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Retrofitting of Boring Machine using MITSUBISHI PLC

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Abstract

The aim of the project is to implement the automatically controlled boring by using PLC. The manual method to work gear case product requires operations to be done by labors. The PLC is used to process the process by using ladder diagram program in which required sequence of operations are programmed. The movement of material to feed the boring tool is carried out by the sliding the job which is controlled by the limit switch and motors. This project is cost effective and saves the processing time and maintains accurate dimensions of the product. Push buttons are used as an inputs. The machine can work in both manual and automatic modes as per required by the worker.

Keywords— *PLC, Boring Machine, limit switches, selonide valve, motors.*

I. INTRODUCTION

This paper presents the basic idea of this project which is to reduce the human efforts while maintaining the quality when manufacturing the product. This is an important factor which is considered in industry. Designing the system with where less human participation is the main focus of manufacturing industries. At the same time aim is to increase productivity and reduce the processing time. Because of this, proposed a system 'Retrofitting of head boring Machine using PLC system' is introduced. It is system which has automated as well manual modes which will help the industries to achieve the required goals while avoiding the errors. PLC is a main controller which will accept the input and take control over the actions of the machine. Head machine in NH/NT block is used for machining liner bore operations. This machine is having old & obsolete Allen barely make PLC system. As this PLC is obsolete, supplier is not providing support for service as well as spares back up for the PLC. This machine is critical for NH/NT block line hence uptime of this machine is very important. Now it is very difficult to diagnosis the problem as online diagnosis is not possible in the existing PLC. Also if some spares are faulty, machine will be down for more time. Hence upgrading the machine with Latest PLC system with Ladder development & electrical switchgear design will help in solving the occurred problem. Advancements in technology will results in revolution of manufacturing industries for increased productivity and quality. Key goal of manufacturing industries is to automate the system for high performance machining. Automated equipment and good shape layout normally improves speed, precision and quality regardless of which type of machinery is performed. The heart of any industries is the motor drives, the automated drives increases the efficiency and even speed control is easy to achieved. Many industries use PLCs in automation processes to reduce the production cost and to increase quality and reliability. PC+PLC based control systems are widely used, not only in the discrete and sequence control processes but also in continuous control processes, because of rapid improvement in performance of PC and PLC. The development and introducing of effective PLC control units. In this, the automation process is explained and why they are used, which enables the increases the accuracy of production.

II. LITERATURE SURVEY

Lauzon, J.K. Mills and Benhabib [2] gave generalized methodology of Supervisory Control of Manufacturing Systems (SCMS) which utilizes recent advances in control theory with the PLC technology. Here a PC is used for the online generation of control strategies and is employed for their

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execution.Valery Marinov[3], said boring is a process of producing circular profiles on a hole made by drilling process. where a single point cutting tool called a boring bar is used. In this process either the boring bar can be rotated, or the work part can be rotated. Machine tools which is used for rotating the boring bar against a stationary work piece are called boring machines or also boring mills. Boring can be achieved on a turning machine with a stationary boring bar placed in the tool post having a rotating work piece, which is held in the lathe chuck. Krar, Gill and Smid [4] used to produce one or more machined surfaces perfectly on work piece using one or more rotary milling cutters. Work piece which are held on work table or holding device are brought into contact with cutter in vertical milling machine most common. In horizontal milling machine checks operations normally performed by other tools. The boring machine removes the metal with a revolving cutting tool called a drill. With various attachments, boring machines can be used for boring, slotting, circular milling dividing, and drilling. These machines can also be used for cutting keyways, racks and gears and for fluting taps and reamers[3].

III. PROBLEM STATEMENT

Understanding the existing problems of the machine:
The present PLC used in the machine is: NEXGEN400
Number of inputs: 64
Number of outputs: 40
The problems with the existing PLC are that:

1. There is no backup in case of any fault. Therefore in case of any breakdown no immediate replacement can be made.
2. There is no longer the production of this PLC. So spare parts are not available

If such problems occur, the following are the actions taken:

1. If a card is having a fault, any other card from an old instrument is replaced at the place of the damaged card.
2. If there is no card available, sometimes even direct connections of wire is made.

