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Review on PLC Based Crankshaft Oil Hole Checking Automation

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ABSTRACT

Crankshaft oil hole checking automation is nothing but the machine used to check the lubrication oil holes on crankshaft. Because of manufacturing inaccuracies or errors there may have chances of blocked or undrilled or semi drill lubrication holes on crankshaft. And due to these inaccuracies or errors no proper lubrication is provided to the complete engine and engine cease may occur. While driving a vehicle this engine cease is occurred then it can causes severe accidents and person may losses his/her life. To avoid this problem this automation is specifically design to check all lubrication hole presence on crankshaft with the help of sensors and actuators and controlled by Programmable Logic Controller (PLC). If all pokayoke sensors are giving desired signal then machine display will show all hole presence with green light and ok job counter, else any of hole is missing or blocked or hole length is improper display will show not ok signal for respective hole and job is not ok with red light indicator and buzzer. This helps to detect the problem at the stage of manufacturing before assembly results in increased productivity and stoppage of severe accidents.

Keywords : Programmable logic controller (PLC) , Pokayoke Sensors, Actuators (Cylinders), Productivity Enhancement, Maximum accuracy, Programming, Mechanical Integration.

I. INTRODUCTION

Definitions: Crankshaft is a large component with a complex geometry in the engine, which converts the reciprocating displacement of the piston to a rotary motion with a four link mechanism. Since the crankshaft experiences a large number of load cycles during its service life, fatigue performance and durability of this component has to be considered in the design process. Design developments have always been an important issue in the crankshaft production industry, in order to manufacture a less expensive component with the minimum weight possible and proper fatigue strength and other functional requirements. These improvements result in lighter and smaller engines with better fuel efficiency and higher power output.

A **crankshaft** is a shaft driven by a crank mechanism, consisting of a series of cranks and crankpins to

which the connecting rods of an engine are attached. It is a mechanical part able to perform a conversion between reciprocating motion and rotational motion.

The crankshaft is a moving part of the internal combustion engine (ICE). It's main function is to transform the linear motion of the piston into rotational motion. The pistons are connected to the crankshaft through the connecting rods. The crankshaft is mounted within the engine block

1. Pistons
2. Connecting rods
3. Flywheel
4. Crankshaft

The pistons, connecting rods and crankshaft together form the **crank mechanism** as shown in Figure 1.1.

The crankshaft, connecting rod, and piston constitute a four bar slider-crank mechanism, which converts the sliding motion of the piston (slider in the mechanism) to a rotary motion. Since the rotation output is more practical and applicable for input to other devices, the concept design of an engine is that the output would be rotation

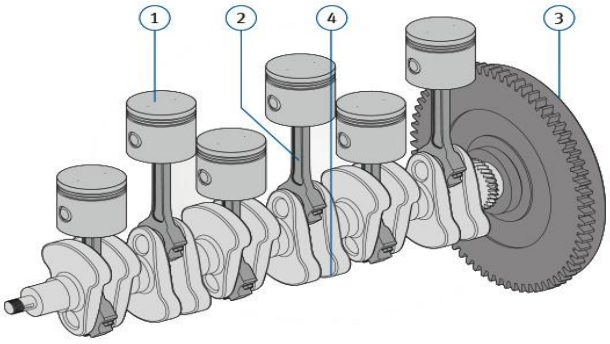

Figure 1.1 Engine Crank Mechanism

Crankshaft oil hole checking automation is nothing but the machine used to check the lubrication oil holes on crankshaft. Because of manufacturing inaccuracies or errors there may have chances of blocked or undrilled or semi drill lubrication holes on crankshaft. This automation is specifically design to check all lubrication hole presence on crankshaft with the help of sensors and actuators and controlled by Programmable Logic Controller (PLC). If all pokayoke sensors are giving desired signal then machine display will show all hole presence with green light and ok job counter, else any of hole is missing or blocked or hole length is improper display will show not ok signal for respective hole and job is not ok with red light indicator and buzzer.

The project includes the following objectives:

·Comparing the available components from the market which meet the best solution. i.e.(PLCs), Pokayoke Sensors, Actuator(Cylinders),Debarring gun, Machine designing concepts etc.

·Designing a layout for the installation of PLC, a Mechanical support assembly and other components together.

·Wiring Design and wiring installation

·Designing and construction of actual machine parts And its assembly

·Designing of the process to check lubrication holes

·Programming

·Testing and Finalizing

·Documenting

Crankshaft types: The crankshaft converts reciprocative motion to rotational motion. It contains counter weights to smoothen the engine revolutions. There are two types of crankshaft, the monolithic type (Fig. 8.1), used for multi-cylinder engines, and the assembled type, fabricated from separate elements, which is mainly used for motorcycles. The type of crankshaft determines what kind of connecting rods are used, and the possible combinations of crankshafts and connecting rods and their applications are listed in Table 1.1.

