Pokayoke Control System Design using Programmable Logic Controller (PLC) on Station Final Check Propeller Shaft

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Abstract

Propeller Shaft is a part of the car that serves to move round from the transmission to the rear wheel axle connection. Demand for the purchase of four-wheel vehicles increases and the demand for parts is increases too. One part that is needed is the propeller shaft therefore; PT BC will make improvements in all aspects. At the plant in line propeller shaft final check constraints often occur in the production process such as error detecting specific propeller shaft IMV models at the model and barcode marking model. To eliminate errors made during the process of marking a device that pokayoke control system that uses a system of Programmable Logic Controller (PLC) and programmed according to the Input and Output of the PLC. In addition, pokayoke system in final check tool can eliminate errors in the marking in propeller shaft. The tool can be used in final check and function in accordance with the process works.

Keywords: Propeller Shaft, Programmable Logic Controller (PLC), pokayoke

1. Introduction

PT BC is a manufacturing company which is engaged in the manufacture of automotive components, specialized manufacturing Rear Axle, Propeller Shaft and Transmission assembly. Broadly speaking, the production process includes: Machining Welding (Welding), Painting (Painting) and Assembling (Assembly).

The demand for the purchase of four-wheel vehicles increases and the demand for parts increases too. One part that is needed is the Propeller Shaft and PT. BC will make improvements in all aspects with respect to Quality, Cost, Delivery, Safety, and Morale.

Error detection is often the one issue that must be resolved to a process. If this is left unchecked, this situation will result in Line Stop because it obstructed the process which has an error. In addition, if the quality of the product NG (Not Good) the absolute error should be resolved. Control error any period of time can be used as a reference to determine whether there is a buildup in the Line.

In Line Propeller Shaft Final Check Category 1, the common constraints often occur in the production process. Among specific error detecting Propeller Shaft IMV models at the model and Barcode Marking model. With the ever-increasing production demands, to solve this problem, it should be resolved quickly because it will result in Line Stop on the Line.

Based on the above conditions can be formulated that the subject matter is an error detecting propeller shaft type IMV, the formulation of the problem to be addressed is the following: How the pokayoke electrical control system adapted to the order of the operator. How to make MITSUBISHI FX PLC program 3U-64MR-ES/UL so it can be used and functioned according to the desired process. How to add Input Output sensors on clamping barcode when marking the final station in the propeller on the check. Previously, we have researched about control system by using PLC [1, 2, and 3]. In addition, we have also research about communication control using GSM (Global System for Mobile Communication) SIM300C and Microcontroller PIC 16F877 [4].

2. Research Methods

PT. BC is a manufacturing company which is engaged in the manufacture of automotive components, specialized manufacturing Rear Axle, Propeller Shaft and Transmission assembly assy. At the plant there are some one line in three joint propeller shaft line which specialized in producing three joint propeller shaft. Figure 1 shows the three joint propeller shaft installation on the car.

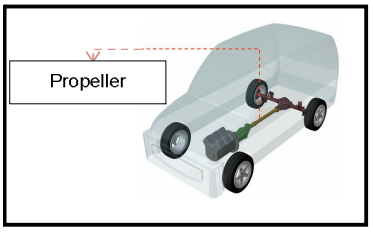

Figure 1. Installation of Propeller Shaft Joint-three in car

2.1 Manufacturing Process of Propeller Shaft

The process of press in the center bearing installation process, the caulking nut tighten and firm the nut on the center bearing mounting. The process of press in the dust cover installation process with center bearing cover, then the sleeve yoke and sleeve yoke assembly sub install is the process of combining the sleeve yoke sub assembly with sleeve yoke install. In the final assembly, this process brings together the products that came out after the dust cover with the pressing and the tightening nut products out of the sleeve yoke and sleeve yoke assembly sub install.

The process of installing the flange yoke, merging with needle bearings, flange yoke sub assembly then the incorporation install the tube yoke, flange yoke, and shaft yoke. Do the balancing load on the part Propeller, mainly differences seen in the side load on the Propeller. Material is used to balance the addition of (Piece Balance) means the addition to the Spot Welding. Machine has the power of 180 kVA, with a maximum rotation speed of 3200 rpm. The process of painting has four parts: the provision of grease filling stage, wiping stages of cleaning propeller with benzene wash, painting stage, and the final stage of checking last inspection products. Figure 2 shows the process flow diagram propeller shaft.