But the above given solutions are very temporary and no long term guarantee is obtained by it. In case any spare parts are not available, direct connections might put the machine into risk. Therefore a reliable PLC is needed here. Thus, in order to establish a reliable PLC system in the machine, the PLC of the company MITSUBISHI is selected to retrofit the older PLC.
The new PLC is MITSUBISHI 128MR. MR stands for relay logic. The programming of PLC is done on the software GX Developer.
The benefits that we will have after this project are:

1. Due to this if there are further problems in the machine, the PLC can be easily worked on
2. Even if there are problems with the PLC, or any modification is to be done, spare parts of the PLC are available.

But the programming methods of the older software and the new software are different. Also, the terminologies of both the PLCs are different. Therefore, all the inputs, outputs and flags of the older systems are to be converted to the new PLC terms. The following is the procedure to convert the PLC inputs and outputs:

IV. PROPOSED SYSTEM

Given below is the proposed system on which the further work will be conducted.

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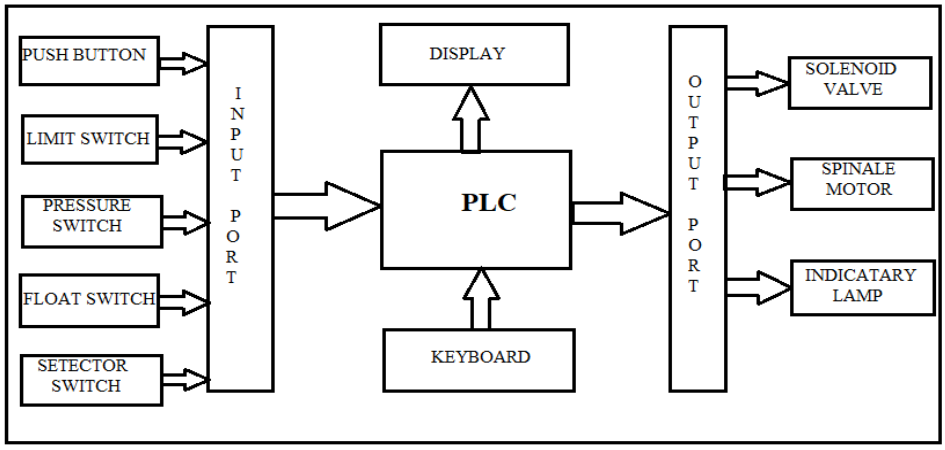

Fig. 1: Machine block diagram

Block diagram of proposed system (Fig. 1) shows the interconnection between the PLC and the other devices as inputs modules, outputs modules, push button and motors has been demonstrated. All field devices, limit switches are inputs to the PLC and motor, relay, contactors are the outputs, the interaction in both directions are as per input which is feed and output results are display by machine performing its work.

Initial control system: earlier the protection and controlling of any electrical circuit or systems were done entirely using relays, contactors etc. But using these circuits caused a lot of problems. As large wiring were used hence there is a large wiring problem and thus the complexity of the increases. Also implementing the hard wiring for every connection is time consuming. Debugging the circuit in case of any fault becomes a hard job in which a person has to trace each and every wire to find out the fault. The size of circuit and the space alternatively increases and also requires large maintenance. In case of any faults present in the hardware parts and the components pertaining to that fault are to be entirely replaced. If the control system is required to be changed, hence the entire hardware of the circuit changes.

In this study the inputs and output gives the information about particular task to PLC unit and we can manually operate as per requirement as well as use automatic mode. PLC controls all the output devices and get the required controlled processes. The boring machine which are considered for producing smooth and accurate holes in a work piece by enlarging existing holes with a bore at different desired length and required diameter in a particular time are set at desired values. This proposed automation scheme will help to achieve the desired requirement.Parameters that are to be considered while selecting a PLC: When a PLC is to be selected for any purpose, the following are the parameters that are to be considered:

1. Check whether the PLC is compatible with the application
2. Environment: check whether the PLC can withstand the environment
3. Voltage and frequency that it can handle
4. Total number of AC and DC inputs and outputs
5. CPU required:
    a. K byte program memory.
    b. K byte data memory.
    c. Scan time.
    d. Check whether battery backup is required
6. Special functions needed and softwares installed
7. I/O locations
8. Communications needed: PLC to PLC Modbus RTU, Other
9. Determine the programming requirements and determine whether any special programming is required.