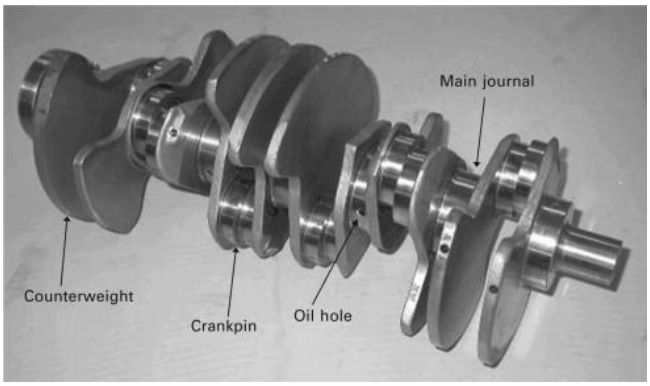

Figure 1.2. Monolithic crankshaft for a four-stroke engine. The fueling holes are for lubrication.

Table 1.1. Combination of crankshafts with connecting rods. The monolithic crankshaft uses the assembled connecting rod, while the assembled crankshaft uses the monolithic connecting rod

Crankshaft type	Con-rod type	Engine
Monolithic	Assembly	Multi-cylinder four-stroke car engine, outboard marine engines
Assembly	Monolithic	Single- or twin-cylinder four-stroke engine, two-stroke engine

Crankshaft Oil Hole Checking: In the manufacturing industry which has implemented production management system which is good, so pay attention to matters related to the amount of product that is rejected due to a process that does not meet the standards and production down time due to trouble on a production machine. This is because it will affect the production cost. Industries always make improvements to meet the standards of the process of a product and reduce maintenance time action against the production machines. If the company is able to reduce the rejected products and production down time, then the greater profits to be obtained by the company concerned. In the process of manufacturing a piston, particularly the DOH (Oil Drill Hole), there are still some drawbacks.

Among them is rejected due to a process that does not meet the standards and production down time due to trouble on the production machine DOH is still above 3.4% of the total production within one month. This happens because when a broken or broken drill tool, the perforation process is still being done. Operators who run these machines do not know when the drill will break. This is what the reason of rejection but this problem of missing or blocked hole is to be detected before the assembly of it into the engine earlier it was checked only with manual eyes and there may have chances manual error and faulty job cannot catch or detected in inspection. This is what underlies this research and concept of PLC Based Crankshaft Oil Hole Checking Automation

II. DESIGN AND DESCRIPTION OF PROTOTYPE

The main objective of this project is to, check all lubrication hole presence on crankshaft for this the machine design and sequence of operation is as shown in flow chart figure 1.3

- Initially operator need to pick a crankshaft from bin and place it on fixture properly and then press two hand safety start push buttons
- As start push buttons are pressed machine cycle is started and crankshaft is clamped horizontally on fixture with clamp cylinder, head of the clamp is made up of nylon material to protect crankshaft from scratches or marks.
- Once job (crankshaft) clamp is confirmed to the PLC then checking rods from the top are coming down to check 3 holes with the help of proximity sensors and checking confirmation is taken by Reed switch connected to the vertical top cylinder.
- If all the three holes are ok then three green LED's for respective hole is on and top cylinder will goes up and if any one of the hole is not ok it will indicate with red light.
- Now left side cylinder for the left hole checking on crankshaft is forwarded with the checking rods near the deburring gun (make-Cargo Pneumatic) is attached so that with the hole length checking bur removal operation is also performed.
- If this hole is ok it will be shown with green light on display and left side cylinder is reverse.

- Now right side cylinder connected on cross flang comes forward to check the cross hole which is the 5th hole with the help of check rods, again if the length is ok then green LED is on else red LED is shown on display and right side cylinder is reverse and for ok job with all holes ok marking cylinder is forward and dot marking is done on crankshaft, marking is done to identify ok and not ok job at the assembly stage.
- By taking confirmation from reverse reed switches of all cylinders clamping cylinder is reverse and job is declamped, cycle completed, if all holes are ok job counter counts 1 and if not then not ok counter will be 1 as shown in flow chart Figure 1.3