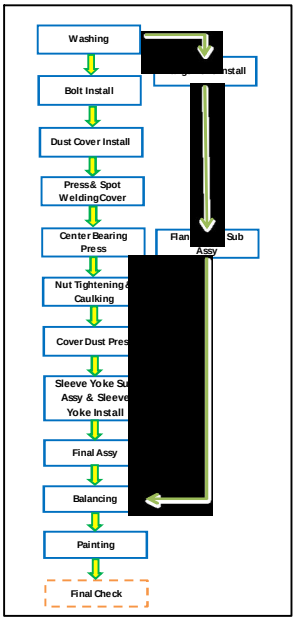

Figure 2. Flowchart of manufacturing process of Propeller Shaft

2.2 Problems in Final Line Check

In the manufacturing process propeller shaft is done automatically unless the process of the final check is still performed manually. Manual process is what causes the cycle time is long, allowing the occurrence of human error. The main process is part detect in the final check, marking process, and barcode clamping. Part detect is the process of checking the existence of objects, marking process is the process of tagging type propeller shaft and clamping barcode is the barcode on the propeller shaft attachment so equally. Part detect at the final check is done so manually that comes the idea to turn the process into a semi-automatic. Additionally, it will make the operator that is comfortable in working. Figure 3 shows the diagram of the final check.

Figure 3. The diagram of the final check

- Part Detect. The part detect process is detecting the type of propeller shaft and propeller shaft total length, because each type of propeller shaft has a different length.
- Marking Process

Marking process in the final check tool is to indicate the type of propeller shaft. In addition to marking, the mark propeller shaft line also marks the final check barcodes that have been installed. In line propeller shaft, red circle is indicated to mark the type of propeller shaft which is blue circle is indicate that the type of tagging has been done. Figure 4 shows the color markings on the propeller shaft. As shown in the white number 1, number 2 for yellow, number 3 for red, 4 for pink, blue number 5 for, and number 6 for green. The six flags on top are used to mark the type - the type of propeller shaft.

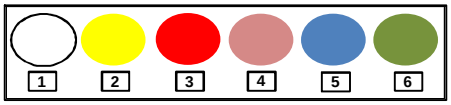

Figure 4. The color marking on the propeller shaft

3. Concept and Design

Figure 5 is the final check that is done manually. In the final check that is still done manually, operator marks the type. The type of propeller shaft relies on tables to see the mark on the propeller shaft. Marking on the propeller shaft is still using markers. When the barcode clamping process, an operator still has to hold the clamping to install the barcode. Figure 5 shows the final manual check.

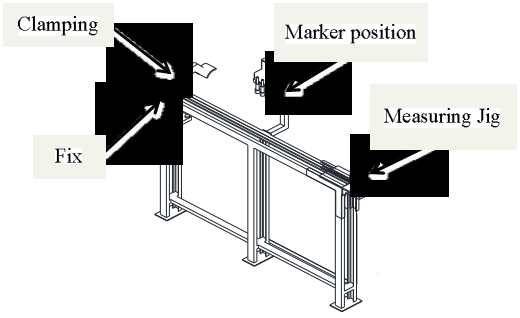

Figure 5. Final Manual Check

Based on the problems described above, then we do the improvement in the process final check. Table 1 shows the comparison of before and after in process final check.

Table 1. The comparison of before and after in process final check

Process	Before	After
Part Detect	Shifting the measuring jig and fixing with the type propeller shaft table	Detecting the type by sensor
Marking Process	using marker	using brash
Barcode Clamping	clamping manually	clamping automatically

In the final check is also added to the system pokayoke. Pokayoke used to prevent operator error when marking on the propeller shaft. Besides pokayoke paired on the final check is also paired andon, which serves to facilitate the operator when the type of propeller shaft that must be marked (marking). Installation andon the final check process is very helpful operator because the operator does not need to see the chart type of tagging propeller shaft.

Based on the concept created earlier, then created an engine design like below. Figure 6 shows the comparison of before and after the final equipment check.

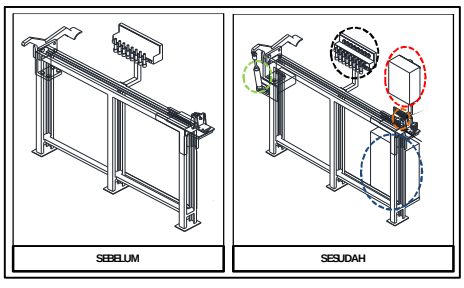

Figure 6. The comparison of before and after the final equipment check.

