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Development of Hydraulics – Pneumatic Impact Wrench

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Abstract

Impact Wrench is a machine use to facilitate the need of tightening and loosening of nut-bolts by using its hammering action. Since, the conventional way for this process is the use of Spanners & these were available as per the need of the user to complete the task but there were some limitations too. So, to innovate and bring new development in the conventional ways of the branch of wrenches, their came an idea of developing Hydraulics - Pneumatic Impact Wrench. This machine would be using two different sources of inputs (i.e. Compressed Air & Pressurised Oil) and would develop an output as per the specifications. The main aim of this project is to reduce the human effort for the tightening and loosening of nut-bolts by the development of Hydraulics – Pneumatic Impact Wrench and to serve the usage of dual source in a single unit for producing variable output as per the requirement of the user. This machine has a vast area of application and would help us to vary the amount of Torque and speed in the output.

Keywords: Anvil, Hammer Assembly, Air Rotor, Hydraulic Motor, Vanes, Casing.

Introduction

A wrench is a tool used to provide grip and mechanical advantage in applying torque to turn objects usually rotary fasteners, such as nuts and bolts or keep them from turning. Wrenches are available in many types of ranges and also have different standard terms used for it. The High quality wrenches are made from chromium-vanadium alloy tool steels & are made from process drop forged. They are sometimes chrome-plated so as to resist corrosion & for easiness in cleaning [6]. Before the 19th century the hand tools were only the basic devices which would be used for the tightening and loosening of the nuts and bolts. Then came the period of impact wrenches and where the most great inventions among the others. "An impact wrench is a socket wrench power tool designed to deliver high torque output with minimum efforts by the user, by storing energy in a rotating mass, then delivering it suddenly to the output shaft"[6]. Compressed air is generally used as a common power source, sometimes electric or hydraulic power is also used. Impact wrenches are available for different standard socket wrench drive size, from small drive tools up to larger square drives for major construction. Impact wrenches are one of the most commonly used air tools [3].

So to innovate and bring new development in the conventional ways of the branch of wrenches, an effort is made for the development of H-P Impact Wrench. The objective behind this development is to reduce the human effort and provide easiness in the way of using an impact wrench. Also, to serve the usage of dual source in a single unit for producing variable output as per the requirement of the user. As this machine has many applications like, Automotive Repair, Heavy Equipment maintenance, Production Assembly, Construction Sites, Automotive Industries, On Road services, Airplane Assembly, Robotics, and many more.

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A. Structure & Related Work

The importance and requirements of wrenches was recognized by the historians' far back around 15th century. But, for the odd-sized nuts of wagon wheels wrenches were manufactured in England and exported to North America in the late 18th& early 19th centuries. Then, around the mid-19th century began to see patented wrenches which used a screw to narrowing or widening the jaws. Before the development of the impact wrench the spanners were only the hand tools which were used for the tightening and loosing of the nut bolts. But the major problem with that was the required human effort. For the tightening of nuts there was no other device which could be used for these operation so it was very hard to complete these process by hands. So, a machine called as the impact wrench was developed to overcome the problems and to reduce the efforts of the human beings. This invention benefited a lot to the people.

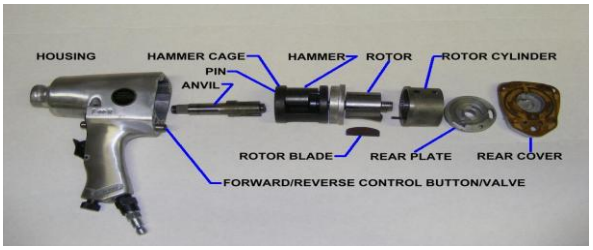

Figure I
Exploided view of Pneumatic Impact Wrench.