V. RESULTS AND DISCUSSIONS

Special Purpose Machines: These are the machines which are designed to serve a specific mechanism that is required in the manufacturing of any product. The requirement of the company and the task which is expected is given to the manufacturer and then he designs the machine accordingly. They can't be used for any other purpose.

This is a special machine designed for the company to serve the drilling purpose. The machine basically does the drilling of the engine block. The unit is used for drilling for gen side of the block. A drilling machine removes metal by rotating a multi-toothed cutter that is fed into the moving job. The spindle can be fed up and down with a quill handle on the head. All the movements of the various components are controlled electrically. The main parts of the drilling machine that require the motor supply to drive them are as follows:

- Motors for the movement of the spindle.
- Motor for the movement of the component. For this purpose a lubricant motor is used.
- Motor to supply power to the pumps that supply oil to gears, various motor parts, etc. A hydraulic motor is used for this purpose.
- Motor for the burr conveyor.

Depending upon the amount of power needed by the components above, the rating of the motor changes.

The entire machine cycle is controlled electrically by various inputs like push buttons, selector switch, etc. The entire control on the input and output is done from a control panel that is located near the operator. There is one separate panel for controlling the main power supply to the machine and the PLC unit is located in this panel.

Basic construction and entities if panel:

An electric panel is basically a combination of various electrical equipments needed to operate a machine.

The various compartments of an electric panel can be described as follows.The compartments are basically divided into two types:

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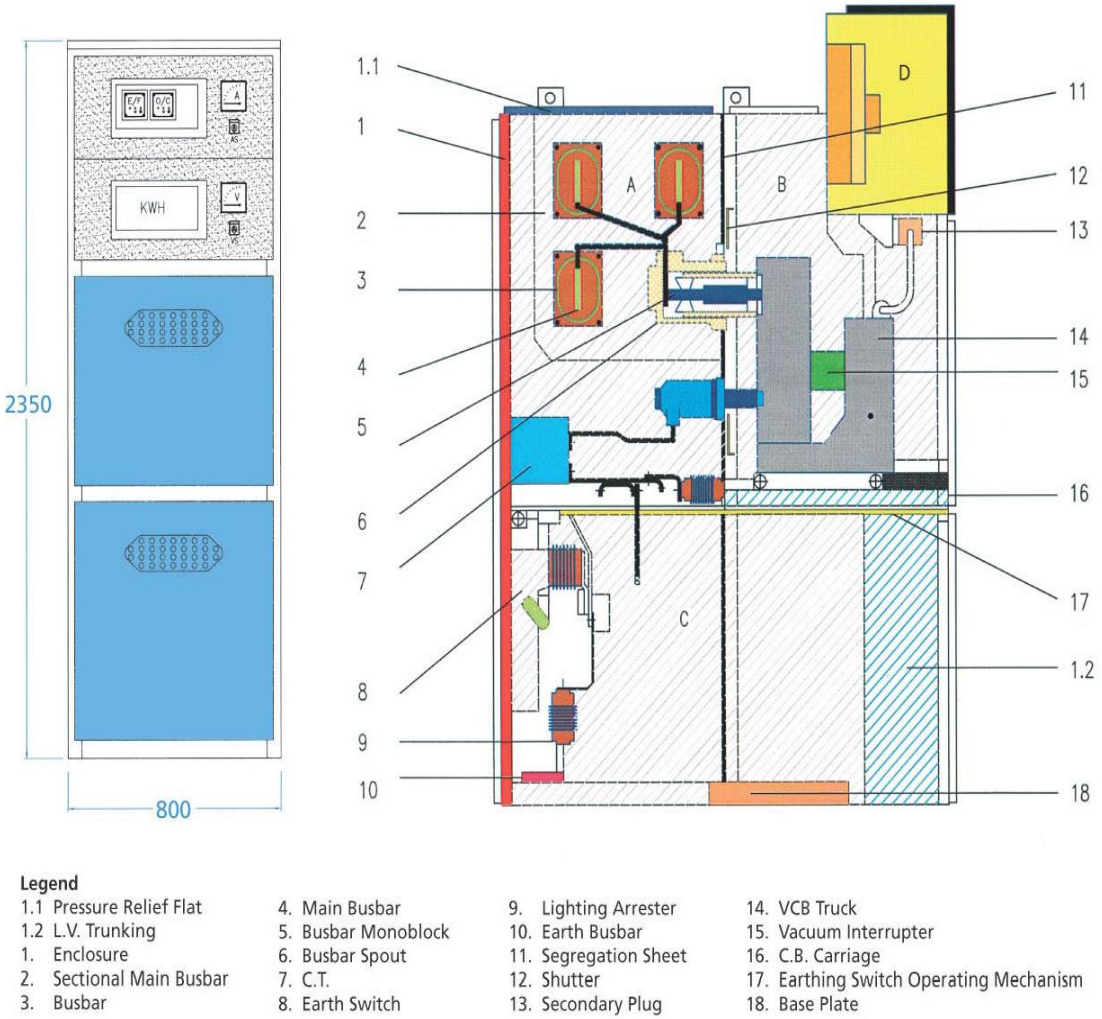

