AUTOMATED AND HIGH SPEED MECHANICAL SYSTEM FOR LOADING AND FEEDING CLUTCH RELEASE BEARING AND HUB FOR ASSEMBLY AND ROTATING THAT ASSEMBLY BY 90˚ IN AUTOMOBILE INDUSTRIES

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Abstract

The agenda of this research poster is to design fully automated high-speed mechanical system which should be cost effective as well. The purpose of designing this system is to assemble two plates and their inspection for a batch or lot production at high-speed. To relate this to real world application in the automobile industry, the whole operation is performed to carry out an assembly of clutch release bearing and its hub. Automated tools like rod less pneumatic cylinder and gripper unit, mechanical flipper wheel, precision indexing conveyors and proximity laser sensors have been used to complete the required tasks at high-speed and with high accuracy. This system is designed and modeled using Creo Parametric 2.0 and its computer-aided structural analysis is carried out with the help of ANSYS Workbench 16.0.

KEYWORDS: Automated high-speed mechanical system; assembly; automated tools; Creo Parametric 2.0; structural analysis; ANSYS Workbench 16.0

Introduction

The word “Automation” is derived from automatic and is the most commonly used word in every industry all over the world. It was still unknown till mid of 19th century when General Motors introduced first automation department, which is considered as one of the milestones in the history of industrial revolution. Today, every industry in the USA and rest of the world is trying to be technologically advanced to deliver high quality products which will be cost effective at the same time. And automation plays a vital role in that as it saves labor, material and energy with high accuracy and precision.

Automated and high-speed mechanical system is a field of engineering which deals with different machine tool development integration of machinery systems and production equipment. The computer-aided design and modeling technology allows mechanical design teams to quickly and cost-effectively iterate the design process with better quality and reliable function. Through this technology, multiple design concepts can be reviewed and evaluated with no real prototype required until the product design is completed.

A conventional clutch release bearing assembly rides over the inner collar. The internal bearing keeps the conventional bearing assembly center on the transmission shaft and provides free movement with only minimal clearance there between. Currently, the clutch release bearing assembly is still done manually which causes increased labor cost, reduced production rates and unexpected assembly errors. This poster introduces a new fully automated, high-speed mechanical system based on computer aided design, analytical calculations and structural.

New Clutch Release Bearing & Hub Assembling System

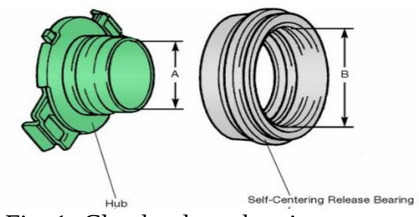

Fig. 1- Clutch release bearing components

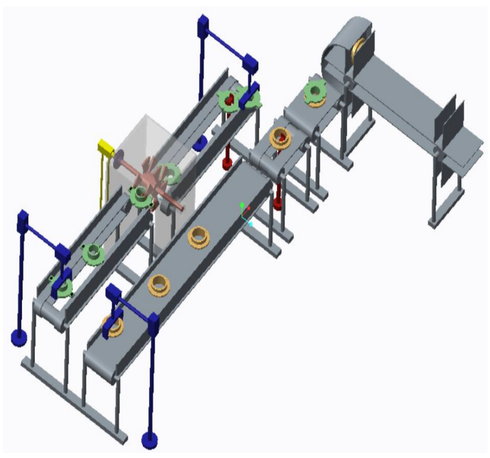

Fig.2. 3D model of a complete system

This automated system is designed to assemble clutch release bearing and bearing hub. Fig. 1 shows schematic of clutch release bearing and hub.

This system performs following operations-

1. Loading clutch release bearing and a hub on separate conveyors from previous work stations.
2. Flipping bearing hub with the help of mechanical flipper wheel.
3. Feeding bearing hub and bearing to assembly station.
4. Matching centers of both components with the help of center matching grippers.
5. Assembly of a hub and bearing.
6. Feeding the assembly to inspection station.
7. Rotating the assembly by 90˚ before inspection station.

