DESIGN AND FABRICATION OF PNEUMATIC TRICYCLE

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Abstract : This project is design, fabrication and development of a DESIGN AND FABRICATION OF PNEUMATIC TRICYCLE it is rear wheel drive. The conceptual design of this model taken from manually operated tricycle. The complete body looks like a Tricycle in which manual operation is replaced by automatic operation. This product is a pneumatic vehicle, useful for handicapped people, equipped with pneumatic ratchet, pressure regulator, DC air compressor, air tank, chain sprocket transmission drive. The power transmission takes place from ratchet to rear wheel through chain drive. Only one person allowed on the Tricycle at any time. Modification by attach support is to make structure more strong at critical point. The materials, mild steel is choose as a main structure fastening by joint

keywords **- Pneumatic ratchet, Pressure regulator. Primary Pneumatic Actuator, Back Air Fill acuator**

1.INTRODUCTION:

Pneumatic systems form the most primitive and distinct class of mechanical control engineering. They are classified under the term 'Fluid Power Control', which describes any process or device that converts, transmits, distributes or controls power through the use of pressurized gas or liquid. In a pneumatic system, the working fluid is a gas (mostly air) which is compressed above atmospheric pressure to impart pressure energy to the molecules. This stored pressure potential is converted to a suitable mechanical work in an appropriate controlled sequence using control valves and actuators. Pneumatic systems are well suited for the automation of a simple repetitive task. The working fluid is abundant in nature and hence the running and maintenance cost of these systems are exceptionally low. All fluids have the ability to translate and transfigure and hence pneumatic systems permit variety of power conversion with minimal mechanical hardware.Conversion of various combinations of motions like rotary-rotary, linear-rotary and linear-linear is possible. The simplicity in design, durability and compact size of pneumatic systems make them well suited for mobile applications. These features make them versatile and find universal applications including robotics, aerospace technology, production and assembly of automotive components (power steering, chassis and engine assembly), CNC machines, food products and packaging industry, bomb deployment units and fabrication process of plastic products.

1.1 Problem statement:

In manually operated tricycle there are some limitations -

a) It requires muscular energy to operate the handle of sprocket gear.
b) More efforts are required to operate this handle.
c) While operating the handle it is difficult to control the other control systems like braking and steering mechanism.
d) It Gives fatigue to operator.
e) Handicapped people may not able to apply the required efforts to drive the tricycle.

1.2 Objectives:

1) Better speed is obtained in case of pneumatic vehicle is high compared to AGV's used in industry for material handling.
2)Industrial material handling effectively. To save energy and reduce power consumption.
3)Energy input saves as in case of pneumatic vehicle after filling air in reservoir we just only recirculate in the system.
4)Better speed is obtained in case of pneumatic vehicle is high compared to AGV's used in industry for material handling.
5) Fabrication model development of single rider automatically operated tricycle.
6) By some modification and improvement inside the engine increase the power and efficiency of motor.

1.3 Future scope

1. Now a days the market demands are increasing day by day to meet their requirement an automated system is needed .so we have developed a new machine tool which will meet this requirement.
2. By making some modifications we can give this project a new direction towards an ecofriendly vehicles.
3. This could be helpful for the handicapped people to travel with ease.
4. We can use high torque Pneumatic motor in this tricycle.
5. We can eliminate the refilling time by instant filling of air directly from a dc air compressor.
6.We can use solar panels at the top of tricycle to power the Dc compressor and to store compressed air into the tank.

2.METHODOLOGY

A compressed air powered tricycle uses compressed air for its operation. Compressed air power system is nowadays widely accepted for research by various industries for the development of different drives for different operations. The pneumatic

technology is not at all complicated. Storage of air by compression in the cylinder will store some energy. This stored energy can be of use in various aspects. The expansion of the compressed air releases energy within the system to do the work. So, this energy released during expansion is used to actuate the piston. This is the basic principle for a pneumatic system. In case of the compressed air driven cycle, there is no combustion process taking place within the engine. So, it is neither polluting nor harmful. And also, the elimination of combustion metal makes it lighter in weight as it does not have to take up elevated temperature..

Firstly, after the literature review our group decided upon two ideas. Both the ideas were closely related to power generation using compressed air. In both the ideas power was derived from the stored energy released during expansion of compressed air. The two approaches included the following:

- Pneumatic engine
- Inversion of slider crank mechanism

1.Pneumatic engine:

The idea was about the cycle able to be driven by using pneumatic engine. A basic cycle was used in this project. In the above approach the pneumatic engine is a four stroke petrol engine with some alteration for the conversion into a two stroke engine. The former was achieved by modification of the basic design of cam shaft and engine. The inlet port being permanently closed, the closing of inlet and conversion of 4 stroke engine to 2 stroke requires change in valve timing diagram. This is gained by alteration of the cam design according to the required specification.

