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Pneumatic Vehicle

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Abstract: ***Compressed air as a source of energy in different uses in general and as a non-polluting fuel. Efforts are being made by many developers and manufacturers to master the compressed air vehicle technology in all respects for its earliest use by the mankind. The present paper gives a brief introduction to the latest developments of a compressed-air vehicle along with an introduction to various problems associated with the technology and their solution. While developing compressed air vehicle, control of compressed air parameters like temperature, energy density, requirement of input power, energy release and no emission development for a safe, light and cost effective compressed air vehicle in near future. Reducing the weight of the vehicle has many advantages as it increases the overall efficiency of the vehicle, helps in improving maneuverability, requires less energy to run and stop the vehicle.***

Keywords: Pneumatic, Compressed Air, Energy density.

I. Introduction

Fossil fuels (i.e., petroleum, diesel, natural gas and coal), which meet most of the world's energy demand today, are being depleted rapidly. Also, their combustion products are causing global problems, such as the greenhouse effect, ozone layer depletion, acid rains and pollution, which are posing great danger for our environment, and eventually, for the total life on our planet. These factors are leading automobile manufacturers to develop cars propelled by alternative energies. Hybrid cars, Fuel cell powered cars, Hydrogen fueled cars will be soon into the market as a result of it. One possible alternative is the Air-Powered Car. Air, which is abundantly available and is free from pollution, can be compressed to higher pressures at a very low cost, is one of the prime option since atmospheric pollution can be permanently eradicated. Whereas so far all the attempts made to eliminate the pollution has however reduced it, but complete eradication is still rigorously pursued. Compressed air utilization in the pneumatic applications has been long proven. Air motors, pneumatic engines, actuators and other equipments are in use. Compressed air was also used in some of the vehicle for boosting the initial torque. Compressed air has been used since the 19th century to power mine locomotives, andwas previously the basis of naval torpedo propulsion. The costs involved to compress the air to be used in a vehicle are inferior to the costs involved with a normal combustion engine. Air is abundant, economical, transportable, storable and most importantly nonpolluting. The technology involved with compressed air reduces the production costs of vehicles with 20% because it is not necessary to assemble a refrigeration system, a fuel tank, spark plugs or mufflers. Air itself is not flammable. The mechanical design of the motor is simple and robust. The tanks used in an air compressed motor can be discarded or recycled with less contamination than batteries. The tanks used in a compressed air motor have a longer lifespan in comparison with batteries, which, after a while suffer from a reduction in performance. Refueling can be done at home using an air compressor or at service stations. Reduced vehicle weight is the principle efficiency factor of compressed-air car. The rate of self-discharge is very low opposed to batteries that deplete their charge slowly over time. Therefore, the vehicle may be left unused for longer periods of time than electric cars. Lower initial cost than battery electric vehicles when mass produced. Compressed air is not subject to fuel tax. Lighter vehicles would result in less wear on roads. The price of fueling air powered vehicles may be significantly cheaper than current fuels.

Light weight vehicles are the next advancement in the development of automobiles. Reducing the weight of the vehicle has many advantages as it increases the overall efficiency of the vehicle, helps in improving maneuverability, requires less energy to stop and run the vehicle. The latest researches are going on around the world in order to come up with innovative ideas. But global

warming is also one of the problems which is affecting the man. The temperature of the earth is increasing drastically and this in turn is causing climatic changes. The fossil fuels are widely used as a source of energy in various different fields like power plants, internal & external combustion engines, as heat source in manufacturing industries, etc. But its stock is very limited and due to this tremendous use, fossil fuels are diminishing at faster rate. So, in this world of energy crisis, it is necessary to develop alternative technologies to use renewable energy sources, so that fossil fuels can be conserved.

The first compressed air vehicle was established in France by a Polish engineer Louis Mekarski in 1870. It was patented in 1872 and 1873 and was tested in Paris in 1876. The working principle of Mekarski's engine was the use of energy stored in compressed air, another application of the compressed air to drive vehicles comes from Uruguay in 1984, where Armando Regusci has been involved in constructing these machines. He constructed a four-wheeler with pneumatic which travelled 100 km on a single tank in 1992. The Air Car was developed by Luxembourg-based MDI Group founder and former Formula One engineer Guy Negre is which works on compressed air vehicle (CAV).