Table 2. Comparison of the Existing Tools in Process Final Check

Before	After
No Pokayoke system	Using pokayoke system
Manual barcode clamping	using cylinder
No sensor	using sensor
Mark using marker	mark using brush
Operator just relies on table	operator sees andon

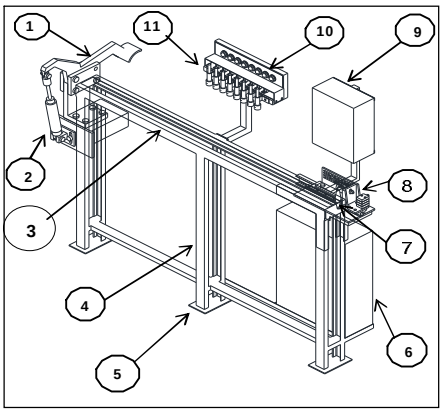

Figure 7. Design of Final Check machine and the parts

Based on Figure 7, Table 3 shows the parts of the final check machine.

Table 3. The parts of Final Check machine

NO	DESCRIPTION	QTY	MATERIAL
1	Silinder	1	
2	*Clamping*	1	S45C
3	Locating Jig	1	SS41
4	Frame Mesin	3	Siku 40X40
5	Sepatu Mesin	3	S45C
6	Main Panel	1	700 X 500 X 300 MM
7	*Handle*	1	SS41
8	*Measuring Jig*	1	*Urethan*
9	Operation Panel	1	700 X 500 X 300 MM
10	Pilot Lamp	8	DR30DOL-E3Y
11	Tempat Kuas	8	SS41

In Table 3, there are several components of the cylinder that serves to make the process of clamping. Clamping is to make the process of attachment of barcode, locating jig the propeller shaft where stored. Frame machine is the framework of the machine.

Shoes machine is functioning base on the chassis engine. Namely Main panel in which there are components such as PLC, terminals, contactors,

relays, noise filter, high speed counters, and power supply. Handle that serves to facilitate measuring jig shift operator. Measuring jig is used to detect the length of the propeller shaft and work weeks to detect the type of propeller shafts, and pilot lamp marking serves to notify the operator propeller shaft. Place brush works for storage, operation panel is to check the operation of the instrument in the final in which there are push buttons, selector switches, emergency stop, annunciate lamp, and buzzer.

3.1 Realization Process of the Machine

Electrical circuit, the figure 8 is a complete wiring drawing. Broadly speaking, the electrical is divided into four sections, namely PLC, input, output, and supporting components. Explanation of figure 8 parts is contained in Table 4.

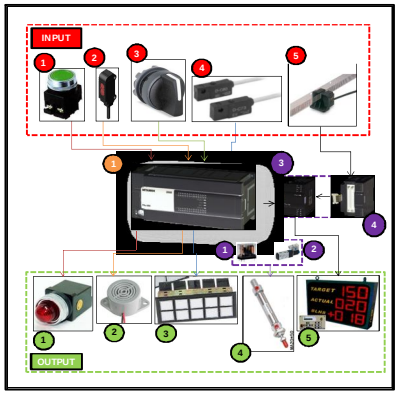

Figure 8. *Wiring Input Output* PLC.

Table 4. Description of figure 8

No	Keterangan	Posisi
1	PLC	Pusat Program
1	Push Buttom	Input
2	Selector Switch	Input
3	Photoelectric	Input
4	Reed Switch	Input
5	Linear Encoder	Input

No	Keterangan	Posisi
1	Pilot Lamp	Output
2	Buzzer	Output
3	Annaunciator Lamp	Output
4	Slinder	Output
5	Andon	Output
1	Relay	Komponen Pendukung
2	Valve	Komponen Pendukung
3	High Speed Counter	Komponen Pendukung
4	High Speed Counter	Komponen Pendukung

In addition, for making control systems, pneumatic systems should also be made, where the wind resource is applied to regulators, then from the Regulator will be streamed to the Solenoid Valve. The wind that flowed into the Solenoid Valve 220V will be channeled into a cylinder to make the process of pressing. Pneumatic system is shown in Figure 9 below.

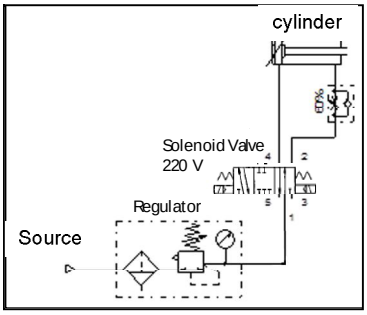

Figure 9. Pneumatic System

3.2 Realization of the Programming

Realization of the programming was first performed to determine the working principle of the machine. The working principle of the machine associated with the work order will be made by the operator. The following sequence of the work done by the tool operator that describes the final check in the form of a flowchart.