Legend

1.1 Pressure Relief Flat
1.2 L.V. Trunking
1. Enclosure
2. Sectional Main Busbar
3. Busbar
4. Main Busbar
5. Busbar Monoblock
6. Busbar Spout
7. C.T.
8. Earth Switch
9. Lighting Arrester
10. Earth Busbar
11. Segregation Sheet
12. Shutter
13. Secondary Plug
14. VCB Truck
15. Vacuum Interrupter
16. C.B. Carriage
17. Earthing Switch Operating Mechanism
18. Base Plate

Fig(2): Compartment block

1. Power equipments:
    a. Busbar
    b. Circuit breaker
    c. Fused contactors
    d. Instrument transformer, etc.
2. Auxiliaries:
    a. Instrument compartment
    b. Wiring ducts for interconnections, etc.

1. The circuit breaker compartment:

This compartment is to accommodate withdraw able circuit breaker or fused contactor, and for truck racking in and out with door closed. Components mounted in this compartment are: Primary disconnects: bushing insulators containing power connections of the circuit breaker or fused contactors and busbar compartment.

2. The main busbar compartment:

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This compartment is located in panel upper back part contains the main bus bar system, which is supported and connected to the circuit breaker and fused contactor fixed insulating contacts by means of branches.

3. Feeder compartment:

It should be accessible from panel front by opening the door. This compartment should include:

a. Branch system for connecting power cables to the circuit breaker or fused contactor fixed insulating contacts.
b. Fault make earthing switch with operation from panel front.
c. Mechanical interlock between circuit breaker or fused contactor and earthing switch.
d. Current transformer
e. PT fixed or withdrawable
f. Other components on request
Cable sealing ends should be visible at anytime via viewing window on compartment door.

4. Low voltage compartment:

This is a separate compartment from the high voltage compartment. It should be placed above the circuit breaker compartment Equipments:

a. Terminal links and wiring
b. Auxiliary equipments of circuit breaker or fused contactor and cubicles(low voltage MCBs, relays, measuring instruments.

5. Cable compartment:

By means of cable bushings, power grid cables are connected to switchgear busbars in cable compartment. Cable compartment comprises the following components:

a. isolator bushings
b. cable clamps,
c. earthing terminals for return cables. Switchgear cubicles are designed for installation of the following cables: plastic sleeve, oil-filled cable with paper insulation saturated with non-running agent and common lining.

