DESIGN AND FABRICATION OF AUTOMATIC PLASTIC PIPE CUTTING MACHINE

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Abstract

The Automation of processes plays a crucial role in improving the overall productivity of Industry. This paper give idea about the live industrial problem of EXCEL INDUSTRIES. It is the electrically automated, mechanically designed model of automatic plastic pipe cutting machine. The main aim is to improve the overall productivity by decreasing the manpower cost, utility cost and improving quality and quantity of production. Quality of production is improved by making the manual cutting operation fully automated ensuring the repeatability of the process with accuracy and precision. This ensures elimination of human error and monotonous work. Quantity of production is improved by avoiding manual delays and achieve quick response time of machine. It also focuses on optimum use of power provided for cutting operation.

Key Words : CREO software, Logical sequential control.

1. Introduction

This is an era of automation where it is broadly defined as replacement of manual effort by mechanical power in all degrees of automation. The operation remains an essential part of the system although with changing demands on physical input as the degree of mechanization is increased. Automation of processes plays an important role in increasing the productivity of the industry. The productivity is increased by following ways:

- Decrease in the labour involvement
- Reduction in the machining time
- Elimination of human errors
- Improvement in product quality
- Reduction in scrap
- High production rate
- Improved working conditions for personnel[1].

2. Automation

Automation can be achieved through computers, hydraulics, pneumatics, robotics, etc., of these sources, pneumatics form an attractive medium for low cost automation[2]. The main advantages of all pneumatic systems are economy and simplicity. Automation plays an important role in mass production. Automation is the process of monitoring, controlling and manipulating the process by using technologies such as software, logic control and Robotics[3].

Automation utilities:

- Electrical automated system decreases human efforts and cost
- Logical control unit increases the repeatability, accuracy and precision of the system
- Elimination of human errors results in improved quality output
- Quick response time of system helps to achieve high production rates
- Highly accurate machined products decreases the scrap and material cost
- Decrease in monotony of work[5].

The electrical system of the model consists of three motors. First motor actuates the stopper mechanism which controls the length of work piece. Second motor drives the Variable diameter selector which selects the desired diameter. Third motor is the universal motor which drives the rollers of the feeder mechanism. Solenoid valve which controls the reciprocating movement of piston of the cylinder is interfaced with the logic controller[4]. The entire system is interfaced with logic sequential controller which ensures automatic sequencing of operations with repeatability, accuracy and precision[8].

3. Material

A. Power Hack Saw Blade Material

The material of the cutting blade used is High Speed Steel. The properties of high speed steel are:

- Hardness: 65 HRC[3].
- Permissible stress: 900 MPA[3].

ATube Material

The material of the workpiece to be machined is Polyurethane. The desired dimensions of the workpiece are:

- Max length : 70mm
- Min length : 30mm
- Max dia: 6mm
- Min dia: 2mm

Fig 1 : Sample Workpiece dimensions

4. Working

A. Controlled Power Supply

The 230Volts AC supply is given to the step down transformer which steps down the voltage to 24 Volts AC. To convert this AC voltage to DC voltage, the full wave bridge rectifier circuit is used which consists of IN4007 diodes of 6 ampere current rating. It converts the AC voltage into pulsating DC voltage. To convert this pulsating DC to pure DC a filter is used. The filter is basically an electrolytic capacitor with ratings 63 Volts and 2200 micro farad. Three voltage regulators are used to get the desired level of voltages at output. The 7812 regulator gives a voltage of 12Volts, the 7805 regulator gives a voltage of 5Volts and the 7824 regulator gives a voltage of 24Volts.

Fig. 2 : Block diagram of Controlled power supply supplying power to each of the system mechanisms.

B. Solenoid Controlled Piston Cylinder Arrangement

The solenoid valve is given a voltage of 24Volts from the 7824 regulator in the controlled power supply. The mechanism consists of a 5/2 solenoid valve which controls the supply of pressurised air for the cutting and retraction strokes of the cylinder. The 5 ports in the solenoid valve are 1 inlet, 2 outlet and 2 exhaust ports.

Working of solenoid control valve: In position 1 of the solenoid valve the inlet is connected to the piston side which makes it move in the downward direction and the cutting action is performed. During this action the other side is connected to exhaust port 2 which releases all the air in the rod side chamber. In position 2 of the solenoid valve the inlet side is connected to rod side and the supply of pressurised air causes retraction stroke and the exhaust air is forced out through the exhaust port 1. Position 1 of the solenoid valve is the normal position but when the coil is activated it is shifted to position 2. After the coil is deactivated the valve will return to position 1 because of the spring return mechanism.

