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Design of Auto Height Check Machine Control System Based on PLC to Improve Quality the Complete Piston Rod Assembly Process

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Abstract

This paper discusses research on improving the quality of the complete piston rod assembly process which is part of the OCU (Oil Cushion Unit) or rear assembly process. The complete piston rod functions to regulate fluid circulation when OCU experiences compression and rebound. The complete piston rod assembly process is a process of combining piston rods, dust seals, oil seals, rod guides, sub springs, valve stopper, leaf springs, non-return valves, leaf valves, special washer, pistons, and piston rings. A non-return valve, leaf valve, and special washer are thin circular plates. The part that has been assembled is checked in number and composition according to the standard. The problem in the complete piston rod assembly process is when the operator counts the number of non-return valves, leaf valves, and special washer according to the required amount. This is because of its very thin size and stickiness. Errors in the number of non-return valves, leaf valves, and special washer assembled will cause the complete piston rod to reject. Therefore, this study aims to provide a solution to these problems, namely designing an auto height check machine. This machine functions to check the number of non-return valves, leaf valves, and a special washer that has been assembled accurately. The auto height check machine control uses the Omron CJ1M-CPU11 PLC (Programmable Logic Controller) that is communicated with the Omron NS5-SQ10B-V2 HMI (Human Machine Interface). Input devices used are pushbuttons, selector switches, state switches, reed switches, emergency stops, and smart sensors. The output devices used are tower lamps and solenoid valves. Checking the number of non-return valves, leaf valves, and special washer using smart sensors. The result obtained after the existence of the auto height check machine is the reduction in the number of the complete piston rod which rejects from 5 pieces per day to 0 pieces per day.

Keywords : non-return valve, leaf valve, a special washer, mesin auto height check, PLC

1. Introduction

This research was conducted at one of the manufacturing industry companies in the field of automotive components with the main product being a shock absorber. The shock absorber is one component in two-wheeled vehicles and four-wheeled vehicles that function as vibration dampers. In two-wheeled vehicles, shock absorber can be divided into two types, namely: Front Fork (front) and Oil Cushion Unit (rear).

In the OCU assembly process, several stages occur, namely: sub assembly, assembly damper and mounting assy. Sub assembly is a line where the internal components of OCU are assembled. One of the processes contained in the line sub assembly is the complete piston rod assembly process. The complete piston rod functions to regulate fluid circulation when OCU experiences compression and rebound. The complete piston rod assembly process is a process of combining piston rods, dust seals, oil seals, rod guides, sub springs, valve stopper, leaf springs, non-return valves, leaf valves, special washer, pistons, and piston rings. A non-return valve, leaf valve, and special washer are thin circular plates. The part that has been assembled is checked in number and composition according to standard. When checking the operator has difficulty in calculating the number of the non-return valve, leaf valve, and special washer according to the amount needed because of its very thin size and stickiness. Errors in the number of non-return valves, leaf valves, and special washer assembled will cause the complete piston rod to reject.

Based on a request from the customer to replace the non-return valve, leaf valve, and special washer checking process which is still manual and to avoid mistakes in the complete piston rod (human error) checking process, so an auto height check machine is made. This machine functions to check the number of non-return valves, leaf valves, and a special washer that has been assembled accurately.

Some studies and research related to the design of this control system, namely the use of PLCs for various control systems, including (Alexander Fay, et.all, 2015); (Gökhan Gelena, Murat Uzamb, 2014). In addition, he has conducted various researches related to the use of PLCs as a control system and HMI, for various systems and machinery, especially in the area of manufacturing and automotive industries, including: (Ardi, S .; Defi, W.Y, 2018); (Ardi, S., Cascarine, L.T, 2018); (Ardi, S., Tommy, M.I., Afianto, 2018); (Ardi, S., Nugraha, Z.A, 2018); (Ardi, S., Ardyansyah, D, 2018); (Ardi, S., Ponco, A., Latief, R.A. 2017); (Ardi, S., Abdurrahman, H, 2017); (Ardi, S., Al-Rasyid, A, 2016). Furthermore, this research is focused on the design of a system that can control the machine auto height check on the complete piston rod assembly process. With the PLC controller and communicate with the HMI (Human Machine Interface).

