

# Ergonomic Solution for Cylinder Head Manipulation at CAMTAC Manufacturing Plant

Spencer Bell, Sandeep Gurm, and David Kvasnica

**Abstract.** This paper outlines a mechanical solution to address an ergonomic issue associated with flipping a 107kg cylinder head on a manufacturing assembly line. The current solution for manipulating the orientation of cylinder heads involves employees using manual force in a motion several times a day that causes repetitive strain injuries (RSIs). SDS Engineering has developed a mechanical solution which uses gas springs and a rotating platform to reduce the risk of RSIs on the manufacturing line workers.

**Key words:** Industrial Ergonomics, Manufacturing Line Engineering, Mechanical Flipping

## 1 Introduction

The risk of RSIs in an industrial setting has become a concern for manufacturing line workers, who generally repeat strenuous motions on a daily basis. These injuries pose financial concerns to the company due to lost-time wages and increased insurance premiums.

Linamar's CAMTAC Manufacturing has had numerous ergonomic issues identified within their Guelph, Ontario plant, including the C7 OP-60 manufacturing line. Currently, a worker on this line is required to flip a 235-lb. cylinder head 90 degrees using a manual pry bar. Throughout industry, there are numerous high-end robotic solutions but these are outside of the projected budget of Linamar. SDS Engineering has proposed a purely mechanical, cost-effective solution for this manufacturing line. This relieves the worker of any physical lifting and allows for a safer and more comfortable working environment.

The following constraints were associated with this problem:

1. Must fit on assembly line
2. Must not utilize exposed pulleys or wires
3. Must be adequate for industrial environment
4. Must adhere to WSIB standards

The following criteria criteria were satisfied:

1. Minimize cost
2. Minimize training necessary for operation
3. Maximize simplicity

## 2 Design Process and Overview

After identification of the ergonomic issue, SDS Engineering group brainstormed numerous ideas to solve the problem. From these ideas, 3 feasible solutions were identified from which the final design was selected. There was a heavy emphasis on safety and cost, as well as flexibility for the design to accommodate for different cylinder heads.

The final design uses the potential energy of the cylinder head to power its rotation on a gas-spring controlled platform. Once the cylinder head has been rotated 90 degrees, it is removed from the platform by rolling along the assembly line, at which point the platform returns to its initial horizontal position using the compressed energy in the gas springs (Figure 1).

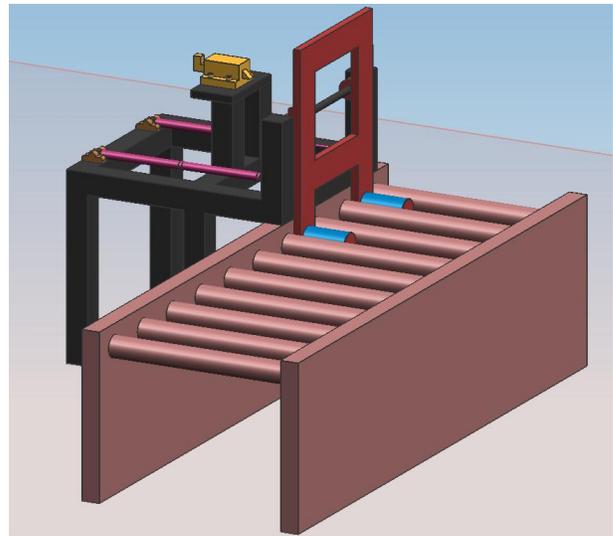


Fig. 1. Trimetric view of final design solution

## 3 Detailed Design

Determining which type of spring to use was also critical. Gas springs can be adjusted to various pressures to accommodate for various loads; however an exact force tolerance needed to be calculated for the current case (a 107 kg cylinder head and 52 kg platform). This was done by doing a moment balance based on Figure 2, and the equation  $\sum M = 0 = F_{Gplatform}A + F_{Gcyl}B - F_{SP} \sin \theta C - F_{SP} \cos \theta D$ .

