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Energy generation from road vehicle

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ABSTRACT

Electricity is the most necessary form of energy. We cannot even imagine our life without electricity. Consumption of electricity is increasing day by day. Nowadays most of the electricity is generated by conventional fossil fuels, eventually, the conventional power sources will get depleted by the next few decades. This paper is about to use nonconventional energy source for power generation. Here we generate energy by air compression. All the setup is placed under speed bumper when vehicle passing from speed bumper it generates electricity. The main benefit of this method is here we use wasted energy for power generation.

Keywords— *Pneumatic, Generator, Electricity, Power and Capacity*

1. INTRODUCTION

In the present day scenario, power is the major need for day to day human life as well as every sector of the economy. The day-to-day increasing population and decreasing conventional sources for power generation provides a need to think on non-conventional energy resources. Roads and highways are the great media of transport in India. A number of vehicles passing over the speed breaker in roads is increasing day by day. A large amount of energy is wasted at the speed road surface through the dissipation of heat and also through friction, every time a vehicle passes over it. There is a great possibility of tapping this energy and generating power by making the desired part of the road as a power generation unit. The generated power can be stored and used to illuminate the lamps, near the speed breakers. Places such as Toll bridges, vehicle parking stands are best suitable for its utilization.

In this project, we discover technology to produce electricity from road surfaces, where the system produced is trustworthy and will help in conserving our natural resources. The overall goal was to design the structural System while keeping the engineering in check.

The methods to generate electricity through road is comprises of the structural bridge, a pneumatic circuit to transfer compressed air, and a power generation circuit usually comprises of DC generator for generation of power using this pressure energy of compressed air.

2. AIM AND OBJECTIVES

(a) The aim of this project is to develop such a system that will effectively convert the road vehicle energy into electrical energy and shall be able to fulfil the energy demands of peoples.
(b) The main objective behind this project is to the recovery of the wasted energy at the road surface and its conversion in electrical energy.
(c) The objective of this project also focuses on reducing the use of non- renewable energy sources by implementing renewable energy source.

3. WORKING PRINCIPLE

The project is concerned with the generation of electricity from speed breakers-like set up. When a vehicle runs on the road due to the weight of the vehicle; The Structure starts to move downward due to this the Bellows which are situated under the road compresses. From this compression of bellows, we get compressed air. This compressed air flow through hoses and store into the reservoir passing through a non-return valve and FRL unit. This compressed air is used also for Industrial purpose.

This compressed air is then passed through a nozzle, which increases the kinetic energy of air hence, although enough speed due to the kinetic energy achieved at the nozzle, this speed is sufficient to rotate the rotor of a generator. The rotor which rotates within a static magnetic stator cuts the magnetic flux surrounding it, thus producing the Electric Motive Force (EMF). This generated EMF is then sent to a bridge rectifier, where the generated AC current is converted to DC. This regulated EMF is now sent to the lead-acid battery.

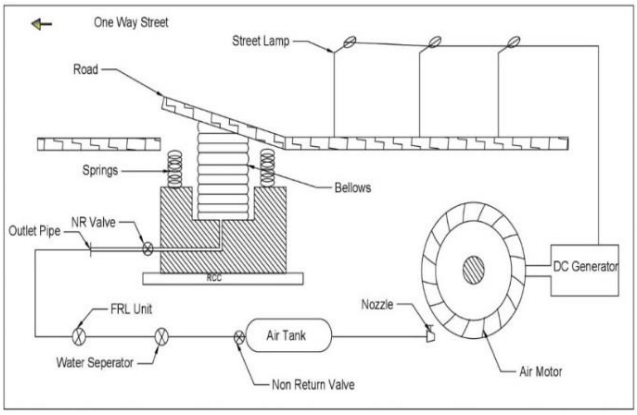

Fig. 1: Block diagram

3.1 Metallic bellows

Thin gauge diaphragms or discs are used in series and joined by the welding process. Fabricated bellows are made from heavier gauge material than formed bellows. Hence fabricated bellows can withstand a higher amount of pressure. The bellows convolutions are formed either hydraulically or mechanically, from the thin walled tube. The forming method should be very precise so that material thinning should be controlled, in order to maintain uniform thickness. The main components of bellows are convolutions, crest, root and tangent part. The other important configurations of bellows are the pitch of convolutions, mean diameter of the bellow, the height of convolutions, convolution depth, tangent part etc. The figure shows various components of bellows.