Because of global problems such as greenhouse effect, ozone layer depletion, acid rain, air pollution our total life of our planet is reducing day by day. These factors are leading automotive technology and development of alternative energy sources. Some of them are electrical powered, solar powered, hydrogen powered, etc. but before we utilize and Compressed air is having energy stored within. This energy can be converted into required output by expanding it to atmospheric pressure. This air without external chemical or physical support is having potential to generate output work. As it is green and clean type of energy environment and roadside issues can be neglected.This paper details how to replace four stroke fossil fuel engines with air charged rotary engines.

II. Working principle

The compressed air vehicle consists of the air storage tank which stores the compressed air inside the tank. Then there is a gate valve for the controlling of the compressed air into the next part of the system. This vehicle also consists of a non-return valve, pneumatic (gun) drill, shafts and chain drive and sprocket mechanism. The compressed air stored in the tank enters the gate valve which is placed near the handle for the comfort of the driver, when the gate valve is opened the air enters the pneumatic drill (gun) for the actuation or the motion of the vehicle. This vehicle is designed as a tri-wheeler for the better comfort and easier handling of the vehicle. The compressed air enters the air gun through a gate valve by which the shaft is driven and by the chain sprocket mechanism the power from a shaft is transmitted to the other shaft or the rear wheel shaft thus making the vehicle driven. Air gun is the main part of this vehicle .it contains a rotor inside the cylinder .the rotor is fitted with three vanes .as the compressed air is flow through the air gun the vanes inside the gun rotates, this motion is transferred to the driven sprocket then using chain drive this motion is given to the back wheel, the supply of air is controlled using gate valve.

3D Modeling

3D modeling is done using the software Autocad.

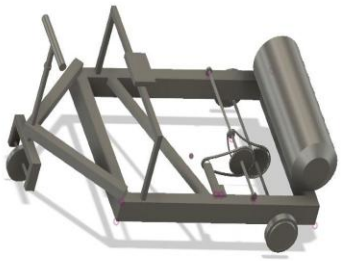

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Figure 1: ISO view of total assembly.

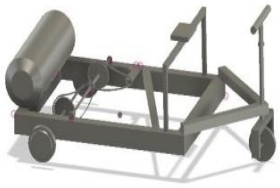

Figure 2: Left side view.

Components and description

Frame

Mild steel is used for the manufacturing of frames. The whole parts are mounted on this frame structure with suitable arrangement. Boring of bearing sizes and open bores done in one setting so as to align the bearings properly while assembling. Provisions are made to cover the bearings with grease.

Sprockets

Sprocket or sprocket-wheel is a profiled wheel with teeth, cogs, or even sprockets that mesh with a chain, track or other perforated or indented material. The name 'sprocket' applies generally to any wheel upon which radial projections engage a chain passing over it. It is distinguished from a gear in that sprockets are never meshed together directly, and differs from a pulley in that sprockets have teeth and pulleys are smooth.Sprockets are of various designs, a maximum of efficiency being claimed for each by its originator. Sprockets typically do not have a flange. Some sprockets used with timing belts have flanges to keep the timing belt centered. Sprockets and chains are also used for power transmission from one shaft to another where slippage is not admissible, sprocket chains being used instead of belts or ropes and sprocket-wheels instead of pulleys. They can be run at high speed and some forms of chain are so constructed as to be noiseless even at high speed.

Chain drive

Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a wheel chair, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides wheel chairs.
Most often, the power is conveyed by a roller chain, known as the drive chain or transmission chain, passing over a sprocket gear, with the teeth of the gear meshing with the holes in the links of the chain. The gear is turned, and this pulls the chain putting mechanical force into the system. The power is transferred by simply rotating the chain, which can be used to lift or drag objects. In other situations, a second gear is placed and the power is recovered by attaching shafts or hubs to this gear. Though drive chains are often simple oval loops, they can also go around corners by placing more than two gears along the chain; gears that do not put power into the system or transmit it out are generally known as idler-wheels. By varying the diameter of the input and output gears with respect to each other, the gear ratio can be altered.