2. **Methodology**

2.1 Product Introduction

The shock absorber or shock absorber is a tool to reduce vibrations that occur in two-wheeled vehicles or four-wheeled vehicles so that motorists are easier and more comfortable in controlling their vehicles. Fig. 1 shows the shock absorber.

Fig. 1: Shock absorber (a) SA Standard (b) OCU (c) Strut (d) Front Fork

In two-wheeled vehicles, shock absorber (SA) can be divided into 2 types, namely Oil Cushion Unit (OCU) and Front Fork. OCU is used at the rear of the vehicle and Front Fork is used at the front of the vehicle. Whereas in four-wheeled vehicles, there are types of SA Standard and Strut. In the shock absorber system on four-wheeled vehicles, the SA Standard type shock absorber is used at the rear of the vehicle and Strut type is used at the front of the vehicle. Besides functioning as a silencer, OCU and Strut shock absorbers also function as a vehicle body support.

2.2 Problem Solution

Based on the problems that exist in the complete piston rod checking process and the request from the customer to replace the non-return valve, leaf valve, and special washer checking process that is still manual, the solution to solve the problem, namely: made a machine that can check the number of non-return valve, leaf valve and special washer that has been assembled accurately.

Expected Machine Specifications are:

- The machine must be able to check the number of non-return valves, leaf valves, and a special washer that has been assembled accurately.
- The non-return valve, leaf valve, and special washer checking system uses the smart sensor type inductive sensor. Smart sensors are used to check the number of non-return valves, leaf valves, and a special washer that has been assembled. The checking method is carried out by measuring the thick dimensions of the number of non-return valves, leaf valves, and a special washer that has been assembled.
- The machine must be equipped with HMI. This aims to facilitate the user in monitoring.
- The machine must be equipped with a tower lamp. This is to find out the results of checking good or not good.
- The machine must be equipped with an emergency stop button. This button is used to stop the machine immediately. This is to avoid work accidents on the operator and the machine.

3. **Design and Testing**

3.1 Auto Height Check Machine Design

Fig. 2 shows the auto height check machine design. The location of the actuator, input device, and output device are used more clearly can be seen in area 1, area 2, and area 3

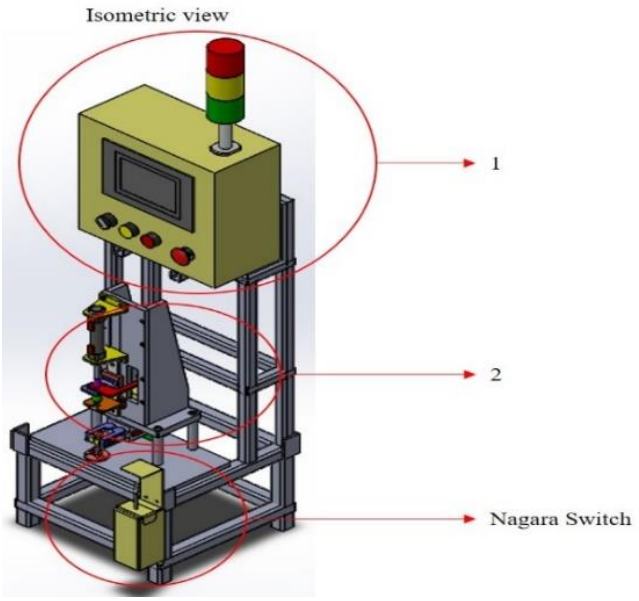

Fig. 2: Auto height check machine

3.2 Electrical System Design: PLC wiring, HMI, and power supply with power supply

Fig. 3 shows the wiring of PLC, HMI, and power supply. The main voltage source used is AC 220V. This voltage source is then connected to the PLC and power supply. The power supply will change the AC voltage to 220V to DC 24V. The 24V DC voltage is then used to turn on the HMI.

