4/5 Spindle Nut-Runner Drive System

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ABSTRACT

Powered hand tools have the potential to produce reaction forces that may be associated with upper extremity musculoskeletal disorders. Repetitive use of hand held power tools, due to their potential to generate forces greater than an operator capacity, is associated with work related upper extremity musculoskeletal disorders. This problem doesn’t occur in multi-spindle drive system as reactions are cancelled by torque distribution between all spindles. The aim of this project which actual is Atlas Copco Client’s requirement is to develop such a spindle nut-runner drive which can be used for wheel with 4 nuts for tightening as well as for wheel with 5 nuts for tightening. By such modification, wheels of two variants (4-nuts & 5-nuts), different no. of nuts carrying wheel can be assembled on the same assembly line. Developed single unit named “4/5 Spindle Drive System”, which completes the aim of the project. Calculation and Analysis of system shows that the system developed is valid and results obtained are as per customer requirement.

Keywords — Power Tools, Pneumatic Nut-Runner, Assembly Works, Torque

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I. INTRODUCTION

Nut Runner & Nut Drivers are tools used for tightening nuts. By definition, nut drivers are purely mechanical hand tools, while nut runners can be Pneumatic, Electrical or Hydraulic power tools. Now-a-days, multi spindle systems are used in vehicle assembly line, where all nuts of the wheels are tightened simultaneously. According to the quantity of nuts of wheel to be tightened simultaneously, the nut runner system is chosen.

The project is based on development of existing system, which is used in vehicle assembly line for tightening of 4nos. of nuts of the vehicle wheels simultaneously, where nuts are tightened with desired torque. For 4-nut wheel vehicles, 4-nut runner multi spindle drive system is required, similarly for 5-nut wheel vehicles, 5-nut runner multi spindle drive system will be required. So we can say that for different number of nuts of wheels of vehicle required different type of nut runner spindle drive system.

Aim of the project is to make combination of 4-nut runner system and 5-nut runner system and build a single drive system which can be used for 4-nut wheel tightening as well as for 5-nut wheel tightening.

Fig. 1 Existing 4- Spindle Drive System

II. THEORY

Most of the Cars (majorly hatchback segment) consist of wheels which are fixed with 4nuts. These wheels are
tightened with help of 4 spindle nut-runner drive system. Introduction of bigger diameters of wheels (especially in Sedan Segment cars), which had be fixed with 5 nuts which made manufacturer to add additional 5 spindle nut-runner drive system in the assembly line. Considering cost of building additional assembly line for sedan type cars, manufacturer needs to think of optimization of assembly lines and assemble big wheel cars on same/existing assembly line. Considering the optimization, investment cost along-with cost of maintaining two different nut-runner systems, manufacture demanded of combination of both the systems. M/s Atlas Copco who is one of the suppliers for such manufactures needed to develop such a system that fulfilled the customer requirement.

The system was to be developed which contains 4 spindle system which would tighten nuts at 100mm PCD and also contain 5th additional spindle which can be used at the time of 5 nut tightening operation with 114.3mm PCD. Some arrangement should be done so that 5th spindle can be parked in idle condition during 4-spindle tightening operation.

Above fig. 2 shows position of 4 spindles, in which 4 spindles are in working condition and the 5th one is in idle position. The PCD given by the customer is 100mm. This used for tightening nuts of wheel with 4-nuts. Also, the above fig. 2 shows position of 5 spindles, in which all 5 spindles are in working condition. The PCD given by customer is 114.3mm. This used for tightening nuts of wheel with 5 nuts.

LM Rails:
On the base plate as shown in the fig. 3, the LM rails are mounted, for each spindle there is one LM guide, which guides the spindle to achieve the correct position for 4 nuts wheel tightening or either for 5 nuts wheel tightening position. Hence, the spindles can achieve the position for PCD 100mm during 4 nut tightening operation and PCD 114.3mm during 5 nut tightening operation.

As shown in Fig. 4, three cylinders are used for upper two spindles, i.e. spindle no. 2 & 3. 1st cylinder is used for locking the position of 100mm PCD. 2nd cylinder for locking the position of 114.3mm PCD and the 3rd cylinder is used for providing the linear motion to the spindle.

Only Two cylinders are used for middle two spindles, i.e. spindle no. 1 & 4 as there is less space available. Therefore, instead of two locking cylinders, only one cylinder is provided for both, 100mm PCD and 114.3mm PCD position locking. 2nd cylinder is used for providing the linear motion to the spindle.

5th Spindle is provided with single cylinder for both purposes, i.e. for locking as well as for positioning. These all cylinders are pneumatic cylinders and their working pressure is 5.5bar. These all cylinders are having sensors at both positions of PCD 100mm and PCD 114.3mm, which actually gives the confirmation feedback to the operator for Spindle positions.

With the help of these LM guides and pneumatic cylinders, two different positions i.e. 100mm PCD and 114.3mm PCD are achieved.

In order to achieve aim of the project, the existing system was to be modified. As the existing system was proven system, hence analysis of only the modified supporting and sliding arrangement for the 5th spindle (marked in red) as shown in fig. 5, was done in Anysis R15.0 software.

**III. ANALYSIS**

In order to achieve aim of the project, the existing system was to be modified. As the existing system was proven system, hence analysis of only the modified supporting and sliding arrangement for the 5th spindle (marked in red) as shown in fig. 5, was done in Anysis R15.0 software.
IV CONCLUSIONS

A combined 4/5 Spindle nut runner drive system is cost effective modification and analysis part proves that the design is on safer side.

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