Air gun

A chuck is a specialized type of clamp. It is used to hold an object with radial symmetry, especially a cylinder. In drills and mills it holds the rotating tool whereas in lathes it holds the rotating work piece. On a lathe the chuck is mounted on the spindle which rotates within the headstock. For some purposes (such as drilling) an additional chuck may be mounted on the non-rotating tailstock.Many chucks have jaws, (sometimes called dogs) that are arranged in a radially symmetrical pattern like the points of a star. The jaws are tightened up to hold the tool or work piece. Often the jaws will be tightened or loosened with the help of a chuck key, which is a wrench-like tool made for the purpose.[1] Many jawed chucks, however, are of the keyless variety, and their tightening and loosening is by hand force alone. Keyless designs offer the convenience of quicker and easier chucking and

unchucking, but have lower gripping force to hold the tool or work piece, which is potentially more of a problem with cylindrical than hexagonal shanks. Some lathe chucks have independently moving jaws which can also hold irregularly shaped objects (ones that lack radial symmetry). Collet chucks, rather than having jaws, have collets, which are flexible collars or sleeves that fit closely around the tool or work piece and grip it when squeezed. A few chuck designs are more complex yet, and they involve specially shaped jaws, higher numbers of jaws, quick-release mechanisms, or other special features.

Non return valve

A check valve, clack valve, non-return valve or one-way valve is a valve that normally allows fluid (liquid or gas) to flow through it in only one direction.Check valves are two-port valves, meaning they have two openings in the body, one for fluid to enter and the other for fluid to leave. There are various types of check valves used in a wide variety of applications. Check valves are often part of common household items. Although they are available in a wide range of sizes and costs, check valves generally are very small, simple, or inexpensive. Check valves work automatically and most are not controlled by a person or any external control; accordingly, most do not have any valve handle or stem. The bodies (external shells) of most check valves are made of plastic or metal.An important concept in check valves is the cracking pressure which is the minimum upstream pressure at which the valve will operate. Typically the check valve is designed for and can therefore be specified for a specific cracking pressure. Heart valves are essentially inlet and outlet check valves for the heart ventricles, since the ventricles act as pumps.

Design

Design of sprocket and chain

Assume n_1= 340rpm and n_2= 120rpm

Transmission ratio (i) = n_1/n_2 = 340/120 = 2.8

Here we take teeth on the smaller sprocket as 15

So, the teeth on the large sprocket = 15*2.8 = 42

C= P*Cp

Where, Cp = optimum center distance between sprockets in pitches.

C = center distance between pulleys mm

Assume center distance = 350mm

Take Cp = 30, with reference to data hand book by K.Mahadevan (page no 301)

Pitch, P = C/Cp = 350/30 = 11.66

Standardized pitch = 12.70 mm

So the standard chain selected as 8B

Pitch circle diameter of smaller sprocket = P/sin (180/75) = 12.70/sin (180/75) = 61.08 mm

Pitch circle diameter of large sprocket = 12.70/sin (180/z) = 12.70/sin (180/42) = 170 mm

Pitch line velocity of small sprocket = $\pi d_1 n_1/60 = (\pi*61.08*340*10^{-3})/60$ = 1.08 m/s

Number of links k = $(T_1+T_2)/2 + (2x)/p + (T_2-T_1/2T_1)^2 * P/x$

= (15+42)/2 + (2*350)/12.70 + (45-15/2*15)^2 * 12.70/350

= 83.64 (i.e. 84 links)

Length of chain L = k * p = 84*12.70

= 1066.8mm

Exact center distance, C = $P/4(k- (z1+z_2)/2 + \sqrt{(m-(z_1+z_2)/2)^2 - 8(z_2-z_1)/2\pi}$ = 330.87 mm

