Pulley System for Flipping C9 Cylinder Head

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Abstract. We present a new system for flipping a C-9 cylinder head 90 degrees for operation 160 in the C-9 assembly line at the CAMTAC manufacturing plant in Guelph, Ontario. The goal is of the device to reduce the manual work exerted by the assembly worker to flip the C-9 cylinder head. The design consists of a motor, steel cable, spinning dowels, hook, and steel frame to keep the components stable.

Key words: CAMTAC, Industrial Ergonomics, Cylinder Head Manipulation, Motorized Pulley System

1 Introduction

In the CAMTAC plant in Guelph, assembly line workers must handle large cylinder heads to orient them for different manufacturing operations. For operation 160 on the C-9 cylinder assembly line, the cylinder head must be flipped laterally ninety degrees for processing and inspection. The current method requires a worker to insert a metal bar into the cylinder head and use his/her arms and lower back to flip the cylinder head ninety degrees. This method poses numerous ergonomic issues, including the discomfort on the elbows and lower back caused while applying force on the bar to flip the cylinder head. Repetitive manual handling of the bulky C-9 cylinder heads could lead to serious elbow and lower back injuries.

An alternative method has been designed to address ergonomic concerns. The design must minimize the number of injuries related to strain and stress from operating procedures, minimize the power consumption for cost benefits, and maximize the output of the production line.

The design proposed by our team uses a motor and pulley system to flip the part in approximately three seconds, which greatly reduces the required input from the assembly line worker. The design is economical, relatively easy to install, and user friendly.

2 Design Overview

The general idea behind the design is to flip the cylinder head by providing leverage and applying the force in the same way it is already applied by a production worker. The leverage is provided by a metal rod designed to fit the geometry of the part. The force is applied by a servo motor through a steel cord connecting the motor to the rod. The cord is supported by a pulley to control the angle of the applied force.

During the flipping process, the production worker aligns the part under the pulley and inserts the rod into the central air duct of the cylinder head. Then the motor is activated by the worker and the cord winds, pulling the part until it flips. A stopper prevents the motor from pulling the cord too far and the worker has complete control over the rotation of the motor.

3 Detailed Design

3.1 Leverage Rod

The rod is designed to provide 2.5:1 leverage ratio. This reduces the applied force required to flip the head. The goal is to minimize the required force, while also keeping the lever reasonably short in order not to obstruct the production line. The lever is designed with a stopper shield that prevents it from being inserted into the part further than a certain length. The worker is also provided with a convenient handle to hold the lever while inserting or pulling it out of the part.
3.2 Cord and Pulley

The steel cord transfers the force from the motor to the lever. The cord is designed to withstand constant tension due to the weight of the cylinder head. Suggested metal cord that satisfies design requirements is 4.8 mm Performance Series 100 Siemens-Martin Grade rope by Wire Rope Industries [2]. The rope should be inspected monthly, especially in the area around the pulley to make sure no individual wires tear.

The cord is suspended above the production line by the pulley. Since the force is applied to the lever along the cord, the position of the cord determines the angle of the applied force. Since the angle of the part and the lever changes during the process, so do the magnitudes of the forces acting on the part. The angle of the applied force was optimized to make sure the applied force component does not become much larger than the gravity component, to avoid excessive acceleration of the part during the flipping process. The cord is also equipped with a stopper that physically prevents the cord from winding or unwinding over a certain length.

3.3 Motor

The electric motor provides force to lift and flip the part. The proposed L1430TM general purpose motor from Baldor Electric Company satisfies the design requirements [3]. The controls allow the worker to start or stop the motor, as well as cut power to the motor in case of emergency. The motor is potentially the most failure-prone part of the design; therefore the maintenance schedule must be strictly followed in accordance with the Operation Manual [4] provided with the motor.

4 Discussion and Recommendations

The safety concerns in large manufacturing plants go beyond the physical hazards related to contact or exposure to active equipment. More importantly there are large ergonomic concerns with the operations involving employees and large equipment or products. There are many possible methods to reduce the ergonomic risks associated with processes of this nature. The pulley system is just one of the methods developed during the design process.

The pulley system offers a simple solution for rotating the C-9 cylinder heads by replicating the process already in use by CAMTAC Linamar employees. By using a motor to exert the force necessary to rotate the cylinder head the ergonomic risks to the employee are reduced almost completely. Since the motor will be controlled by pressing a button the safety of the employee is not compromised.

The associated benefits of the pulley system greatly out weight the costs. The production and installation costs of the pulley system is approximately USD1,000. The maintenance and operation costs for a single motor and simple system are low requiring short weekly inspections and power consumption is low. The benefits of the pulley system are measured in the health of the employees and increased productivity. The CAMTAC Linamar plant currently has approximately 9 employees per shift on light duty. With the implementation of the pulley system productivity can be expected to increase while financial compensation to injured employees can be expected to decrease.

Given the timeframe for the design process the pulley system is kept simple. Further work on the design can be used to further develop the control system for the motor to improve safety and efficiency. The motor can be changed to allow the process to move smoother or to allow the pulley system to stop instantaneously if needed. A microcontroller could also be added to control the speed, positioning and/or power consumption of the motor.

References


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