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AIR CONDITIONING AND POWER GENERATION USING VEHICLE SUSPENSION

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Abstract*— *In this paper, we have designed a suspension operated AC system and power generation from suspension in automobile. This idea comes out as efficiency of vehicle reduces because of compressor and energy is wasted when vehicle goes from bumpy roads. After implementing this idea the efficiency of vehicle will vary to some extent by replacing compressor with pneumatic cylinder. The main concept is that the air conditioning effect will get on the basis of suspension system in vehicle. We designed the suspension operated AC system. We followed the various design process to finalize our project. Vehicle air-conditioning can significantly impact fuel economy and tailpipe emissions of conventional and hybrid electric vehicles (HEV).

Keywords*— *air condirioning,VCR cycle,rack & pinion,suspension.

I. INTRODUCTION

The function of vehicle suspension system is to support the weight of the vehicle body and to isolate the vehicle chassis from road disturbances and to enable the wheels to hold the road surface. Two main elements in suspension systems are spring and damper. The damper is designed to dissipate vibration energy into the heat to attenuate the vibration which is transmitted from road excitation. However, the dissipated heat is from fuel or electrical power. So, we have to pay little attention to energy loss of vehicle suspension. So we have came with a new idea of generating air-conditioning effect and power generation using vehicle suspension.

A. Air-conditioning Effect

When a vehicle runs on bumpy road it causes the suspension system to work and due to this there is

linear motion of the suspension system and most of the energy is dissipated. So to use this we had an idea of attaching a pneumatic cylinder in place of compressor so as to avoid energy loss and using VCR cycle we can obtained Air-Conditioning effect.

B. Power Generation

As we have obtained the Air Conditioning effect, we also have used the suspension system to generate electrical energy using Rack and Pinion. The motion of the rack and pinion runs the motor and thus the mechanical energy is converted into electrical energy and thus the aim of generating power and refrigeration effect is obtained.

II. PROBLEM STATEMENT

The conventional vehicle suspension dissipates the mechanical energy i.e. potential and kinetic energy. Inspiring potential energy is stored and kinetic energy is wasted. The aim of project is this wasted energy is used to compress refrigerant by using double acting cylinder by proper arrangement.

III. OBJECTIVE

The primary objective of this project is to fabricate a very simple and portable yet an effective air-conditioning unit which will help in energy conservation.

1. A very low capital investment; hence affordable for the common vehicle rider.
2. This will not need an artificial power source, ensuring minimum running cost.
3. Portability, which will be an added feature reducing the carrying or transportation cost.

IV. LITERATURE REVIEW

The purpose of this literature review is to go through the main topics of interest. The literature reviews is concerned with design of spur gear, DC generator, design of shaft, selection of bearings & shock absorber with theoretical and experimental evaluation.

1. “Fabrication of a Device Used For Producing Compressed Air Using Vehicle Suspension” by “Rajesh Kumar Sahu, Rajkishor Das, Jitendra Sahu, Akash Satapathy”

   This Paper includes how the compressed air is produced by using vehicle suspension. We know Pneumatic energy is the readily available and low cost energy. So here we are focusing on pneumatic type of energy for this project.
2. “Air Conditioning System Using Vehicle Suspension” of “Borse S.H., Satpute A.G., Mude J.M., Pokale R.S., Prof. Wabale A. D., Prof. Bhane A.B.”

   This paper is focused on energy saving mechanisms by using vehicle suspension system. This project can be very much useful

for Indian conditions because of geographical sites. Taking into consideration other manmade sites like road it is well known fact that we have one of the best as well as worst road conditions available. So this kind of project is well worth regarding Indian context of view. Using of this system in vehicle we are save fuel economy.

3. "Energy Generation by Suspension System" by"Ravindra Bhoite, Somanath Jadhav, Akshay Jape, Vikram Phadatare, Amardip Jadhav".
   From this paper, we used shock absorber, rack & pinion arrangement and dynamo. As shock absorber effect formed, spring is compressed and linear movement of rack is converted in rotary motion due to pinion moves as the rack is meshed with pinion. And the pinion is mounted on the shaft which is connected to shaft of dynamo. Due to this arrangement, rotary motion of pinion is used to rotate dynamo. As dynamo rotation leads to generation of energy.