This poster predominantly focuses on 1st, 2nd, 3rd and 7th operations.

- **Loading of Clutch release bearing components:**

A rod less pneumatic cylinder and gripper unit is used to pick and place hub and bearing from previous work station on to the conveyor. Advantages like cost effectiveness and easy to use than that of robotic arms make rod less pneumatic cylinder and gripper unit more popular in the automation industry. Fig.3- explains this operation.

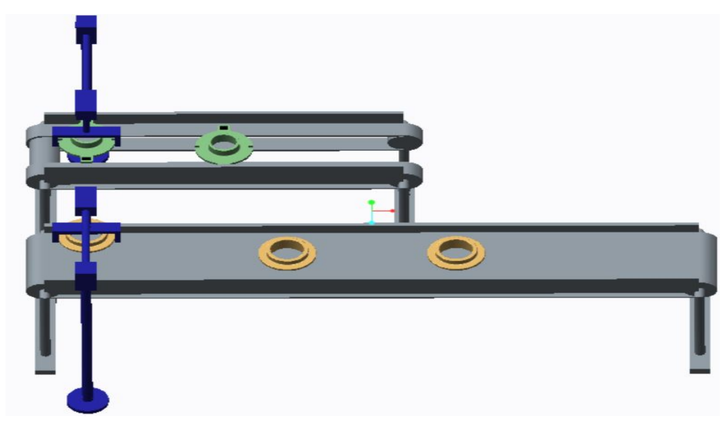

Fig.3- Loading of clutch release bearing components

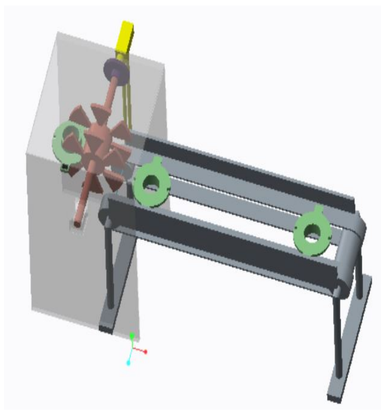

Fig.4- Mechanical Flipper Wheel

- **Flipping of bearing hub:**

A mechanical flipper wheel is used to flip the bearing hub upside down before it goes to the assembly station. The purpose of using this wheel is to ease the assembling function without investing any labor or additional tool cost. This wheel is driven by a brushless DC motor and is also protected by a cage to restrict lateral movement of bearing hub. This DC motor is directly connected to the shaft of mechanical flipper wheel with the help of a pin bush type flexible coupling. Fig.4 explains this flipping operation.

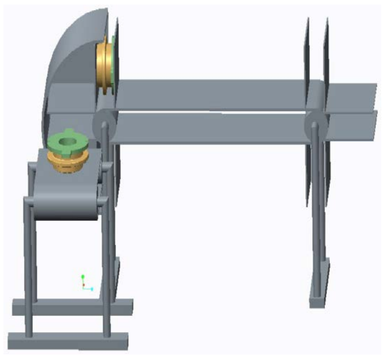

Fig.5- Assembly rotation by 90˚

- **Rotation of assembly:**

The After the assembly of clutch release bearing and a hub is completed, it is then rotated by 90˚ before feeding it to the inspection station. Assembly rotation is required for CMM to check dimensions accurately. This operation is performed using precision indexing conveyor and proximity laser sensor. Precision indexing conveyors are particularly well suited to high-speed assembly of small components where high part count or assembly process complexity is involved.

Analytical Calculations

Some analytical calculations have been done to verify computer aided structural analysis results.