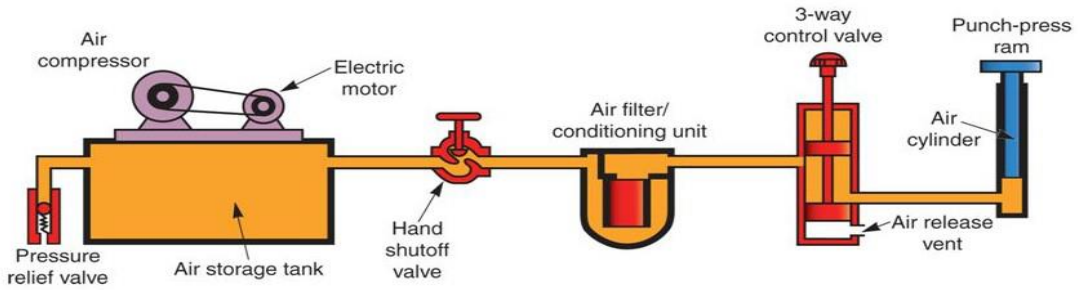

Fig.no..2 : Pneumatic System

The power transmitted in the scenario is done by the sprocket on the engine shaft. The engine assembled is placed on the rear carriage and is fixed on to the carriage. Whenever the air enters the engine, it moves the piston so as to rotate the shaft. The extended shaft has a sprocket on one end.

2.1.Inversion of slider crank mechanism

In this approach a piston being used to actuate the inversion of slider crank mechanism is the focus. Inversion of slide crank mechanism is shown in figure. An air compressor is used to pump air into the storage tank. The piston is to be placed in such a way that it rotates the crank attached on to the sprocket. The air storage tank and cylinder assembly is mounted on to the cycle above the rear wheel.

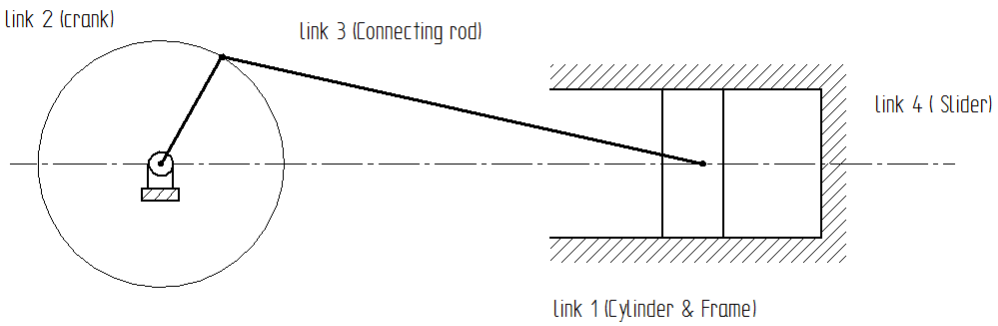

Fig.no.2 : Inverted slider crank

The air stored in the tank has a definite pressure and it holds some stored energy. This air enters the piston and it actuates the piston rod in the forward direction. This forward stroke is being translated to a rotary motion of the wheel using inversion of slider crank mechanism. This requires a plate which is to be fixed on to the cycle sprocket which is being used for the wheel rotation. A hub is used to connect the metallic plate and the piston rod. The actuation of the piston will rotate the crank which will rotate the wheel sprocket.

3 .LITRETURE REVIEW

[1]A.A.Keste, S. B. Viseet [2012] [1]
A pneumatic vehicle uses compressed air as a source of energy for locomotion. In this system, a double acting pneumatic cylinder is operated as a slider crank mechanism which converts the linear reciprocation of the cylinder piston rod into oscillatory motion of the driver crank about the pinion shaft.
[2]W.K Lai, M. F. Rahmat (2012)[2]
Have presented a journal paper stating the controller design parameters and the modelling of pneumatic actuator system with control valve.
[3]Sujit Kumar, Jayanta Das[2013][3]
Have said that flywheels have significant moment of inertia and thus resist change in rotational speed.
[4]Jian Chu, Yan Feng [2013][4]
This article introduces the automatic control process of solenoid valve production line with PLC control and touch screen user interface. The production line can produce four types of solenoid valves.

[5] Franco Antony, P J Albert [2014] [5] Many hybrid technologies are arriving which intend in reducing the fuel usage there by increasing the fuel economy and also reduced exhaust emission.
[6]James C. Martin, Douglas L. Milliken [2014][6]
This journal paper has discussed about the validation of a mathematical model for cycling power. This paper has helped us do the calculations regarding the resistances offered to riding a bicycle and calculating the total power required to overcome it.