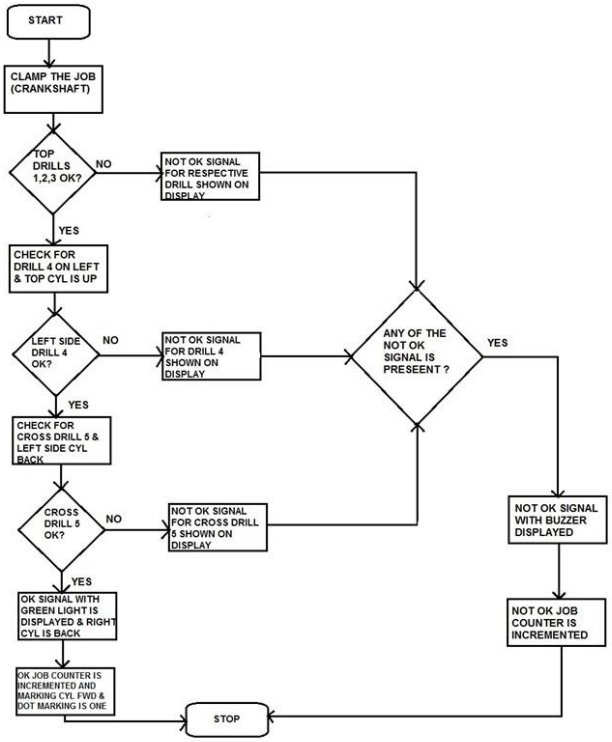

Figure 1.3. Flow Chart

Hardware and Software Requirements: For this project, we require different hardware component and different software. So that this project is a combination which full fill the definition of automation. This is a list of all the hardware components that will be used in this guide:

- Programmable logic controller (PLC)
- Reed Switches
- Pneumatic cylinders
- Proximity sensors
- Solenoid Valve
- Relay board
- Contactor
- Power supply
- Miniature circuit breaker (MCB)
- Wires with dia 0.5sq.mm, 1sq.mm

Three different types of Sectors covered in this project is Mechanical, Pneumatic, Electronics (which includes software) and the Software used in this project is as below:

- PLC programming software CODESYS V2.3

Hardware Configuration:

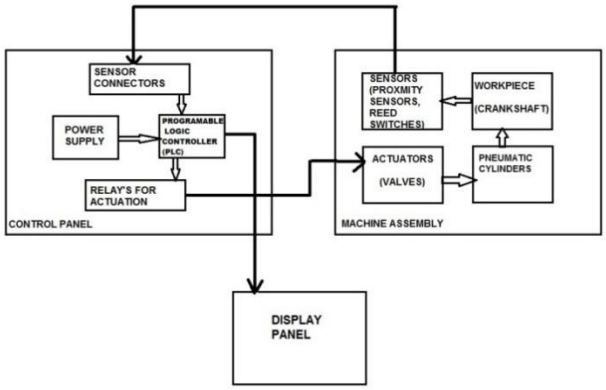

Figure 1.4. Block Diagram

Automation is defined as a combination of hardware and software, here basically software part is provided by PLC programming software and hardware part is mechanical assembly. We are now going to see main block in detail

- **Programmable Logic Controller**: A programmable logic controller (PLC) or programmable controller is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light

fixtures. PLCs are used in many industries and machines. Unlike general-purpose computers, the PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in battery-backed-up or non-volatile memory. A PLC is an example of a hard real time system since output result must be produced in response to input conditions within a limited time, otherwise unintended operation will result[8]

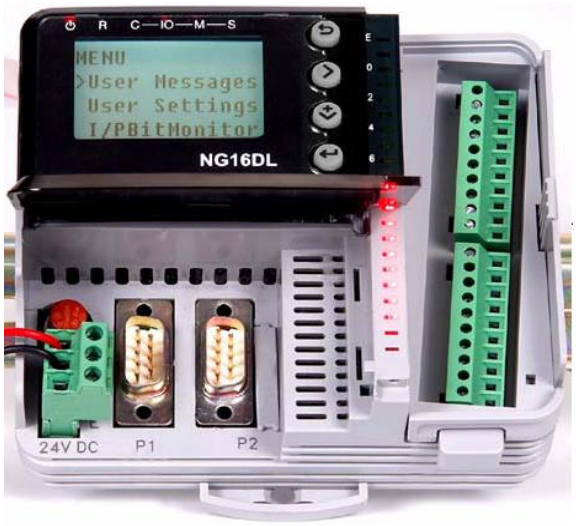

Figure1.5. PLC NG16DL

- **Sensors and Actuators**: In this automation sensors and actuators are used to drive complete machine system. Variety of sensors such as inductive proximity sensors (M8,M12,M18) , Reed switches are used also different actuators (specifically Pneumatic) are used with different dimensions cylinders with diameters and length details of these blocks are below:

1. **Sensors:** Sensors are the devices used for data acquisition i.e. whenever particular object comes in front of the sensor it will give high pulse signal to the PLC in form of voltage (24VDC). Different type of sensors such as proximity sensors, optical sensors, magnetic sensors are available in market, Here in this project proximity sensors (Inductive type) and magnetic sensors which are nothing but reed switches of SMC make and optical or photoelectric sensor (100 mm range) of baner make is used.