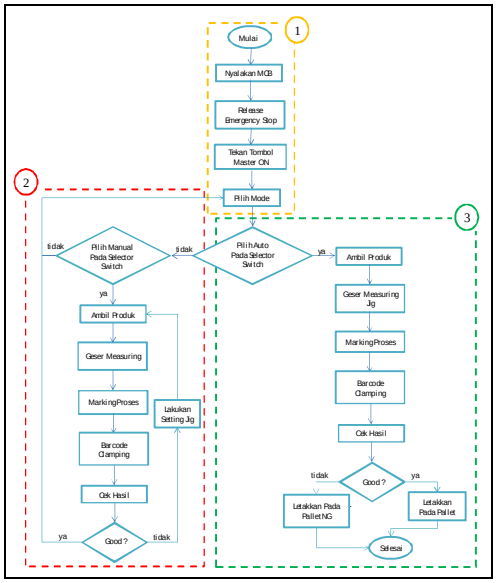

Figure 10. Flowchart of work sequence

Based on the flowchart in Figure 10, the working principle of the machine is divided into 2 parts, the manual work and auto work.

3.3 Work Manual

Flowchart of manual labor process can be seen in figure 10 indicated in point number 2. Manual work is done when the machine was firstly turned on to set up the jig. After the manual operation mode selector switch on, the operator puts the product on a jig machine. The next step, the operator shifts measuring jig to determine the type of propeller shaft. Next, the operator does marking propeller shaft in accordance with the type

of propeller shaft. When it has finished, check the results of tagging (marking) if it is good or not good. Good product if the position expressed tagging (marking) is in conformity with the type of propeller shaft. Size according to type of propeller shafts can be seen in the table in the paste on the final equipment check. If the product has been declared good so the final check of the equipment is ready to perform the automatic mode. If it is not, the operator sets up the measuring jig and checks again to check whether the result is good or is not good.

3.4 Automatic Work

Flowchart automated work processes can be seen in Figure 11 is shown in point number 3. Work will be performed automatically after the process of manual work to get good results. To change the work process to be automated, the operator must rotate the mode selector switch from manual operation to automatic operation mode. Once converted into automatic mode, then the operator put the product on the base of the jig final check. After that, slide measuring jig to make the process of marking and barcode automatic clamping. After marking and barcode clamping process is complete, place the products into pallet which is provided, as shown in figure 11 below.

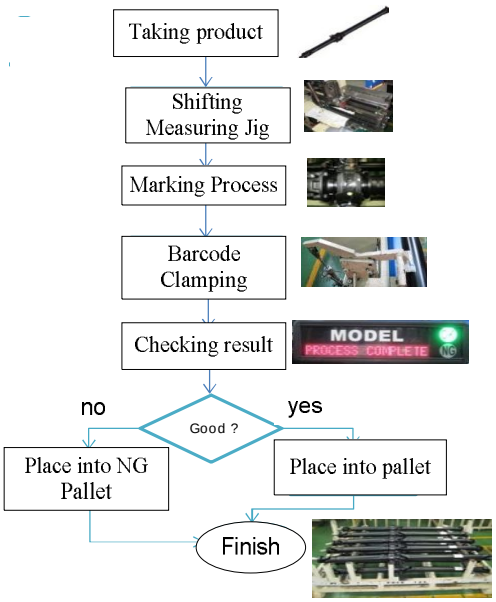

Figure 11. Flowchart automatic work

Based on the order of the operator that has been discussed in the previous section, it was made in the PLC program flowchart to meet the employment standards. The following is flowchart programming of the PLC. Figure 12 shows the flowchart program.

