International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Design and Fabrication of Pedal Operated Air Compressor

Vishal Gehlot[1], Abhinay Nigam[2], Kunal Marmat[3]

[1]Assistant Professor, Department of Mechanical Engineering, M.I.T.S. Ujjain, India

[2]Assistant Professor, Department of Mechanical Engineering, M.I.T.S. Ujjain, India

[3]B.E. Student, Department of Mechanical Engineering, S.G.S.I.T.S. Ujjain, India

Abstract: ***This paper describes a new approach to design and fabrication of Pedal operated air compressor with the goal of building a working prototype. Here is a try to create a mechanical device that can use the mechanical power operated by pedals as in bicycles to run an air compressor and additional water pump. The additional cooling system is used for maintaining the temperature of compressed air. We used a cycle chain-sprocket system as a basic pedaling power source and connect it to the main shaft joining both the air compressor and a water pump through several gears. This approach will be helpful for saving a sufficient amount of electricity and get a robust portable air compressor system.***

Keywords : Air compressor, Components and parts, Gear ratio, mechanism, Pedal driven air compressor.

1. Introduction

The first idea for powering the pump would be a stationary bicycle. Pedal power is simple, efficient, and practical. Its most familiar use is the bicycle for personal or cargo transportation. But pedals can also power small stationary machines. Since the system is to remain human powered and large amounts of power are required, having the operator use their stronger leg muscles was intuitive. A stationary pedal-driven device seemed to agree with most of the design considerations related to the power source. [1]

Initially our design settled on using a pedaling system to harness the human input energy. We decided to go with this style of power procurement because a person can sustain large power expenditures more readily

2. Design

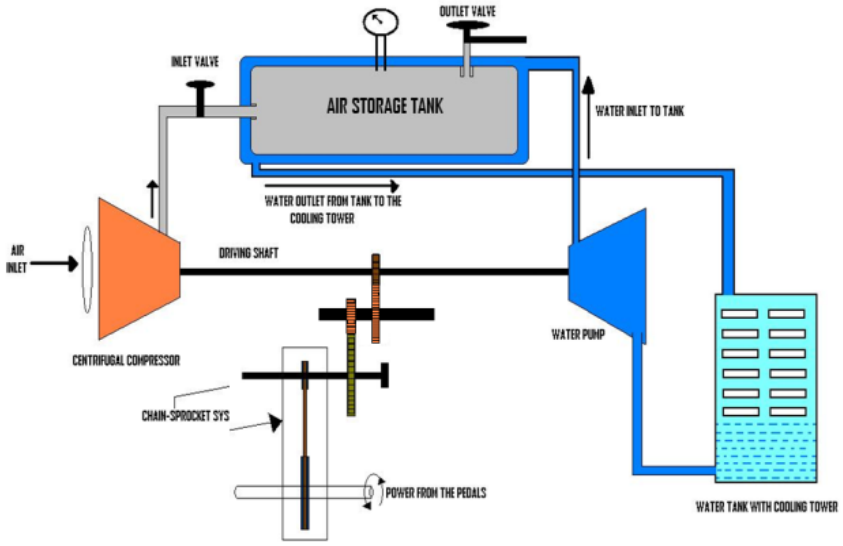

Figure 1: Design of pedal operated air compressor system

3. Mechanism

The pedal powered air compressor set up, has a simple mechanism operate with the chain and sprocket arrangement. The chain is place on the teeth of the wheel and pinion. Pedal and connecting rod are interconnected to each other with bolts.

The power is transmitted from the connecting shaft to the gear 1. Gear 1 is connecting from the gear 2 with 4:1 gear ratio. It produced 4 times more torque from the pedaling effort. Another shaft connects gear 2 to gear 3 each having same axis. The difference is only in the size. The gear 3 again connects from gear 4 with 4:1 gear ratio. So it produced 4x4=16 times more torque from the pedaling effort. [Fig. 5] This rotational power is used for the rotary air compressor and barrel pump. The main criterion for the compressor is that it supplies enough pressure (approximately 25 psi). An inlet air filter is used to prevent contaminants in the air from being pumped through the

compressor. The barrel pump is used for producing cooling effect around the pressurized air tank. [Fig. 4]

The seat has mounted on a position that can slide along the frame for varying user heights. The most difficult challenge was transferring the manual power to the compressor without exhausting the user too quickly. The gear ratios required for attainable pedaling speeds are determined by the specific well conditions. The last part of the design is the water retrieval system. This is the storage tank that the water drop pipe feeds around it.

4. Parts and Components

Centrifugal air Compressors

The main criterion for the compressor is that it supplies enough pressure (approximately 25 psi). The suitable rotary compressor that will choose meets this requirement.

Figure 2: Centrifugal compressor

Sprocket

A sprocket is a profiled wheel with teeth, cogs or even sprockets that mesh with a chain, track or other perforated or indented material.