4.CONCEPT DESIGN

1) **Pneumatic Actuator** - The compressed air is fed in one direction of actuator which reciprocates the piston to and fro by the impact of high pressure air. Cylinder is manufactured generally from Aluminum & aluminum alloys with central bore on lathe machine. We uses cylinder of SC Series of size 50×100. Fig.

Fig. no..3.1 Pneumatic Actuator

2) Solenoid Valve – Solenoid valve is a valve operated & controlled electromechanically. Firstly the electric current controls the valves through solenoid, the valve is on or off when it is of 2 ports. Solenoid valve gives high reliability, fast & safe switching, and long service life. Valves are made from cheaper materials (e.g. aluminum and polymer). For our system we uses solenoid valve of DV4-08, Pressure: 0.16-0.8 MPa.

Fig. no. 3.2 Solenoid Valve

3) **Air Circulating Devices** - The compressed air is stored in an air receiver from which air is drawn out in to application point by means of air circulating devices. PU tubes are made up of Polyurethane. It has sufficient strength to handle high pressure of compressed air.

Fig. no.3.3 Air Circulating Devices

4) Air back fills Actuator - It is used to refill the actuator with air which is used to run vehicle according to revolution of wheels. It is actually a pneumatic actuator but in our project we use 2 actuators of different capacity for 2 different applications. It is Connected rear wheels to work according to wheel revolution. We used actuator of model 25M100, pressure range 0.1 – 0.15 MPa.

5) Limit Switch –Limit switch is operated by the motion of machine parts or by presence of the object. It is a mechatronics device that mechanically controls the actuator links to set of contacts. When an actuator comes in contact with the actuator, the device operates the contacts to make or break electrical connections. It is used to actuate primary & back air fill actuator alternately according to wheel revolution.

Fig no.3.4 Limit Switch

6) **Gears –** It is used to obtained desired speed & gear ratio as per our need. In our project we need more speed & torque than power developed at actuator, so we placed first gear & then pinion in transmission lines to obtain comparatively more speed. In our system we have gear teeth difference of 30 so we obtained gear ratio of 2.

Fig. no.3.5 Gears

7) Chain & Sprocket- In chain & sprocket, sprocket is a toothed wheel with only one directional rotation restricted by suitable mechanism. Chain drive is considered as positive drive as there is no slip occurs in chain drives. It is used to transmit power obtained at actuator from pinion to the rear wheel shaft

Fig.no.3.6 chain & Sprocket

8) Bearings – It is used to reduce friction between two rotating part in order to reduce wear & tear of rotating materials.

Fig.no.3.8 Bearing

9) **Chassis** – Chassis is the foundation of any vehicle from which system is developed. It is supported on wheels using that it have to sustain all the loads of the system. It is the base of vehicle on which whole components and Pneumatic control system.