➢ **Proximity Sensor:** A proximity sensor is a non-contact sensor that detects the presence of an object (often referred to as the "target") when the target enters the sensor's field. Depending on the type of proximity sensor, sound, light, infrared radiation (IR), or electromagnetic fields may be utilized by the sensor to detect a target. Here M12 PNP NO non flash inductive type proximity sensor is used as shown in Figure1.6

Figure 1.6. Proximity Sensor

➢ **Reed Switch:** A magnetic reed switch is an electromagnetic switch used to control the flow of electricity in a circuit. When the piston with the magnetic band passes under the pneumatic cylinder Reed Switch, the switch's reeds close a circuit to generate a signal that can be used to control an electric operated device. In this project SMC make (DM9B) reed switches are used for oil hole depth confirmation via checking rods connected to the cylinder Figure1.7 shows SMC make reed switch.

Figure 1.7. Reed Switch

➢ **Photoelectric or Optical Sensor:** A photoelectric sensor is a device used to determine the distance, absence, or presence of an object by using a light transmitter, often infrared, and a photoelectric receiver. A photoelectric sensor emits a light beam (visible or infrared) from its light-emitting element. A reflective-type photoelectric sensor is used to detect the light beam reflected from the target. A thrubeam type sensor is used to measure the change in light quantity caused by the target crossing the optical axis. Here baner make photoelectric sensor having range 100 mm is used for presence of the job (Crankshaft) as shown in Figure1.8

Figure 1.8. Photoelectric Sensor

2. Actuators: Actuators are the device that causes a machine or other device to operate. Here in this project basically the actuators are pneumatic cylinders (Figure1.9) operated through solenoid valve. Different cylinders are used such as cylinder for job lamping is clamp cylinder , left and right side hole checking cylinders, cross hole checking cylinder operated through respective solenoid valve connected through pneumatic piping.

Figure 1.9. Pneumatic Cylinder

➢ **Solenoid Valve:** A solenoid valve is an electro-mechanical valve that is commonly employed to control the flow of liquid or gas. There are various solenoid valve types, but the main variants are either pilot operated or direct acting, Here single coil SMC make valve (SY Series) are used for cylinder actuation shown in Figure2.0, As per the command given by the PLC (i.e PLC output is on) written in logic sequence particular solenoid coil is on and will actuate respective cylinder connected to it.

Figure 2.0. Solenoid Valve

Therefore sensor and actuators are another important block for working for this automation

- **Display panel:** Machine display panel is the actual surface on which information is displayed to public view that it is the window through which operator or user can be able to evaluate the Ok or not Ok crankshaft through the result shown or displayed on display panel. Specifically this machine's display panel is having different indicators in red and green light to show status of Ok(by green indicator) and not Ok(by red indicator) for respective crankshaft oil hole. This display panel also provides switches for manual operation of machine. This machine operates in two modes 'Auto Mode' and 'Manual Mode' by selecting auto-manual switch position on panel. For manual operation of individual cylinder multiposition selector switch is also provided on display panel, selection of the manual operating cylinder is indicated via yellow light on display panel. Hence the display panel is the actual interface between operator or user and machine.

After complete crankshaft checking if the result is ok then making ok is done on objet with the marking unit which also the part of display panel.

- **Mechanical Assembly:** Machine assembly is nothing but the complete integrated view of different parts for specific task which is to be performed. Here in this project task is to heck crankshaft oil holes presence and this is done by actual machine assembly which is nothing but integration of sensors, actuators through fixtures and mechanical parts made up of different engineering materials such as table structure is made up of mild steel (MS), some parts are of EN31, Where there is sliding or moving parts in between part harden material is used (by changing material property through heat treatment). Control panel is mounted on below side of the machine table and display panel is on front top side of the machine table. This complete crankshaft oil hole checking automation is made up of basic three important blocks- control panel, display panel and machine assembly as shown in block diagram Figure1.4

III.CONCLUSION

This paper, presents what Crankshaft oil hole checking automation is, which components are necessary to make a Crankshaft oil hole checking automation Thus at the end the machine used to check the lubrication oil holes on crankshaft in hazardous environment with same accuracy and precision for long time. This is one of the low cost solution among all other special purpose machines available in market. Also the following objectives of dissertation are accomplished :

- Comparing the available components from the market which meet the best solution. i.e. (PLCs), Sensors, Actuators, Engineering materials etc.
- Designing a layout for the installation of PLC, and other components together.
- Wiring Design and wiring installation
- Designing and construction of a wiring rail and machine operation system
- Designing the automation (machine)
- Programming
- Testing and Finalizing
- Documenting

This Application notes detailed how to design and install Crankshaft oil hole checking automation and testing them This automation can be used many of the industries with slight changes for the purpose of a specific industry following are Some of the applications where this type of machine with slight design changes.

1. Defense Applications
2. Medical Applications
3. Pharmaceutical Industries
4. Automobile Industries
5. Process industries

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