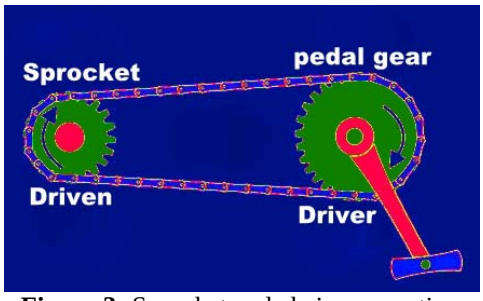

Figure 3: Sprocket and chain connection

Chain length

$L=2C+1.57(D+d) + (D-d)^2 / 4C$
Where: L= length of chain at pitch line (in inches)
C = center distance (in inches)
D = pitch diameter (in inches) of large sprocket
d = pitch diameter (in inches) of small sprocket [2]

Spur gears
We used Spur Gear as the main gearing system in this machine. There is different gear drives used to achieve sufficient torque. [fig.5]

Air storage tank
Compressed air energy storages a way to store energy generated at one time for use at another time using compressed air. There is an outer shell for providing circulation of water around the storage tank.

Shafts
In this machine we are using three different shafts. First shaft is the basic driving shaft. The second shaft is the driven shaft and driving shaft for the final shaft which rotates the compressor and the pump.

Pump
The last part of the design is the water retrieval system. This is the storage tank that the water drop pipe feeds around it. We used hand driven barrel pump for the cooling around the pressurized air storage tank. Pump is additional element of this system. This it detachable or we can say that it is another application of the pedal powered machine.

Figure 4: Manually Driven Barrel Pump

5. Calculation and Formulae

Calculation for the storage volume of compressed air
The storage volume for a compressed air can be calculated using Boyle's Law [3]

$$PaVa = pc\ Vc$$

Pa = atmospheric pressure (14.7 psia)
Va = volume of the gas at atmospheric pressure (Cubic feet)
Pc = compressed pressure (psi)
Vc = volume of the air at compressed pressure (Cubic feet)
Volume of free air in a storage volume
The amount of free air at atmospheric pressure in a given volume as a cylinder storage can be calculated by

$$Va = Pc\ Vc / Ps$$

Torque ratio:
It is the ratio of its output torque to its input torque.

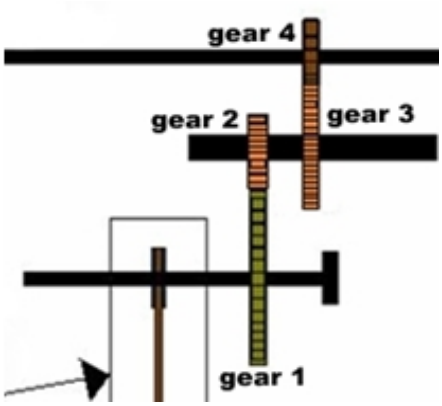

Figure 5: Gear arrangement

Consider the speed of pedal = 60 RPM
And gear ratio = 1/4
Then Speed of Gear 1 = 60 RPM
Gear 2 = 60x4 = 240 RPM
Gear 3 = 240 RPM
Gear 4 = 240x4 = 960 RPM (pedaling power on rotary compressor)
Teeth of gear 1= T1 = 80
Teeth of gear 2= T2 = 20
Teeth of gear 3= T3= 80
Teeth of gear 4= T4 = 20

6. Conclusion

The pedal powered machine has been experimentally verified. It achieved supply pressure up to 23-26 psi under the normal conditions. This pedal operated mechanism can generate enough power to drive the air compressor and the water pump. The compressor and pump both are human powered. This narrows down our powering options significantly to something purely mechanical (probably no electric power of any kind). This system is easy to operate and can be made at a very less expense. The pressurized air generated and be used in various other purposes such as filling air in tires, paint sprayer etc.

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Author Profile

Mr. Vishal Gehlot is working as Assistant Professor in Dept. of Mechanical Engineering Mahakal Institute of Technology & Science, Ujjain -456010, Madhya Pradesh. He received B.Tech degree (2012) in Mechanical Engineering from Rajiv Gandhi Technolgy, Bhopal, India. He obtained M.Tech degree (2014) in Tribology & Maintenance Engineering from S.G.S.I.T.S. Indore, India. He has attended many International Seminars and Conferences. He has published four papers in International Journals and presented two papers in International conferences. His research interests are in the areas of Tribology, Thermal and Mechatronics etc.

Mr. Abhinay Nigam is working as Assistant Professor in Dept. of Mechanical Engineering Mahakal Institute of Technology & Science, Ujjain -456010, Madhya Pradesh. He received B.Tech degree (2013) in Mechanical Engineering from Rajiv Gandhi Technolgy, Bhopal, India. He is doing his M.Tech degree (2014-2016) in Automobile Engineering from Truba Institute of Technology & Engineering Indore, India. He has been teaching for the past 1 year. He has published 2 papers in International Journals. His research interests are in the areas of Automobile, Thermal and Design etc.

Mr. Kunal Marmat is doing his B.E. degree (2011-2015) in Mechanical Engineering from Shree Guru Sandipani Institute of Technology, Ujjain-456010, M.P. India. He has published 2 papers in International Journals. His research interests are in the areas of Automobile, Design and Hydrualics etc.