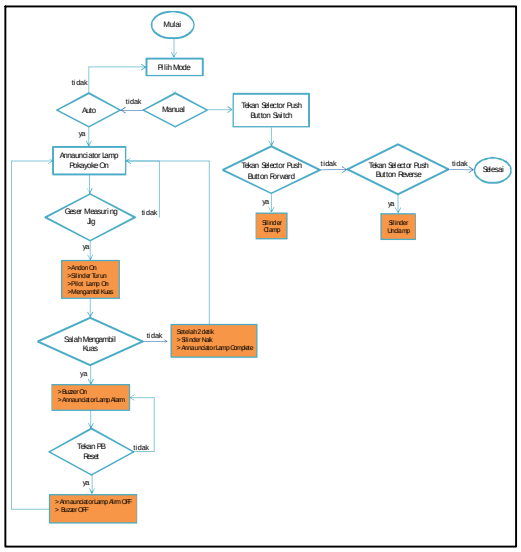

Figure 12. Flowchart of the Programming

4. Results and Discussion

After testing concluded that the final equipment check can be run in accordance with the desired run as desired specifications. On the system of manual or automated same, functions of andon, electric sensors, linear encoder, selector switch, selector push button switches, push button reset, push button master on, emergency stop, cylinder, annaunciator lamp and buzzer is working as expected. In the manual system, the function selector push button switch forward reverse cylinder is functioning as desired. Below is a table of the work function of the final instrument check shown in Table 5.

In Table 5 it can be seen that the final check function tool runs as expected. The results of the products tested by conducting tests with 20 pieces of propeller shaft IMV models. The results of the test can be seen in Table 6.

Table 5. Testing the final check machine

No	Fungsi Kerja	Hasil	
		OK	NG
1	Flow proses yang dibuat sudah sesuai	✓	
2	Proses alat berjalan otomatis jika selector switch diubah ke mode operasi manual	✓	
3	Proses alat berjalan manual jika selector switch diubah ke mode operasi manual	✓	
4	Emergency stop berfungsi menstop sistem saat mesin terjadi kesalahan	✓	
5	Linear encoder dapat menentukan tipe - tipe propeller shaft	✓	
6	Photoelectric sensor aktif apabila kuas disimpan ditempat kuas	✓	
7	Andon berfungsi dan memunculkan tulisan tipe propeller shaft yang harus si tandai	✓	
8	Pilot lamp 8pcs menyala sesuai dengan tipe propeller shaft	✓	
9	Selector push button switch dapat menggerakkan silinder maju/mundur pada saat mode manual	✓	
10	Buzzer aktif ketika terjadi kesalahan pada sistem maupun proses	✓	
11	Silinder dapat bergerak maju/mundur pada saat meng clamp propeller shaft	✓	
12	Alat dapat melakukan marking dan menempelkan barcode ke propeller shaft	✓	

Table 6. The results of the test

Testing propeller shaft IMV							
No	Test	Result		No	Test	Result	
		OK	NG			OK	NG
1	IMV(1)		V	11	IMV(11)	V	
2	IMV(2)		V	12	IMV(12)	V	
3	IMV(3)		V	13	IMV(13)	V	
4	IMV(4)		V	14	IMV(14)	V	
5	IMV(5)		V	15	IMV(15)	V	
6	IMV(6)		V	16	IMV(16)	V	
7	IMV(7)		V	17	IMV(17)	V	
8	IMV(8)	V		18	IMV(18)	V	
9	IMV(9)	V		19	IMV(19)	V	
10	IMV(10)	V		20	IMV(20)	V	

5. Conclusions

Based on the testing that has been described in the previous chapter, it can be concluded that the control system to be placed in the tool Pokayoke Final Check to run and function. Addition Pokayoke system in Final Check tool can eliminate errors in the marking in Propeller Shaft. The tool can be used in Final Check and function in accordance with the Final Check tool work. Input, Output and Barcode Clamping Final Check sensors on the device to function in accordance with the PLC.

References

[1] Syahril, A & Meylati, N (2012). Design of Gasket Loading and Crimping Machine Control System for Oxygen Sensor Products 2 Wheel Vehicle Based PLC. Page: 79-85; Proceeding ISSTIN 2012; ISBN: 978-602-19043-0-5

[2] Syahril, A& Cokro, S (2012). Control System Design of the Machine Pump Inspection using PLC-LG Glofa G7M DR60A in PT XYZ. Technologic Vol.3 No.1; ISSN: 2085-8507; pp. 38-43

[3] Syahril, A, Agus P, Adhari, F A, Design of Automatic Sleeve for Transfer Nut Clutch using Programmable Logic Controller, Prosiding Seminar AVoER 2012.

[4] Syahril, A, Muhammad, H, & Arum Y (2010). Alat Kontrol Jarak Jauh Menggunakan GSM (Global System for Mobile Communication) SIM300C dan Mikrokontroler PIC 16F877. Halaman 65-71, Proceeding Seminar Nasional SNEEMO 2010, Tahun 2010, ISSN 2085-8507.