Table 1
Material Specification

SR NO:	PART NAME	MATERIAL
1.	Housing	Aluminium
2.	Anvil	Hardened Steel
3.	Pin (Stud)	Cast Iron
4.	Hammer Cage	
5.	Hammer	
6.	Rotor	Mild Steel
7.	Rotor Cylinder	
8.	Rear Plate	Aluminium
9.	Rear Cover	
10.	Gasket	Samsonite

II. Problem Identification & Summary

By Observing at some places and also by studying some literatures we found some problem in the conventional way of using the impact wrenches. We found that in heavy manufacturing industries the method of using wrench is not appropriate which leads to some causes of the company. For the tightening and loosening of nut-bolts they use wrenches for both the kind of purposes i.e. light & heavy works. This leads to increase in human efforts, number of operations, maintenance of machine, more number of machines are required, time consuming job. So, these are the common problems which are faced by the industries and all these leads to the cost increment of the company. Also, at other places like garages, assembly lines, railways & aerospace industries such problems might be faced frequently. So, to overcome such kind of problems an effort is made for the development of Hydraulics-Pneumatic Impact wrench which might be helpful to solve such factors which are faced in day to day life [5]. This project involves the solution for the usage of impact wrenches for the tightening and loosening of nut-bolts for some of the firms. The major problems as discussed ahead, the requirement of the frequent maintenance of the conventional machine is increased, Manpower fatigue level raises because of the increment in the operation for the same kind of purpose, Cost per units of the machine bought increases as required for the different outputs. Also, this machine might be helpful in the reputed garages and for the on-road servicing.

III. Aim & Objective

The Hydraulic-Pneumatic Impact wrench is a machine which would be used for the tightening and loosing of nut-bolts of some vehicles and heavy machineries. It uses compressed air and pressurized oil as source of inputs and would deliver a particular output as per the configurations. This machine would help us to bring different outputs as per the requirement of the customer to complete a particular task/job by using a single machine. This machine has a vast area of application and would help us to vary the amount of Torque and speed in the output. The main aim of this project is to reduce the human effort for the tightening and loosening of nut-bolts by the development of H-P Impact Wrench. And to serve the usage of dual source in a single unit for producing variable output as per the requirement of the user.

IV. Methodology

For the solution of the major problem occurring in the conventional ways, an effort has been made to find an optimum way of getting rid of the problem. Instead of using only Pneumatics individually hydraulics also could be combined together and get different outputs. This would be achieved by studying some literatures and then understanding the combined setup for both the sources. The material and specifications of the components might be change, so that it could be used for both the sources [4].

- For the development of this machine, certain parameters of Pneumatics and Hydraulics are required to be studied.
- Pneumatics setup consist of various components and the major one is air compressor. Also, in the case of Hydraulics setup there are various different components and the major one is Hydraulics power pack.
- For obtaining a certain output, there should be a particular configurations of inputs which should be specifically available to perform a certain task as per the requirement.
- Also, for this kind of sources the circuits are to be defined for the successful performance of the device. And so the knowledge of working principle of both the systems is necessary to be studied.

After understanding the working and circuits, the own mechanism is to be setup as per our convenience. So, lastly design, and analysis is to be completed for the successful performance of the product.

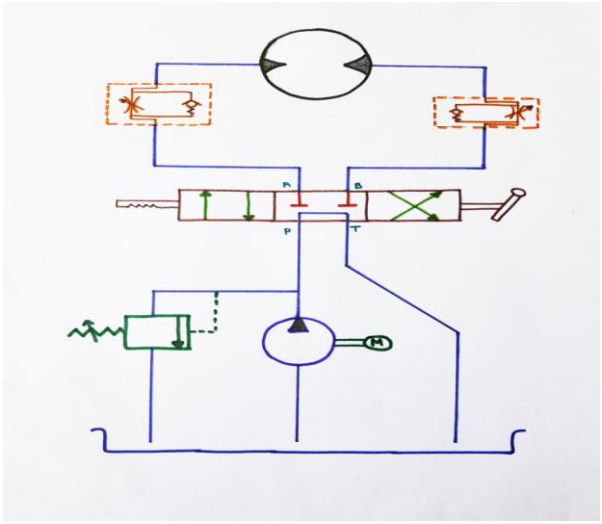

Figure II
Hydraulics Circuit.