Conversion of inputs and outputs of the current PLC into new PLC

Table I Inputs to PLC

SR.NO.	PLC PINS	INPUT MODULES
1.	X000	I0:0 DOWEL PIN SENSOR
2	X001	I0:1 TOOL RETRACT PROXY
3	X002	I0:2 SLIDE AT HOME
4	X003	I0:3 SLIDE FEED END LS
5	X004	I0:4 TABLE HOME OR LS
6	X005	I0:5 FIXTURE 1 TO 5 POSITION LS
7	X006	I0:6 INTER CYCLE START PB
8	X007	I0:7 BIG CAM CYCLE SEL SWITCH
9	X010	I0:8 SECOND SLIDE RETURN END LS
10	X011	SLIDE AT TOL ADV POSI BIG CAM
11	X012	I0:10 FIX AT BORE NO .6 POS LS
12	X013	I0:11 BAREL INDEX CORRECTELY
13	X014	I0:12 BAREEL AT POSITION 1
14	X015	I0:13 ADVANCE TOOL SS
15	X016	I0:14 TOOL ADVANCE PROXY

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16	X017	SLID AT TOL ADV POSI SMALL CAM
17	X020	I0:16
18	X021	I0:17 LIMITS SWITCH 6
19	X022	I0:18 CLAMP PRESSURE SWITCH
20	X023	I0:19 JACK ADVANCE PRESSURE SWI
21	X024	I0:20 SLIDE RESTED ON JACK
22	X025	I0:21 TOOL AT CENTER PROXY
23	X026	I0:22 TOOL RETRACT SS
24	X027	I0:23 MANUAL/ AUTO SS
25	X030	I1:0 HYD ON PB
26	X031	I1:1 HYD OFF PB
27	X032	I1:2 DOOR INTERLOCK
28	X033	I1:3 CONTACTOR HEALTHY SPIDNLE
29	X034	I1:4 SPINDLE INCH P.B
30	X035	I1:5 JOB CLAMP PB
31	X036	I1:6 JOB DECLAMP PB
32	X037	I1:7 TABLE RIGHT PB
33	X040	I1:8 TABLE LEFT PB
34	X041	I1:9 SLIDE UP PB
35	X042	I1:10 SLIDE DOWN PB
36	X043	I1:11
37	X044	I1:12 SPINDLE STOP PB
38	X045	I1:13 SPIN DLE ROTATE PB
39	X046	I1:14 SMALL CAM CYCLE SEL SWITCH
40	X047	I1:15 ROTATE BARREL PB

Table II Outputs of PLC

SR.NO.	PLC PINS	OUTPUT MODULES
1	Y000	O0:0 JACK DOWN SOL
2	Y001	O0:1
3	Y002	O0:2
4	Y003	O0:3 DECLAMP SOL
5	Y004	O0:4 TABLE RIGHT SOL
6	Y005	O0:5 TABLE LEFT SOL
7	Y006	O0:6 SLIDE DOWN SOL
8	Y007	O0:7 SLIDE UP SOL
9	Y010	O0:8 ROTATE BAREL SOL
10	Y011	O0:9 RESET BAREL SOL
11	Y012	O0:10 SPARE
12	Y013	O0:11 TOOL RETRACT SOL
13	Y014	O0:12 SPARE
14	Y015	O0:13 HYDRAULIC
15	Y016	O0:14 SPINDLE MOTOR
16	Y017	O0:15 HYDRAULIC
17	Y020	O2:0 CLAMP SOL

18	Y021	O2:1 LIMIT SWITCH FAULT LAMP
19	Y022	O2:2 BAREL AT POS NO 1 LAMP
20	Y023	O2:3 LAMP TOOL AT CENTER
21	Y024	O2:4
22	Y025	O2:5 BAREL INDEX CORECT LAMP
23	Y026	O2:6
24	Y027	O2:7 TOOL ADVANCE SOL
25	Y030	O2:8
26	Y031	O2:9
27	Y032	O2:10
28	Y033	O2:11
29	Y034	O2:12 SPARE
30	Y035	O2:13
31	Y036	O2:14
32	Y037	O2:15

Programming the ladder:

The entire ladder is written in the software. This is latter programmed into the PLC. The new PLC is installed in the machine and the wiring is done. And after the complete installation, trials are taken to test whether the program is properly working.