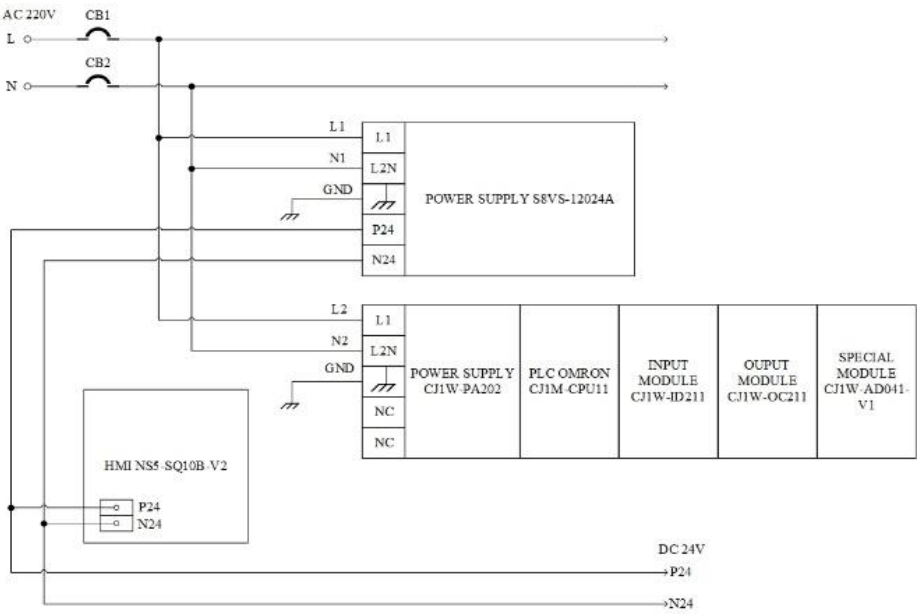

Fig. 3: Wiring of PLC, HMI, and power supply

Wiring input components with PLC
It is a process of connecting input components with PLC. Input components that function to provide input will be connected to the PLC with certain addresses through the CJ1W-ID211 input module.

Wiring the output component with PLC
It is a process of connecting the output components with a PLC. The output component will be connected to the PLC with certain addresses via the CJ1W-OC211 output module. The output component is an embodiment of the program algorithm.

Smart sensor wiring with PLC
The smart sensor used is a smart sensor with an inductive sensor type. Smart sensors are activated with a voltage of DC 24V from the power supply. The way to connect a smart sensor with a PLC is to use the special module CJ1W-AD041-V1. Special module functions to convert analog data into binary data that can be processed by a PLC processor. Fig. 4 shows the wiring between the smart sensor and the PLC special module.

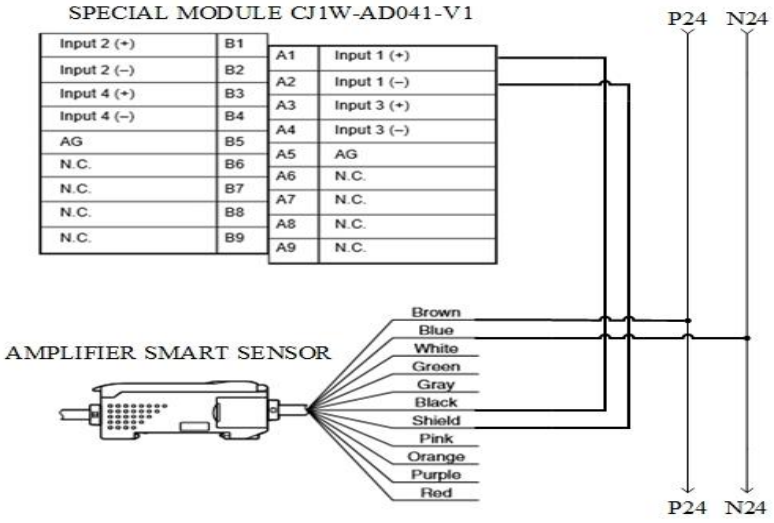

Fig. 4: The wiring between the smart sensor and the PLC special module

3.3 Testing

PLC input Testing
How to test the PLC input can be done in 2 ways, namely by connecting the PLC with a personal computer (PC) through monitoring mode or can see directly through the status of LEDs that are on the PLC. Testing is done by pressing the push button, rotating the selector switch and activating the smart sensor. The OK parameter when testing the input is if the sensor, push button, selector switch, or another input device that is given a trigger or pressed will turn on the input contacts in the CX-Programmer monitoring mode according to the address of the input device respectively. OK, when the Input component is activated and the input contact is in active monitoring mode. NG parameter, i.e. when the Input component is activated and the input contact in monitoring mode is inactive.