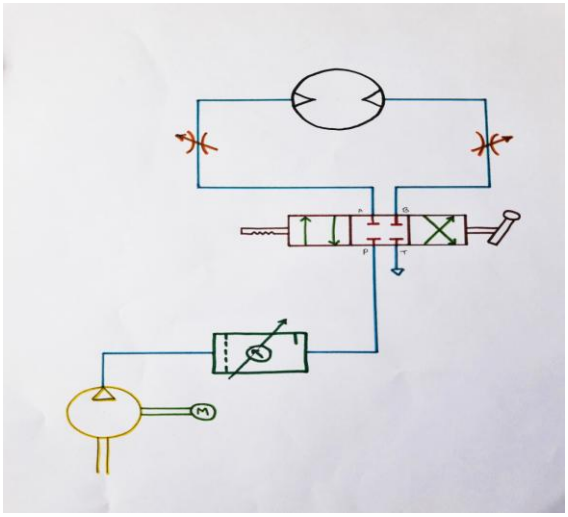

Figure III
Pneumatic Circuit.

V. Experimental Study

A. Design (3D Model)

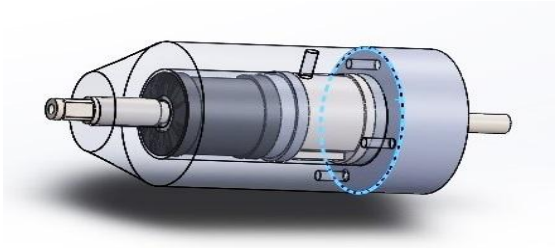

Figure IV
Pneumatic Assembly

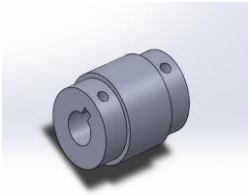

Figure V Coupling.

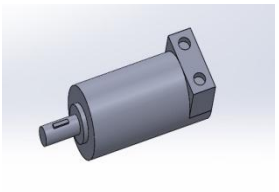

Figure VI Hydraulic motor

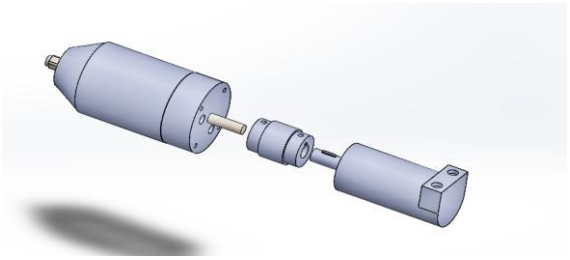

Figure VII
Whole Unit Assembly

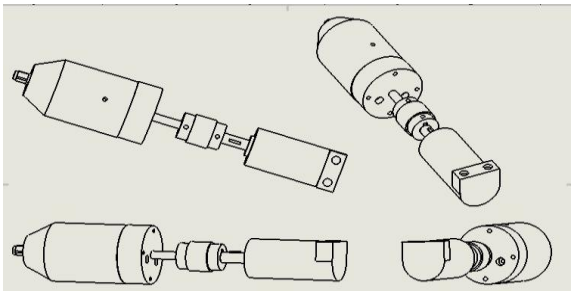

Figure VIII
Two dimensional sketch of model.