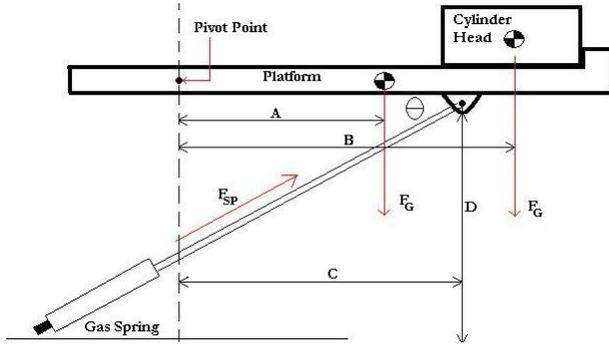


Fig. 2. Schematic of loading scenario of the gas springs

### 3.1 Frame

The frame is manufactured from 3 in. structural square tube having a 3/16 in. wall. It features a 1 in. diameter fixed steel axle that supports a 1 in. thick steel plate. The plate is attached to the axle using two RHP Self Lube NP-1 Pillow Block Bearings, which will allow for a smooth, controlled rotation of the plate about the fixed axle. The plate features two 3 in. diameter steel rollers to support the weight of the block as it rotates. The rollers allow the cylinder head to be easily rolled off the platform once it is finished its rotation and flush with the assembly line.

### 3.2 Gas Springs

This design features two Type 14 industrial grade compressive gas springs with a 16 in. stroke length (manufactured by Industrial Gas Springs Inc.) to dampen the rotation of the platform with the loaded cylinder head. The combined output force from the two springs ranges from 498 N to 4981 N depending on the pressurization of the internal chambers. Based on mechanical analysis of the model in Figure 2 with the 107 kg C7 cylinder head, this application will require a total spring force of 973 N. The ability to vary pressurization makes the design flexible, which allows for accommodation of future cylinder heads of varying weights.

### 3.3 Additional Features

A polyurethane cover is applied to the steel plate and the rollers to minimize scratching of the cylinder head. A safety latch is also engaged when the platform returns to its original horizontal position, preventing the platform from immediate rotation upon loading of the cylinder head. This allows the worker to safely detach the overhead jig from the cylinder head before the rotation process begins.

## 4 Discussion

Overall, the design will cost \$1110.56, assuming it is built in-house with labour costs covered by the company. The

system was designed and justified based on mechanical analyses. From hand calculations and assuming a frictionless pillow block, it was determined that the platform required 77s to rotate the platform 90 degrees and 54 s to return to its initial resting position. Furthermore, digital simulations were performed using RecurDyn™ in the NX5.0™ software package to compare results and provide proof of concept. The model was simplified for the simulation, such that frictionless surfaces were assumed, and dampening coefficients were applied to prevent oscillations resulting from these frictionless surfaces. Constant spring values were applied to the gas springs and a rectangular block of 107 kg was placed on the platform. The simulation results were comparable to the mechanical analyses, but there were slight differences, which can be attributed to the aforementioned simplifications. Prior to implementation of this system a P.Eng must review and certify the design.

## 5 Simulation and Proof of Concept

Using NX5.0™ software, a simulation was run by parametrizing a functional model of the design depicted in Figure 3. Springs were used to simulate the gas springs, and a to-scale rotational platform was used, along with a 107 kg block to simulate a cylinder head. The results of the simulation indicate that the concept of a rotational platform with compression springs will rotate clockwise when loaded, and then return to its initial position when the load is removed. This simulation validates the design concept as being suitable for the proposed application.

## 6 Acknowledgement

SDS Engineering would like to thank Michael Minogue of Linamar for his technical assistance.

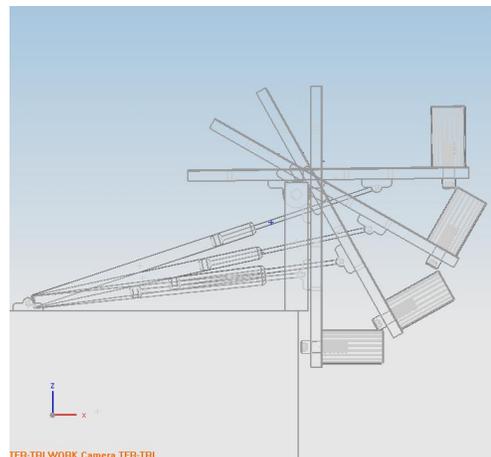


Fig. 3. Phases of the platform returning to its initial position during simulation after the cylinder block is removed