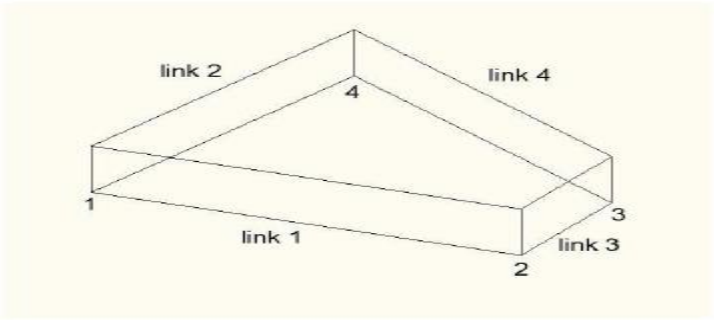

Fig.no.3.9 Chassis

3.1Cad Model

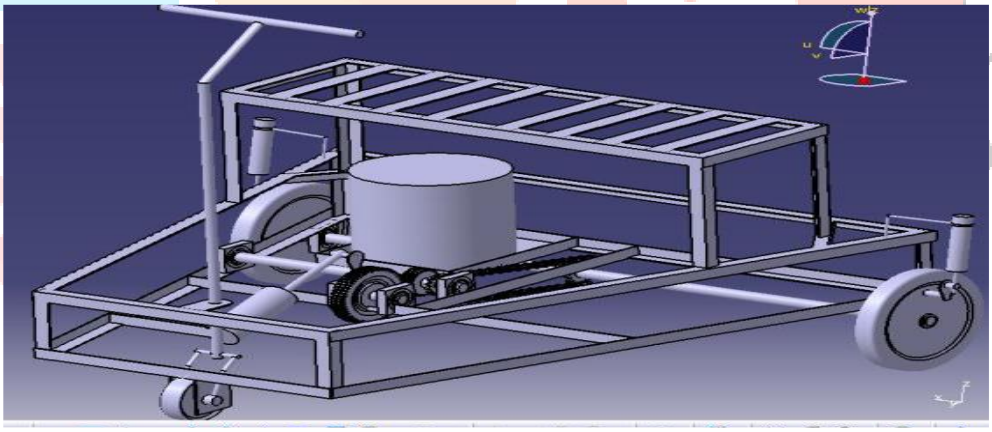

Fig3.10 Cad Model

4.Calculation

Design Of Chassis:-

Input data

- total weight = 70 kg
- no of links = 4

2 links of 915 mm

1 link of 910 mm

1 link of 300 mm

Force = 70 kg

= 70 × 9.81

= 686N

Face Width:-

- In the design of gears it is necessary to express the face with in terms of module.
- If the face width is to large there is possibility of non-uniform distribution of load across the face with of the tooth.
- In practice the face width is taken as 9 and 15 times the module

Assume the face width 12 m.

$$Fb = \sigma bp \times b \times m \times Yp$$

$$=166.67\times12m\times m\times0.402$$

$$=804.016\ m^2,\ N$$

For wear strength,

$$Dp = m \times Zp$$

$$=35\ m$$

$$Q = \frac{(2.Zg)}{(Zp+Zg)} = \frac{(2\times70)}{(70+35)} = 1.33$$

For FG 350

$$K = 0.16\left(\frac{BHN}{100}\right)^2$$

$$= 0.16 \times \left(\frac{240}{100}\right)^2 = 1.21\ N/m^2$$

$$Fw = Dp \times b \times Q \times k$$

Where,

Dp = pinion diameter.

b = face width.

K = load stress factor.

Q = ratio factor.

$$=35\ m\times12m\times1.33\times1.21=675.906m^2\ N$$

As Fb < Fw pinion is weaker in beam strength

Effective load

Dia. of piston = 25mm

Length of crank = 60mm

Pressure = 5 bar

Pressure = force/area

$$\text{Force} = P.A = 5\times10^5\times10^{-6}\times\left(\frac{\pi}{4}\right)25^2$$

$$=245.43\ N$$

Torque = force × radius of crank

$$=245.43\times60$$

$$=14.725\ Nm$$

$$\text{Power} = \frac{2\pi Nt}{60} = \frac{2\pi\times80\times14.75}{60}$$

$$=123.31\ Watt$$

Assuming the gear is manufactured by hobbing, shaping or milling machine

So the velocity factor becomes

$$Kv = \frac{6}{6+v}$$

$$=\frac{6}{(6+0.1125m)}$$

Service factor Ka = 1

Load factor Km = 1

$$F\ effective = \frac{Ka\times Km\times Ft}{Kv} = 1\times1\times\left(\frac{3412.3}{m}\right)/\left(\frac{6}{6}+0.188m\right)$$

$$= (3412.3+160.37m)\ N.m$$

6.WORKING

Working of our vehicle is same like typical pneumatic System but with some different aspect. Firstly compressed air from compressor is stored in tank. Then air from passing through control system according to our requirement and speed conditions. Then air allows passing through primary actuator by which piston rod of actuator pushes the gear and pinion

For next half revolution of wheel, limit switch is there, which actuates at the extreme end of piston rod of Primary actuator. Limit switch then actuates solenoid valve and also then activates back air fill actuators placed at rear wheels. Back air fill actuate circulates air back to reservoir for moving remaining half revolution of the wheel.

7.ADVANTAGES

1. Easy Construction.
2. Can be built up to various capacities easily.
3. Low maintenance cost.
4. It has Simplicity of design & construction.
5. It has good reliability.

DISADVANTAGES OF COMPRESSED AIR SYSTEM:-

1. It is inaccurate in operation.
2. High forces cannot be transmitted.

3. It provides non-uniform speeds.
4. Creates noise pollution.
5. Expensive.
6. Conditioning of air is needed.

8. APPLICATIONS:-

Usually air at low pressures in the range of 5 to 7 bar is used in pneumatic systems. Compressed air systems are used for many industrial applications. Some of its applications are:

1. To operate pneumatic tools
2. Spray Painting
3. Refrigeration and air conditioning systems
4. Gas turbine power plants
5. Supercharging of I.C Engines
6. Conveying materials like sand and concrete, coal mixtures etc. in pipe line
7. Pumping of Water
8. Driving the mining machinery.

9.SCOPE FOR FUTURE WORK

- Actuators which can work at higher pressures can be utilised for higher power output.
- The arrangement of the frame can be altered so as to decrease weight and increase the comfort level of the rider.
- The friction at the bearings and the piston connecting rod interface can also be reduced through a thorough analysis of the mechanism.

10.REFERENCES

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