Fig. 3 : Positions of Solenoid Valve

C. Stopper Mechanism

This mechanism takes care of the length of the workpiece that has to be obtained by varying the distance of the stopper. The stopper mechanism consists of a motor that can rotate at 10RPM in both clockwise and anticlockwise direction. The rotating motor is connected to a lead screw which moves forward and backward because of the rotation it is given. A clockwise rotation makes the screw move forward and anticlockwise rotation makes it move backwards. This rotation is controlled by switches provided on the apparatus and the screw can be made to stop at any desired position. The mechanism also consists of limit switches which do not let the screw move after the extreme position has been reached. As soon as the extreme position is reached the limit switch cuts off the power supply to the motor.

Fig. 4 : Stopper Lead screw

D. Cutting Mechanism

The cutter used in the model is a power hack saw cutter which has high strength. Here for having a straight cut, the workpiece needs to be held firmly. This is achieved by providing platforms above and below the workpiece. The platform below the workpiece is fixed whereas the platform above moves with the cutter. As soon as the cutting stroke starts first there will be contact of workpiece with the top platform and it goes on tightening as the piston moves downward. The tightening is only done to an extent such that there is no excessive compression of the pipe and so that the workpiece does not move during cutting action and there is a straight cut. This tightening is achieved with the help of springs which also provide the cushioning effect.

E. Sequential Logic Controller [2].

It is a highly reliable and highly accurate industry level controller. The purpose of this controller is to see to it that each of the operation is carried out in the specified order. The special features provided by the controller are:

HOLD

When the slide switch on the front panel is kept in the hold position, the Timing data is retained in case of power failure. Upon resumption of power the timing continues from the point where it has stopped.

RESTART

When the slide switch is kept in the restart position, the timer resets in case of power failure and starts from beginning upon power resumption.

EXTERNAL START

By shorting terminals S1 and S2 for minimum period of 120 milliseconds (potential free shorting) or by keeping S1 and S2 permanently shorted, the timer sequence is initiated.

SINGLE CYCLE OPERATION

By keeping the terminals C1 and C2 shorted (potential Free) on the front panel, the sequential switching of output is executed for one Cycle and stops.

CYCLIC OPERATION

By keeping the terminals C1 and C2 on the front panel open, the Sequential switching of outputs keeps repeating after the end of each cycle.

INHIBIT

By shorting terminals I1 and I2 (potential free) on the front panel, status of relays/triac output (ON or OFF) is maintained irrespective of the program timing. By removing the short, the programmed timing continues and relay / triac respond as per the pre-programmed timings.

CYCLE COMPLETE OUTPUT

This feature namely an opto coupled output signal from terminals O1 and O2 is available at the end of one switching sequence. This signal is intended for cascading one or more units to increase the number of output channels.

ONLINE PROGRAMMING

This facility is provided only in model ST10 wherein it permits the user to change the program online by setting the switches in "PROG" position making the required changes in timing and implementing the same, for the cycle in progress.

Fig. 5 : Interface of Sequential Controller

1 SEQUENCE

This button is used to select the required output / channel to program the timing.

2 ON / OFF

This button is used to select the ON time and OFF time for particular output / channel

3 RANGE

This button is used to select the desired time range (SEC/SEC, MIN/SEC, and HRS/MIN)

4,5 ADV

These buttons are used to increment the time range digits

6 PROG/RUN

This switch is used to select the mode of operation (for

programming PROG mode& for running timer RUN mode)

7 RESTART/HOLD

This switch is used to select the RESTART or HOLD mode.

8 DISPLAY

It displays the relay number which is in function.

9, 14 INDICATOR

It is the indicator for ON time and OFF time.

10, 11 & 12 INDICATORS

It indicates the different time combinations

13 DISPLAYS

It displays the time combination.

15 INDICATORS

It indicates the relay on function.

A1, A2: Power

S1, S2: External Start

C1, C2: Single Cycle or Cyclic operation selection terminal (SHORT single cycle, OPEN for Cyclic operation)

O1, O2: Output for cascade mode operation

I1, I2: Inhibit terminals

RLY0 TO RLY9: Normally open relay contacts (for ST10, ST10-M1)

RLY0 TO RLY5: Normally open relays contacts (for ST6-M1)

OP0 TO OP9: Triac outputs (for ST10-M2)

CREO MODEL

Fig. 6 : Creo Model of the system

5. Results

Pipe cutting, or pipe profiling, is a mechanized industrial process that removes material from pipe or tube to create a desired. The net cost of machining is reduced by improving output, efficiency and effectiveness. The machined products have improved quality. Total production increases for same inputs. Reduction in loss of

material. Easy handling of machine. This shows elimination of human error and monotonous work. Total output is improved by avoiding manual delays and achieve quick response time of machine. It also found that optimum use of power provided for cutting operation.

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