5	Mounting Plate for PLC & Relay Board	1	Made
6	Control wire 0.5 Sqmm ,Blue/black Color	15 mtr	Req.
7	Cable Tie, Insulation tape, lugs, Ferrules		Available in Store
8	Push buttons	4 No's	Available in Store
10	Selector switches	2 No's	Available in Store
11	Reed switches Festo make	3	Old One to be Used
12	25 pin Female pin	1	Available in Store
13	16 c cable for Controller IO	5 mtr	Available in Store

III. PRESENT SYSTEM

Present system consists of

A. Hardware:

1) Number punching machine: Number punching machine is used for marking the job in the mechanical industries and for giving the unique identification mark to the job developed by the company and so as to identify the job being designed by which manufactured is easy if marking is being done on the job.

Types of number punching or marking techniques:

1. Hand Marking

- 2. Chemical etching
- 3. Laser Marking
- 4. Dot peening

We have used Marks Pyro Number Punching Pneumatic machine and we have replaced the relays and contactors by Programmable logic controllers. We have used Schneider Electrical Programmable logic Controller (SR3B261BD)

- 2) Relays and contractors.
- 3) Controller attached to Number punching machine.

Material used for building the setup of project:

B. Software: The programming of PLC is basically an idea of storing and instructing the controller to perform according to the logic being used by the user for defining the elements and the mechanical and electrical components to function without any human interface and just a click away function are being programmed. IEC 1131-3 is the international standard for programmable controller programming languages. The following is a list of programming languages specified by this standard:

- Ladder diagram (LD)
- Sequential Function Charts (SFC)
- Function Block Diagram (FBD)
- Structured Text (ST)
- Instruction List (IL)

The programming language compatible to our PLC is ladder diagram and FBD's and we have used the LD. The supporting logic range software is Zelio software.

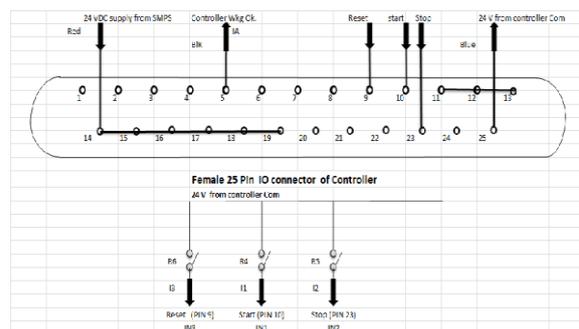


Figure : Controller Connection for ladder logic.

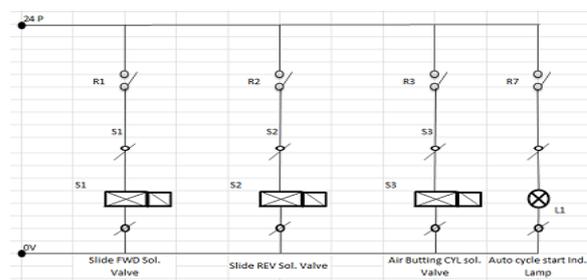


Figure 6: Ladder logic for solenoids.

C. Block Diagram

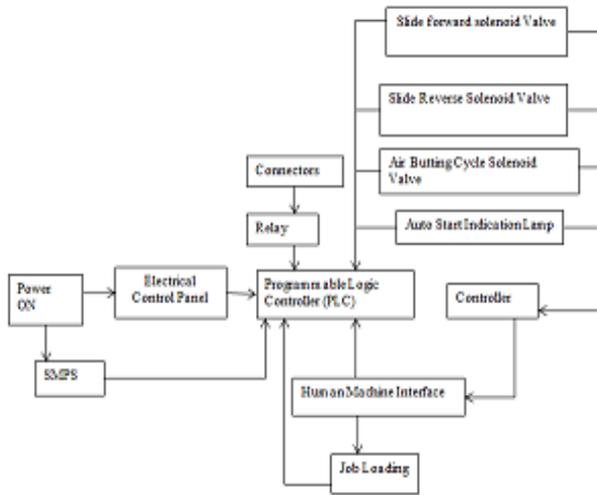


Figure 4: Block diagram of the system.

Using the Zelio software we updated the relay based system to PLC automation. Zelio supports the FBD and LD.

III. DESCRIPTION OF THE SYSTEM

The system consists of a controller with integrated keyboard, remote start/stop box (optional) and marking head.

1. The Controller and Software: The controller software lets you select the option you want by highlighting it using the cursor keys and pressing the Enter key or by pressing the appropriate function key. You can create marks (layouts) in either straight lines or arcs. Each layout may contain up to 40 lines of characters, with up to 150 characters in each line. Each line has its own character size and marking force. You may specify the horizontal and vertical position (straight lines) or the radius and start angle (arc marking) of Each line. Once a layout has been created it may be checked to see that it will fit in the available marking area. If it will fit you may then do a trial run to make sure the mark will be in the correct position, or go ahead and actually mark the layout. Various options are available to mark layouts at any angle, change the style of mark, change from straight to arc mode etc.

2. The marking head: The marking head consists of 2 main parts, the base and column (for column mounted systems) and the X-Y marking head. The gap between the marking unit and the base can easily be varied to accommodate various work pieces, fixtures etc.

3. Dot marking (E & DP Models): The dot mark unit marks characters using either a 5x7 or 7x9 matrixes of dots. The depth of mark may be varied for each line in a layout. The stylus should be replaced or reground if it becomes worn or chipped.

4. Digital input output: The inputs and outputs can be configured to operate in several modes. Select F7)

Configure hardware from the Configuration menu and change In/outs to the appropriate mode (Programmable, Select layout, Remote or Special interface).

The connector pinout is:

Pin	Name	Description
6-, 19+	OUT1	Relay 1 connections.
5-, 18+	OUT2	Relay 2 connections.
4-, 17+	OUT3	Relay 3 connections.
3-, 16+	OUT4	Relay 4 connections.
2-, 15+	OUT5	Relay 5 connections.
1-, 14+	OUT6	Relay 6 connections.
10	IN1	Input 1.
23	IN2	Input 2.
9	IN3	Input 3.
22	IN4	Input 4.
8	IN5	Input 5.
21	IN6	Input 6.
7	IN7	Input 7.
20	IN8	Input 8.
11	INGND	Input 1-8 isolated GND.
12, 13	GND	Controller GND.
24, 25	24V	Controller 24V 500 mA max.

IV. CONCLUSION

In this project we have replaced the use of relays and contactors as they incurred various disadvantages like their parts wear out as switch contact become dirty. They cannot be switched ON and OFF at high speed because they have slow response. Relays maintenance becomes difficult from time to time. Because of these disadvantages we proposed a system with the use of PLC (Schneider Electrical Programmable logic Controller (SR3B261BD) in the Mark Pyro Numbering pneumatic machine. The Mark Pyro Numbering pneumatic machine is basically used to number the job manufactured in the company. The numbering of job is performed to identify the faulty job when placed in the machine and also to identify a particular job .It is also used to determine the number of jobs manufactured by the specific company. The example of numbering sequence is BF 1207 12.

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