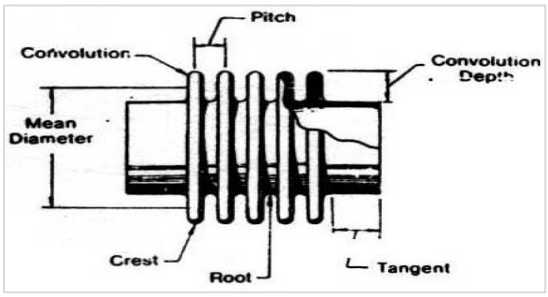

Fig. 2: Components of a bellow

The material used for bellow is Stainless steel 304 is an austenitic grade that can be severely deep drawn. This Property has resulted in 304 being the dominant grade used in applications like Sinks and saucepans.

Table 1: Physical properties of stainless steel sheets-SS 304

Property	Value
Density	8.00g/cm3
Melting point	1400-1450°C
Modulus of elasticity	193000 MPa
Thermal conductivity	16.2W/m.Kat 100°C
Thermal expansion	17.2x10-6/Kat100°C

3.2 Helical compression spring

A coil spring, also known as a helical spring, is a mechanical device which is typically used to store energy and subsequently release it, to absorb shock, or to maintain a force between contacting surfaces. They are made of an elastic material formed into the shape of a helix which returns to its natural length when unloaded.

3.3 Air receiver

Air receiver is a storage tank to store the compress air. The capacity of receiver means the volume of the receiver. Receiver tank must be sufficiently large to store sufficient reserve amount of compressed air and to cool, condense and contain water until it is drained out. The capacity of air receiver should be greater than the volume of compressed air produced in one minute.

$$\text{The capacity of air tank} > \frac{\text{Atmospheric pressure} * \text{FAD per minute}}{\text{The pressure of compressed air}}$$

3.4 FRL unit

FRL Unit is a device consisting of air filter, Air Regulator and Lubricator. It is also called air servicing unit, because it does the function of cleaning, pressure adjustment and lubricating the compressed air.

3.5 Check valve

A normal check valve has only two ports, namely inlet port "A'' and outlet port "B''. Normally check valve is open in the forward direction and closed in the reverse direction.

3.6 Air motor

A pneumatic motor (air motor) or compressed air engine is a type of motor which does mechanical work by expanding compressed air. Pneumatic motors generally convert the compressed air energy to mechanical work through either linear or rotary motion. Linear motion can come from either a diaphragm or piston actuator, while rotary motion is supplied by either a vane type air motor, piston air motor, air turbine or gear type motor. From parker manufacturing catalogue P1V-A260 Vane type Air Motor is selected with an output speed of 1200 rpm.

3.7 Generator

In electricity generation, a generator[1] is a device that converts motive power (mechanical energy) into electrical power for use in an external circuit. Sources of mechanical energy include steam turbines, gas turbines, water turbines, internal combustion engines and even hand cranks. The first electromagnetic generator, the Faraday disk, was invented in 1831 by British scientist Michael Faraday. Generators provide nearly all of the power for electric power grids since the maximum output speed of the Air Motor is 1200 rpm. DC Shunt Generator is selected with Rating Power of 5 KW.

