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Research Article

STOCKER CONVEYOR USING PROGRAMMABLE LOGIC CONTROLLER

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ABSTRACT

This paper presents the idea behind the implementation of stocker conveyor machine with the use of Programmable Logic Controller (PLC) in the automation industry. The main idea behind this machine is to design a conveyor system that conveys the unfinished jobs by loading on the pallet through indexing to gear Hobbing machine. Basic PLC functions like timing, sequencing and controlling were implemented. The hardware contains lifter and stoppers. Induction motors were used for conveyor and lifter while hydraulic cylinders were used for operating the stoppers. Operation of motors and cylinders is completely automated using PLC. The result shows that the machine gives the unfinished job to Hobbing machine one at a time and also receives the finished job from latter in synchronization.

INTRODUCTION

In the manufacturing of a product, the product is usually processed at many workstations or processing machines. The transporting or conveying of partially-finished products, or work-in-process (WIP) parts, is an important aspect of the total manufacturing process.

Stocker conveyor is hydraulic machinery that uses liquid fluid power to do simple work. In this machine, hydraulic fluid is transmitted throughout the machine to various hydraulic cylinders, the fluid being pressurized according to the required resistance. The fluid is controlled directly or automatically by control valves and distributed through hoses and tubes. Hydraulic machinery was used here due to the fact that very large amount of power that can be transferred through small tubes and flexible hoses which is required for lifting the pallet and stopping all the pallets present on the conveyor.

In 1968, the Hydra-Matic of General Motors requested proposals for an electronic replacement for hard-wired relay systems. The winning proposal came from Bedford Associates with their 084 project. The 084 was a digital controller made to be tolerant to plant floor conditions, and was latter known as a Programmable Logic Controller, or simply PLC [1].

The logic controller is a miniature computer that controls equipment in real time according to the pre-programmed set of instructions. A good definition of real time is "any information processing activity or system which has to respond to externally generated input stimuli within a finite and specified period" [2]. Here it receives inputs from the inductive sensor, proximity sensor, pushbuttons, emergency stop, selector switch and interfacing machine. There are many accepted languages to program a PLC, but the most widely used is called ladder logic, which follows the IEC 61131–3 standard [3]. After processing the inputs, the corresponding controlling instruction from CPU is converted into an output signal that drives the solenoid coils, motor controllers, indicating lamp and buzzer.

Mechanical Assembly of Machine

It consists of following sub-assemblies:

1. Pallet Assembly
2. Main Frame Assembly
3. Chain Guide Assembly
4. Lifter Assembly
5. Stopper Assembly.

Pallet Assembly

A pallet is a flat transport structure that supports the job in a stable fashion while being lifted by the lifter. Here aluminum pallets were used due to its lightweight property. A single job is placed on each pallet.

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Main Frame Assembly

The main frame structure of the conveyor is made of Mild Steel (MS) due to its immense strength, flexibility (it can bend without cracking) and its ductility.

Stocker conveyor is a type of chain link conveyor which consists of a series of journal bearings that are held together by constraining link plates. Each bearing consists of a pin and a bush on which the chain roller revolves.

Chain Guide Assembly

Wear Strip is commonly used as guide rails or support members under belting or tabletop chain because of the advantages provides like Low Friction Surface, High Chemical Resistance, and No Liquid Adsorption. Here UHMW (Ultra High Molecular Weight polyethylene) Guide rail was used which is an extremely tough plastic with high abrasion and wear resistance.

Lifter Assembly

The job of the lifter is to lift the pallet with the unfinished job and give it to the Hobbing machine and take the finished job from latter. Before the lifter lifts the pallet it should ensure that pallet has properly been interlocked on the lifter and while coming down it should ensure proper placement of finished job on the pallet.

Stopper Assembly

It is used to stop the pallets on the conveyor while the conveyor is moving if lifter station is busy. It allows accumulating pallets on conveyor. It ensures that only one pallet reaches the lifer at a time.