V. WORKING PRINCIPLE

In this project we have attached single acting cylinder to the frame. The single acting cylinder works due to linear motion or due to compression of the spring. Due to this the piston the single acting cylinder reciprocates and due to which air is compressed in the cylinder and then passed forward. A NRV valve is fitted so that the passed compressed air does not changes it direction. The compressed air is passed to the refrigerant tank then the air is mixed with the refrigerant and due to this temperature of air is lowered and then this mixture is passed through condenser. Condenser condenses the mixture of compressed air and refrigerant and due to this the the mixture attains high pressure and low temperature. Now then it is passed to the evaporator. A fan is located near the evaporator and due to forced circulation of air over the evaporator a cooling effect is obtained. Now the mixture is again passed to the refrigerant tank so that it may get used for further compressed air and then due to this cycle rotates and cooling effect is obtained. The NRV valve is fitted after the evaporator so that the mixture of air and refrigerant do not change direction as it has gained some little increase in temperature and low pressure. Thus the cooling effect can be varied on the compression of the spring and the flow of refrigerant. The results are measured using temperature measuring laser gun and thus results are obtained.

When vehicle is run on bumpy road then suspension spring continuously move up and down. Rack is attached to the vehicle frame which is continuously moved up and down. Pinion is mesh with rack. As rack moves up and down pinion rotates clockwise and anticlockwise. Gear train is attached to the pinion which is useful for generating high R.P.M. to generate electricity. Ratchet is used there for one way rotation of gear. D.C. generator is attached to the high-speed gear train in which mechanical energy is

converted into the electricity which stored in battery and used for glowing lamp.

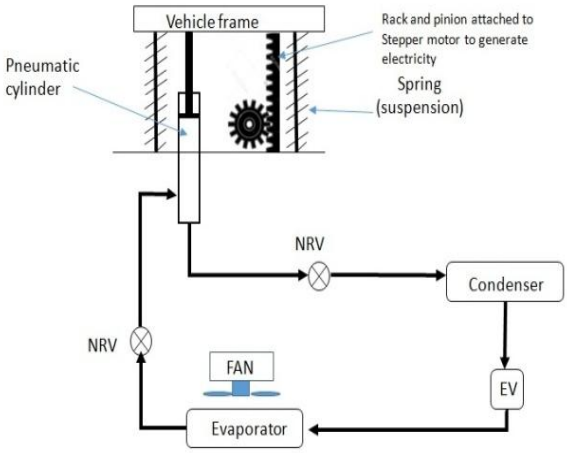

Figure 1: Block Diagram of System

VI. ACTUAL REPRESENTATION OF MODEL

Figure 2: Actual Photograph of System

VII. THEORETICAL ASSUMPTIONS AND CALCULATIONS

We attach piston to the vehicle frame because of linear motion of piston, high pressure coolant comes out from cylinder. This high-pressure coolant is passed through

A. CYLINDER

Cylinder Bore: 50mm

Stroke: 100mm

Pressure range = 0 to 10 Mpa

Volume of cylinder fo = Stroke × Area of Piston.