4. METHODOLOGY

The various methodologies used for getting different results and for selection of different components from manufacturing catalogue are given below

(a) Design of bellows
(b) Design of spring
(c) Selection of pneumatic component
(d) Selection of Air motor
(e) Selection of Generator

4.1 Design of bellows

Specifications:
Size (Inside): 1220mm×610mm
Size (Outside): 1462.4mm×852.4mm
Height: 562.5 mm
Design pressure: 5 Bar
Design Temp: 50˚C
No. Of Convolutions: 5
Thickness: 8 mm
According To Design Calculations

- Axial Load On Bellows: 33354 N
- Perimeter Stresses on Bellows: 10860 KN/M$^{\wedge 2}$
- Axial motion: (X): 150mm
- Lateral motion (Y): 40mm
- Bending Stresses due to Deflection: 6009.08×10$^{\wedge 3}$ KN/M$^{\wedge 2}$

4.2 Design of spring

Specifications from Design Calculations:
Material Used: C65 (Oil-Hardened and Tempered Material).
Tensile Strength: 1380 N/mm^2
Yield Strength: 430 N/mm^2
Diameter of Wire: 28 mm
Mean Diameter of spring: 201.54 mm
Spring Index: 7.19
Axial load on spring: 8338.5 N
No. of total turns: 15
Deflection: 150 mm
Shear Stress Produced: 234 N/mm^2

4.3 Selection of Pneumatic Components

P_1= Atmospheric Pressure = 1.10325 Bar
P_2= Design Pressure = 5 Bar
V_1= Volume of air before compression = 0.418 m^3
V_2 = Volume of air after Compression= 0.306 m^3

Table 2: Specification

S no.	Name of Components	Type selected	Specification
1	Non Return valve	Inline Equal NRV	Working Pressure: 5 – 10 Bar Working Temperature: -20˚C to 70˚C
2	Filter	Standard Filter	Correction Factor -0.85
3	Muffler	Metal Muffler	Size 3/8
4	Tube	Fire Proof High Resistant Polyamide Tube	Inner Diameter: 10 mm Outer Diameter: 12 mm
5	Nozzle	Standard Nozzle	Diameter: 2.5 mm Temperature: -15˚C to 50˚C

4.4 Selection of air motor

Selection of Air Motor
P1V-A260 Vane type Air Moto
F_{axial} = 700 N
F_{radial} = 1400 N
Output Speed = 1200 rpm
Output Torque = 34 N.m

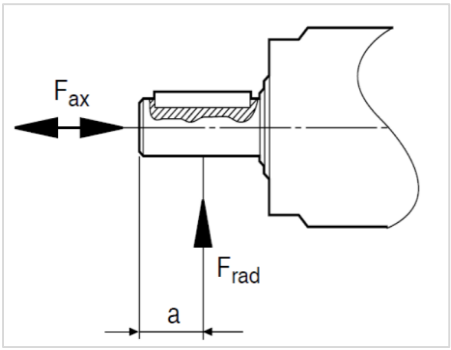

Fig. 3: Air motor

4.5 Selection of generator

Specifications:
Rating Power = 5 KW
Voltage = 440 V
Maximum speed = 1440 rpm
No. of Poles = 4 Poles

5. RESULT

5.1 Numerical analysis

Bellows Size: 1220 × 610 mm
Lateral Force: 3400 Kg

5.2 Mechanical output of air motor

Output speed = 1200 rpm
Axial Load = 700 N
Radial Load = 1400 N
Output Torque=34 N.m

5.3 Electrical output

Power Generated = 4.058 KW

6. CONCLUSION

- The result shows that power generated from the generator of 5 kW rating is 4.058 kW with generator efficiency 0.95.
- The air motor would be able to generate electrical energy using a generator.
- The Bellows compression mechanism driven by a vehicle on a road as a prime power generation source has many benefits like it does not depend on any type of fuel to run it, no waste production at any stage of the power generation process.
- Power generation is environmentally friendly, more sustainable and can be applied on a large scale to produce a larger amount of energy to benefit a bigger population.

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