Electrical Assembly of Machine

It includes selection of switch gears, motor controllers, sensors, indicators, PLC etc. with proper current and voltage ratings (depending upon the power rating of each electrical component).

Few components that were used here are:

- PLC: its selection was done on the basis of inputs and outputs required while considering speed of operation, memory of PLC and machine requirement.
- SMPS: to convert single phase A.C. into 24V dc required for powering PLC and sensors.
- Control relay: to isolate power circuitry from control circuit.
- MCB: To protect the circuit from short circuit and overload current.
- VFD: To control the speed of conveyor and lifter motor.
- Proximity Sensor: To determine whether pallet is carrying finished or unfinished jobs.
- Inductive Sensors: To detect the presence of pallet on conveyor and job on pallet at lifter and stopper assembly.
- Indicator lamp: to indicate various operations of machine like incoming three phase supply, conveyor on etc.
- Pushbuttons: for manually operating the machine.
- Two tier tower lamp with buzzer: for healthy and fault indication of motor.

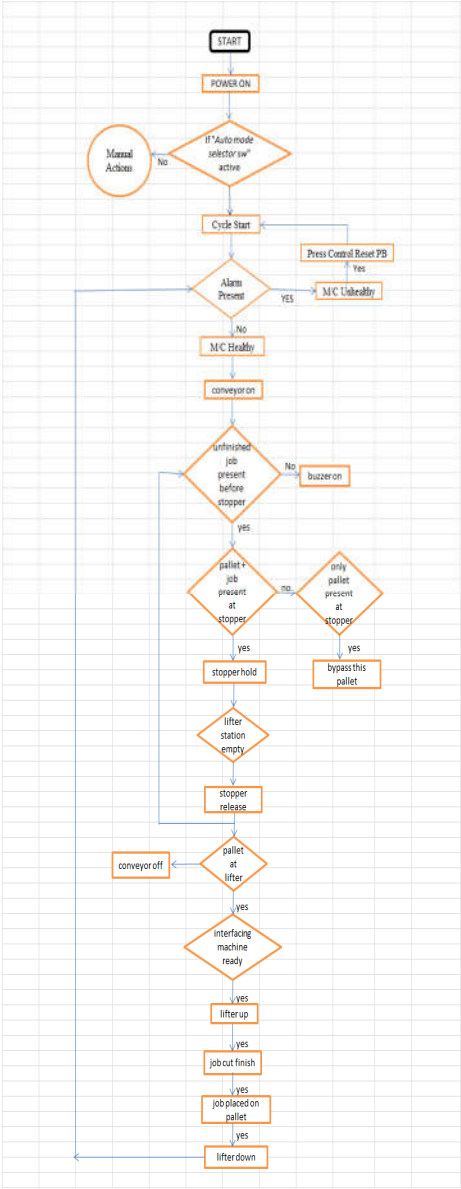
Observations

The machine is started by pressing the start push-button. The conveyor starts immediately after this. The jobs are loaded on the pallet manually.

The proximity sensor is correctly able to distinguish between finished and unfinished jobs on pallets. If finished job reaches near the stopper, then the machine stops. Red tower light with buzzer indicate this condition.

The inductive sensors sense the presence of pallet and job at stopper and lifter. If pallet at lifter does not have a job on it, then the lifter station bypasses it.

Flowchart



Lifter does not lift itself until the interfacing machine is ready and pallet is present there.

When machine is working properly, it is indicated by green tower lamp.

CONCLUSION

The machine is working properly as per the required application. The cycle time for each pallet can be changed by changing the frequency of conveyor and lifter motor.

This machine can be used for other applications too where any product has to be conveyed from one work station to another. The PLC is a type of micro-processor which has on board memory for storing programs. The programming language used by it is known as 'ladder logic'. The PLC processes the inputs according to the logic fed in controller and drives the corresponding outputs.

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