$= 100 * (\pi/4 \times D^2)$

$= 100 * (\pi/4 \times 50^2)$

$=196349mm^3$

Outward force of cylinder =pressure *area

$=0.4*\pi/4*D^2$

$=0.4*\pi/4*50^2$

=758.39N

B. SPRING

Maximum Deflection = δmax = 80 mm

Maximum Mass = m = 50kg

Maximum Force = F = mg= 50* 9.81= 490.5 N

Spring Index = C = 6

Material of spring = Spring steel

Modulus of Rigidity = G = 85 * 103 N/mm^2

Maximum Shear Stress = τ = 1300 N/mm^2

1. Wire Diameter

Wahl Factor shear stress factor = K_w

= (4C-1)/(4C-4)+0.615/C

= (4*6-1)/(4*6-4)+0615/6= 1.2525

$\tau = (K_w*8*C*F)/(\pi d^2)$

$1300 = (1.2525 * 8 * 6 * 490.5)/(\pi d^2)$

Wire Diameter = d = 2.68 ~ 3mm

2. Mean Coil diameter

Mean Coil diameter =D = C * d

= 6* 3= 18 mm

3. Number of Coils

Spring Stiffness = K = $F_{max}/(\delta_{max})$

= 490.5/80= 6.1312 N/mm

Now

$K = Gd/(8* c^3*n)$

$3.924= (85*1000*3)/(8*6^3*n)$

n= 37.6~38

Assume Plain End condition, so

Total number of coils = n = 38

4. Solid length

L_s= (n+1)*d= (38+1)*3= 117 mm

5. Free length

L_f= Solid Length + Maximum Deflection + Total Clearance

= $L_s + \delta_{max}$ + 15 % of δ_{max}

= 117+ 125 + 0.15* 125

= 260.75~261 mm

6. Pitch of coil

Free length = L_f= pn + d

261 = p* 38 + 3

p = 6.78mm

C. RACK & PINION

Data:

Z_1=50 Z_2=25 D=40

R=20

Length=250 mm

Pitch = 5mm

Addendum = m = 2

Module = pitch/π = 5/π = 1.59 = 2

1. Least pressure angle to avoid interference

Let

Φ = least pressure angle to avoid interference

Addendum = rsin2φ

2 = 20sin2φ

Φ = 18.434

2. Length of the arc of contact

Length of the path of contact

$=\sqrt{((r + addendum)^2 - (rcos\varphi)\text{^}2)}$

$=\sqrt{((20 + 2)^2 - (20cos18.434)\text{^}2)}$

=11.13 mm

3. Minimum no. of teeth

Circular pitch = $P_c = \pi d/Z_2$

=π*40/25 = 5.0265 mm

Therefore length of the arc of contact = (Length of path of contact)/(cosφ)

=(11.13/cos18.434) = 11.73

4. The no. of pairs of teeth in contact

= (Length of the arc of contact)/(circular pitch)

= 11.73/6.28 = 1.78

Therefore, minimum no.of teeth in contact = 2 or 1 pair

Addendum = m = 2mm

Dedendum =1.25*m = 2.5mm

Clearance = 0.25m = 0.5mm

Working depth = 2m = 4mm

Whole depth = 2.25m = 4.5mm

Tooth thickness = 1.5708*m = 3.1416mm

Tooth space = 1.5708m = 3.1416mm

Fillet radius = 0.4m = 0.8mm

D. CONDENSER

1. We are assuming a small increase in pressure will occur

P_2 =1.05 bar

P_1 =1 bar

$T_2 = T_1(P_2/P_1)^{((\gamma-1)/\gamma)}$

$=298\ (1.05)^{((1.4-1)/1.4)}$

= 302.1832 K

2. Volume flow rate of air = Volume/time

$=(\pi/4*d^2\ h)/time$

$=(\pi/4*(20)^2*100)/1$

One stroke in 1 seconds

$= 3.141592654*10^{-5}\ m^3/s$

3. Mass flow rate= volume flow rate* Density

$m = 3.141592654*10^{-5}*1.25$

$=3.926990*10^{-5}$ kg/s

C_p = 1.005 KJ/KgK

$.Q = m\ C_p\ (\Delta T)$

$=3.926990*1005*(302.1832-298)*10^{-5}$

= 0.694079 J/s

Consider the process lasts For 10 Minutes

Q=.Q * Time

=.Q*10*60

= 416.4477 J/s

Q = UAΔT

U =1000 J/KgK

416.4477=1000*A*10

A=39.26/(1000*10)

$A=99.55*10^{-3}\ m^3$ is the condensor area.

Evaporator is absorbing the temperature and giving a cooling effect on ourt side. The cooling is provided by Fan.

VIII. ACKNOWLEDGMENT

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