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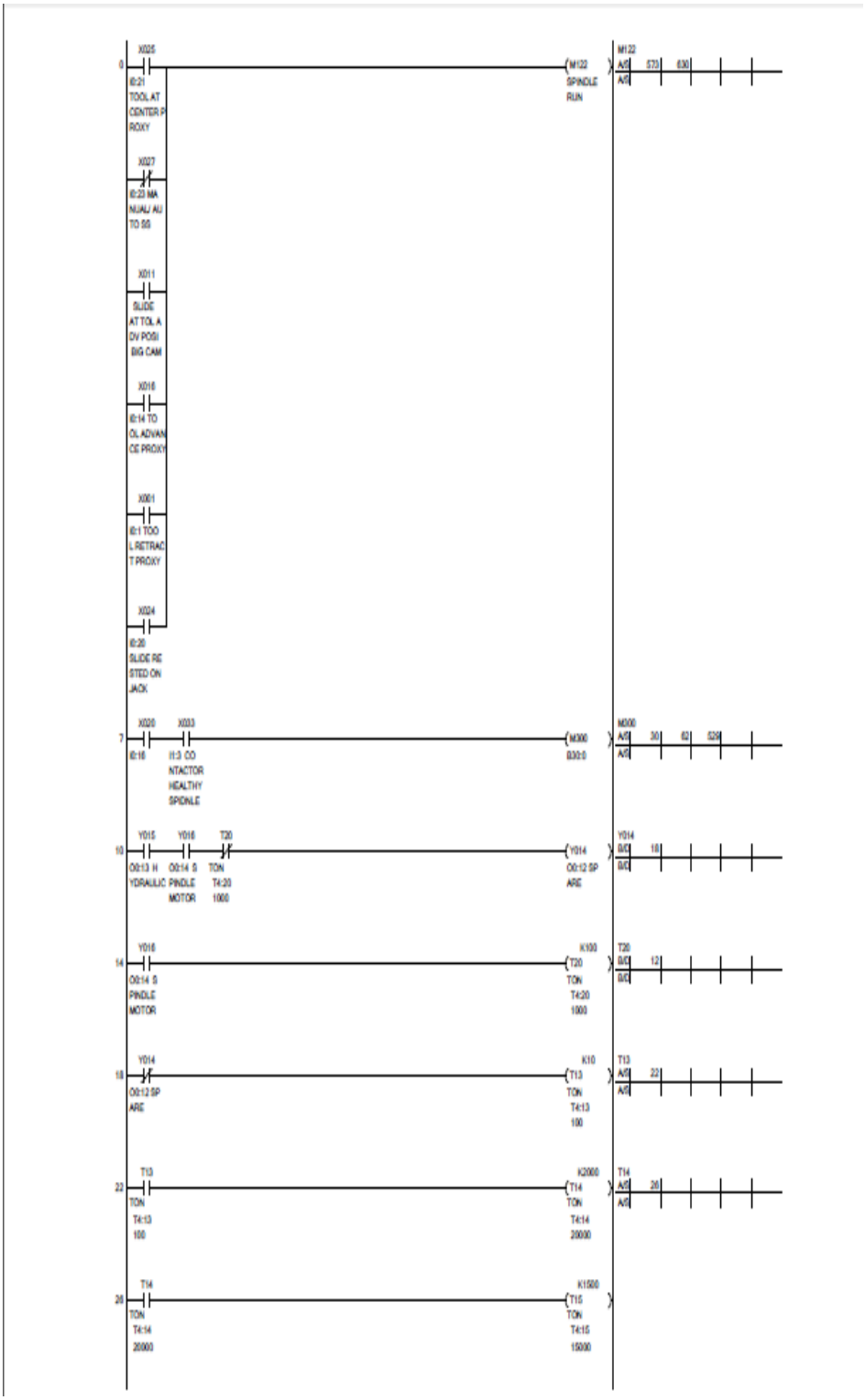