B. Process Parameters

Table 2
Terms/units necessary for calculation

SR NO:	NAME	DENOTION	UNIT
1.	POWER	P	kW (Kilowatt)
2.	SPEED	N	rpm (Revolution per minute)
3.	TORQUE	T	Nm (Newton-meter)
4.	FORCE	F	N (Newton)
5.	PRESSURE	p	bar
6.	AREA	A	m^2 (meter square)

- Formulas:-

SR NO.	EQUATION	
1.	$P = (2*\Pi*N*T)/ 60$	(1.1)

2. $p = F/A$ (1.2)

3. $T = F*r$ (1.3)

Table 3
Operating criteria

SR NO:	COMPONENT	MATERIAL/ TYPE	SPECIFICATION
1.	Air Compressor	Reciprocating	Pressure limit upto 15 bar
2.	Hydraulic Pump	Vane Type	Pressure limit upto 200 bar
3.	DCVs	4/3	4 port, 3 position
4.	Vanes	Vesconite	6 vanes
5.	Bearing	Deep Groove Ball Bearing	6001Z
6.	Socket	Hexagonal Socket	Standard Size

VI. Analysis

The Static analysis is done on the major component of the model which behaves critically under the application of various inputs.

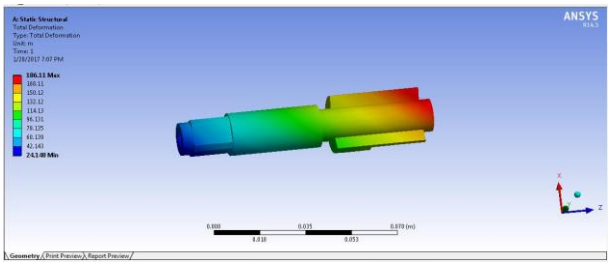

Figure IX
Anvil Analysis

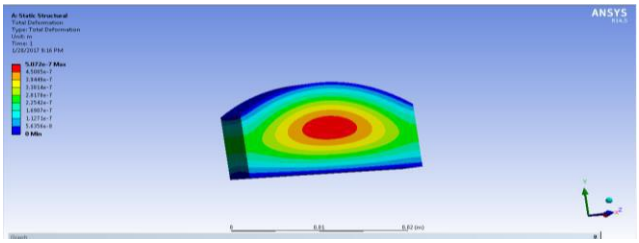

Figure X
Vane Analysis

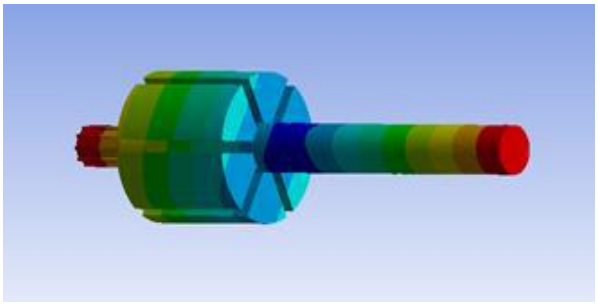

Figure XI
Rotor Analysis

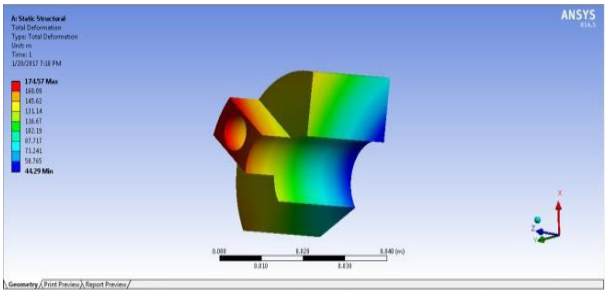

Figure XII
Hammer Dog Analysis

VII. Results & Discussion

After completing the design and understanding the working of the model some results are achieved which are discussed below. After completing the Ansys Static Analysis we found that the sensitive components of the machine might be deformed under the heavy application of pressure in the pneumatics assembly. The range of pressure might be 1 bar to 15 bar which is safe as per the design & working purpose. Also for Hydraulic Orbital motor the pressure range might be 10 bar to 125 bar which is safe for the operating purpose. Hydraulics Orbital motor can work under the pressure upto 230 bar but the requirement is not such high.