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Design of shaft

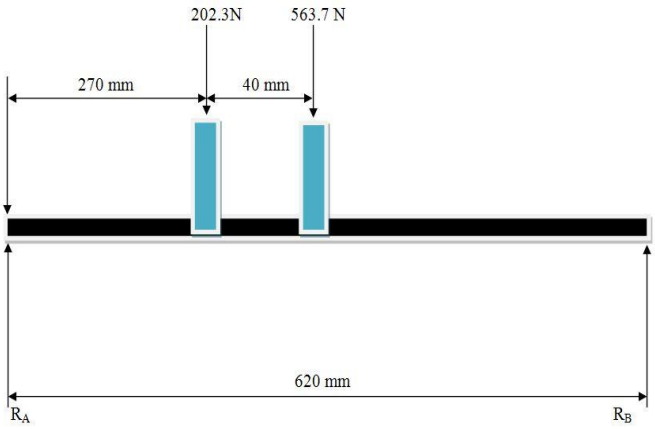

Figure.3. Free body diagram.

From Figure.1, $R_A + R_B$ = (202.3 N + 563.7 N) = 765.5 N

Torque on the shat is taken as 17.2 Nm
Force on the shaft by large sprocket ,T/(D/2)
$= (17.2*10^3) / (170/2) = 202.3$ N

Force on the shaft by small sprocket
$= (17.2*10^3) / (61.08/2) = 563.1$ N
$R_A + R_B = 765.5$

Moment at A,
Ma = (202.3*270) + (563.1*310) – 620 Rb
Rb = 369.64N
Ra = 395.85N
Mc = Ra*270 = 395.85*270 = 106879.93 Nmm
Md = Rb*310 = 369.64*30 = 114588.4 Nmm

Take maximum bending moment ;$Teq = \sqrt{T^2 + M^2}$
$= \sqrt{(17.2*10^3)^2 + (114588.4)^2}$
= 115872.09 Nmm
From the torque equation,
$T = \pi/16\ \tau\ d^3$
Assume shaft material is mid steel, so value of τ = 200Mpa
$d^3 = (115872.09*16)/(\pi*200)$
$d^3 = 2950.65$
d = 14.34mm

Standard diameter of shaft is 15mm from data book

Design of ball bearing
Bearing No. 6202

Outer Diameter of Bearing (D) = 35 mm
Thickness of Bearing (B) = 12 mm
Inner Diameter of the Bearing (d) = 15 mm
Corner radii on shaft and housing, r_1 = 1
(From design data book)

Maximum Speed = 14,000 rpm
Diameter (dm) = (D + d) / 2
= (35 + 15) / 2
dm = 25 mm

Advantages

. It uses no gasoline or other bio-carbon based fuel.
. Compressed air engines reduce the cost of vehicle production because there is no need to build a cooling system, spark plugs or starter motor.
. Reduction or elimination of hazardous chemicals such as gasoline or battery acids/metals.
. Pollution free and easy to manufacture.
. Very low cost and fuel efficient (compressed air).
. Low maintenance cost.

III. Conclusion

This work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this work. We are proud that we have completed the work with the limited time successfully. The technology of compressed air vehicles is not new. In fact, it has been around for years. Compressed air technology allows engines/ motors that are both non-polluting and economical. After one year of research and development, our compressed air car is brought into existence. Unlike electric or hydrogen powered vehicles, compressed air car is not expensive. Compressed air car is affordable and have a performancerate whose power to weightratio stands up to 0.0373kW/kg. For arriving at afair power to weight ratio, we considered possible factors which would result to minimize the weight of the car. For this we designed 3 wheeled vehicles. The entire chassis is fabricated with 1 inch angular frames. Unlike conventional transmission systems which include clutch, counter shaft, fly wheel, propeller shaft, differential, our pneumatic motor is coupled to the rear wheel with intermediate gear box which greatly reduces the transmission losses and weight of the vehicle. It also occupies lesser space compared to a four wheeler. This car gives an economy of about Rs.1 per kilometer. At the same time the well to wheels efficiency of the vehicle need to be improved. This is a revolutionary design which is not only eco friendly, pollution free, but is also very economical. This addresses both the problems of fuel crisis and pollution. However excessive research is needed to completely prove the technology for both its commercial and technical viability. Our motto is to bring peace and tranquility to earth from pollution.

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