PLC output Testing
How to test the PLC output can be done by connecting the PLC with a personal computer (PC) through monitoring mode and can see directly through the status of LEDs that are on the PLC and by seeing changes or movement of the actuator used. The OK, when the output of the contacts in monitoring mode is activated and the output component is active. The NG parameter, i.e. when the Contacts output in monitoring mode is activated and the output component is inactive.

4. Results

The results obtained from the manufacture of auto height check machines include a decrease in the time of the complete piston rod assembly process, from 11 seconds to 9 seconds; a decline in the number of rejecting the complete piston rod from 5 pieces a day to 0 pieces per day. This data is taken based on OCU assembly production data and test results. The making of an auto height check machine gives good results to the complete piston rod checking process so that the results obtained from the checking process are more accurate.

5. Conclusion

In this paper, the design and manufacture of an automatic height check machine control system have been used using the Omron CJ1M-CPU11 PLC which is communicated with the Omron NS5-SQ10B-V2 HMI. Input devices used are push-buttons, selector switches, state switches, reed switches, emergency stops, and smart sensors. While the output devices used are tower lamp and solenoid valve. PLC as the brain of the auto height check machine regulates the input and output devices to produce a machine that can check the number of non-return valves, leaf valves, and a special washer that has been assembled accurately. Checking the number of non-return valves, leaf valves, and special washer uses smart sensors. The result obtained after the existence of an auto height check machine is the reduction in the number of the complete piston rod which rejects from 5 pcs per day to 0 pcs per day. For further research, this auto height check machine can add a buzzer alarm, so in the event of an error, an operator can immediately find out.

6. Acknowledgment

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7. References

SMC. 2007. Reed Switch AutoSW Band Mounting Style.

Yves dan Fiset J. 2009. Human-Machine Interface Design for Process Control Applications.

Alexander Fay, et.all. 2015. Enhancing a model-based engineering approach for distributed manufacturing automation systems with characteristics and design patterns. The Journal of Systems and Software 101, 221–235.

Gökhan Gelena, Murat Uzamb. 2014. The synthesis and PLC implementation of hybrid modular supervisors for real time control of an experimental manufacturing system. Journal of Manufacturing Systems 33, 535–550.

Ardi, S.; Defi, W.Y. 2018. Control Systems Modification of Loading and Unloading in Oil Filling Machine Based on Programmable Logic Controller at Manufacturing Industry. AIP Conference Proceedings 2021, 060029.

Ardi, S., Cascarine, L.T. 2018. Design Control System of Auto Air Remaining Machine based on Programmable Logic Controller in the Automotive Manufacturing Industry. MATEC Web Conf., Volume 197, 2018, The 3rd Annual Applied Science and Engineering Conference (AASEC 2018).

Ardi, S., Tommy, M.I., Afianto. 2018. Automation of Waste Treatment on the Washer Machine Based on PLC Control System in the Manufacturing Industry. July 2018.

Ardi, S., Nugraha, Z.A. 2018. Design Control System of Washing Oil Pan Machine Based on PLC in the Automotive Manufacturing Industry. Published in: 2018 International Conference on Electrical Engineering and Informatics (ICELTICs)

Date of Conference: 19-20 Sept. 2018, Date Added to IEEE Xplore: 29 November 2018, INSPEC Accession Number: 18290112.

Ardi, S., Ardyansyah, D. 2018. Design Control Systems of Human Machine Interface in the NTVS-2894 Seat Grinder Machine to Increase the Productivity. IOP Conference Series: Materials Science and Engineering, 306 (1), 012112, (2018).

Ardi, S., Ponco, A., Latief, R.A. 2017. Design of integrated SCADA systems in piston production manufacturing case study on the conveyor, the coolant, the hydraulic, and the alarm systems using PLC. IEEE Xplore, 187 – 191.

Ardi, S., H Abdurrahman. 2017. Design of pokayoke systems to increase the efficiency of function check oxygen sensor machine using programmable logic controller in manufacturing industry, IEEE Xplore, 192 – 196.

Ardi, S., Al-Rasyid, A. 2016. Design of Pokayoke Sensor Systems in Drill Oil Hole Machine to Detect the Presence of Drill using Programmable Logic Controller. Advanced Science Letters 22(7), pp. 1813-1816.