- Deformation and stress induced in rod less pneumatic cylinder and gripper unit which is used to feed bearing are calculated using following formulae respectively-

$$y = \frac{W \times L^3}{3 \times E \times I} \qquad \& \qquad \sigma = \frac{W}{A}$$

- Secondly, torque generated by mechanical flipper wheel is calculated to determine shaft diameter and to select appropriate motor by using following formulae-

$$T = F \times r \times \sin\theta \qquad \& \qquad \tau = \frac{16 \times T}{\Pi \times d^3}$$

- In both the cases, factor of safety is calculated based on yield strength of material. Its formula is given as- $$FS = \frac{Yield\ Strength}{Maximum\ Stress}$$

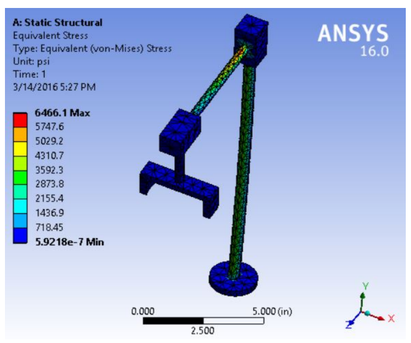

Fig.6- Stress profile of rod less pneumatic cylinder-gripper unit

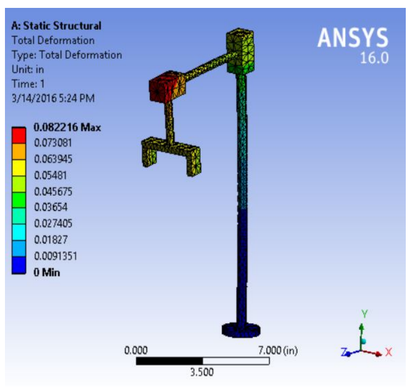

Fig.7- Displacement profile of rod less pneumatic cylinder-gripper unit

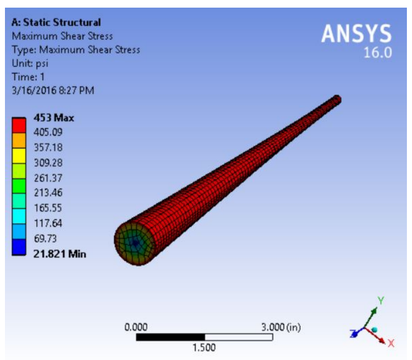

Fig.8- Max. Shear Stress profile of shaft of mechanical flipper wheel

Computer Aided Analysis

A static structural analysis of rod less pneumatic cylinder and gripper is carried out by applying a force on it with the help of ANSYS Workbench 16.0 to observe stress and displacement profile. The material used for this pneumatic cylinder and gripper unit is A36 structural steel. Fig. 6 shows maximum stress induced as 6466.1 psi. Since the yield strength of A36 steel is 36000 psi, we get a 5.56 of safety factor which is well above the required value of 2. Fig. 7 shows displacement profile which is well within the limit as well. Similarly, a static structural analysis of shaft of mechanical flipper wheel is performed by applying torque with the help of ANSYS Workbench 16.0 to observe maximum shear stress and displacement profile. The material used for shaft is also A36 structural steel. Fig.8 shows maximum shear stress induced in shaft as 453 psi. Allowable shear stress is considered as 30% of yield strength. Since the yield strength of A36 steel is 36000 psi, the allowable shear stress is 10800 psi and thus we comfortably get a safety factor of more than 2. Fig. 9 shows displacement profile of shaft which is highly negligible.

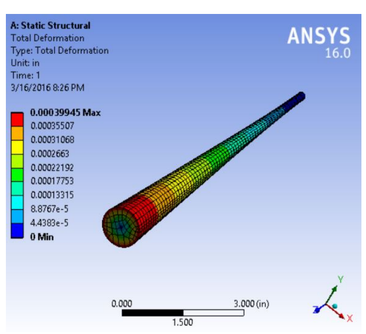

Fig.9- Displacement profile of shaft of mechanical flipper wheel

Conclusion

This system is designed to improve product quality, productivity and also provide more cost-effective production technique. The result obtained from computer aided structural analysis is verified with analytical calculations and it shows that this newly developed automated high-speed clutch release bearing assembling system works properly. However, there is still some scope to make it more cost effective by reducing the size of rod less pneumatic cylinder-gripper unit and mechanical flipper wheel shaft as well as changing their material from A36 structural steel to low yield point steel (like LYP100 or LYP235) as we are getting more than required value of factor of safety.