- For Pneumatic Operating Conditions:

Table 4
Pneumatic working readings

PRESSURE	SPEED
1.37 bar	175 rpm
1.9 bar	375 rpm
2.25 bar	775 rpm
3.11 bar	1200 rpm
3.54 bar	1492 rpm

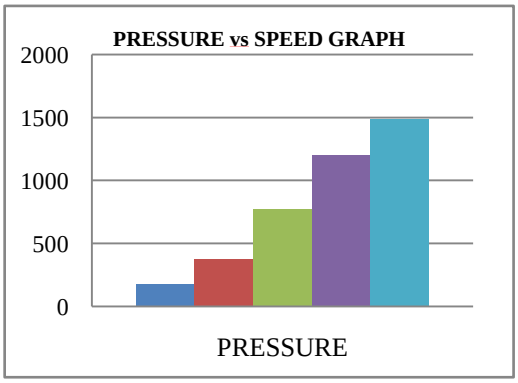

Figure XIII
Pneumatic Reading Graph

- For Hydraulics Operating Conditions:

Table 5
Hydraulics working readings

PRESSURE	SHAFT TORQUE
20 bar	3.2 Nm
50 bar	8.01 Nm
70 bar	11.2 Nm

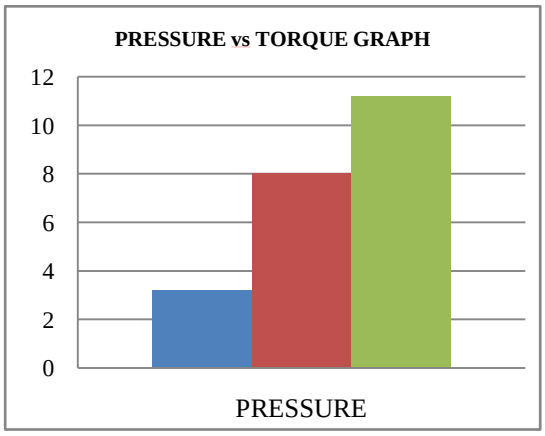

Figure XIV
Hydraulics reading graph.

- General Performance Graph:

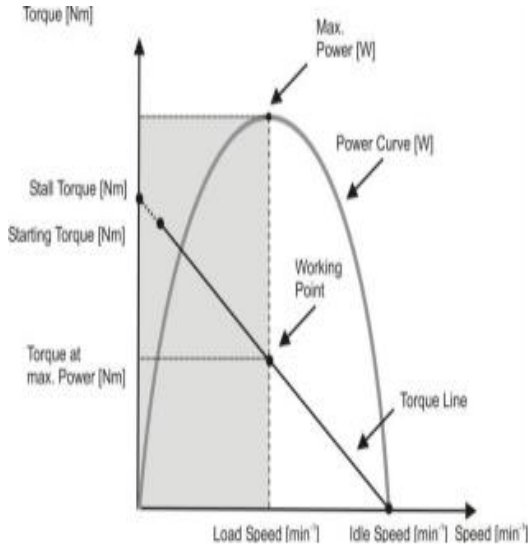

Figure XV
General Torque – Speed Graph, [2].

VIII. Conclusion

This machine is a new invention for the upcoming era and this combination of two sources gives benefits a lot. This gives a golden opportunity for every user to use such kind of machine. This machine provides various outputs which is its major benefit. So, this way it will change the method of application and use of impact wrenches. Also, in India Hydraulics and pneumatics combined machines are not used as a single unit so this might be the new change in the method of application of wrenches and it's a new invention in the impact wrenches category. So,

This is a new birth in the field of impact wrenches.

Acknowledgement

It gives us immense pleasure in submitting this research work entitled **"Development of Hydraulic-Pneumatic Impact Wrench"** as a partial fulfilment for the B.E. Mechanical Engineer Course at Alpha College. I take this opportunity to expire my gratitude towards number of people, who were directly or indirectly involved in my project and without whom this could not have been a great success. First of all, I sincerely thank to our H.O.D**. Prof. Vijay Bariya** and for this constant support and guidance during the development of project. We would like to thank **Prof. Swetank Srivastava** internal guide, of our college for their help in project. We are grateful for his prolonged interest in our work and excellent guidance. He has been a constant source of motivation to us.

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