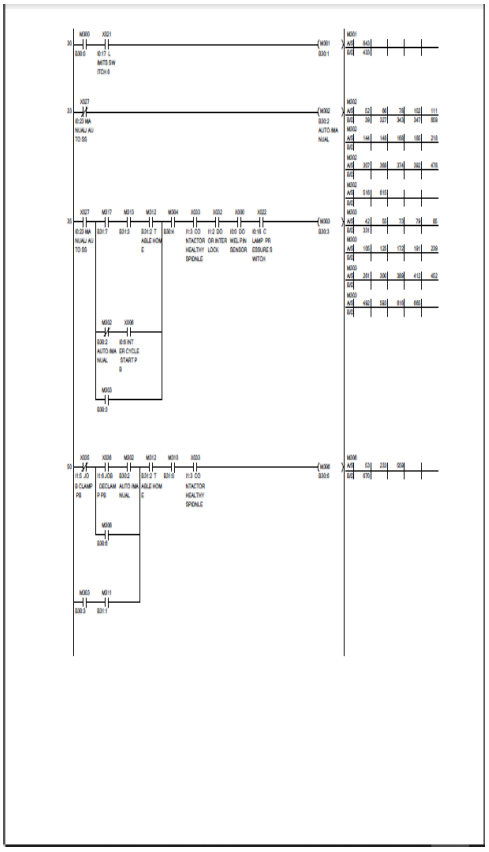

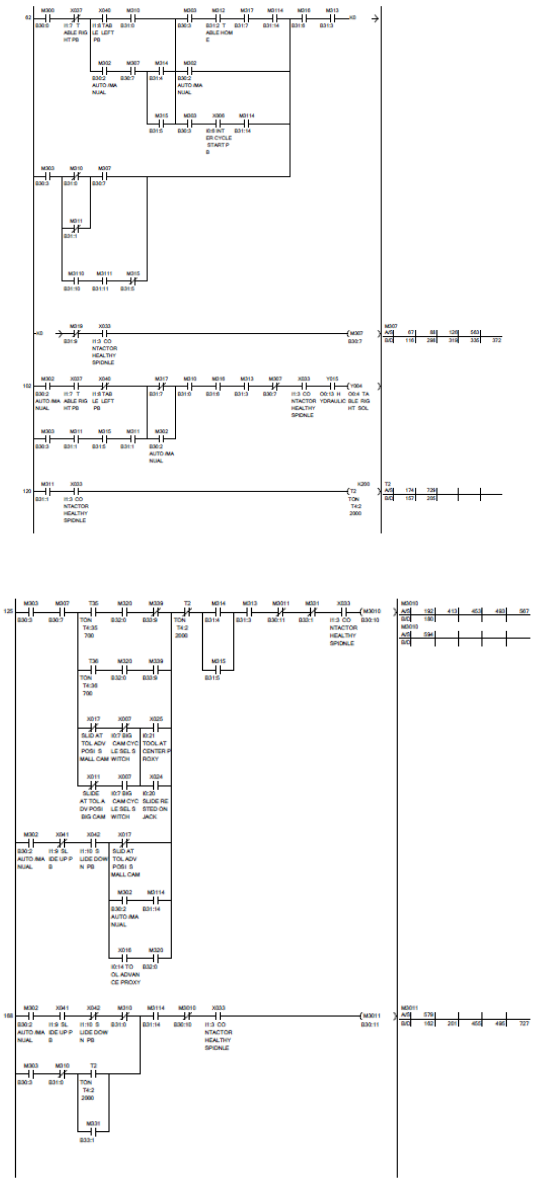

Fig. 3 ladder for PLC

VI. RESULTS

Thus a simple and manual operated machines are used for boring process, which is time consuming and several labour power is required which was the disadvantage in terms of labour, production and maintenance. These machines becomes phenomenally productive and flexible by retrofitting them with automated controllers. Upgrading the old machines restore them close to their original performance levels. The concept of remanufacturing machine tools is emerging. These are cost effective solutions of automation (on PLC based control systems) are equally beneficial to the small, medium and large industries. This project undergoes automation which is controlled by PLC control panel, speed of the motors used for boring and milling controlled by the servo drives. Thus the entire PLC of the machine was retrofitted with a reliable PLC system of MITSUBISHI. Trials will be taken to test the working of the machine. This would ensure the proper working of the machine in the future.

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