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Air Compression and Electricity Generation by Using Speed Breaker with Rack And Pinion Mechanism

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ABSTRACT: *On roads, speed breakers provided to control the speed of traffic in rushed areas. The potential energy in terms of weight of vehicle is loss on speed breaker can be utilized for useful purposes. This paper describes the potential energy of such type of energy available on roads and its utilization for useful work. The stages of development of a speed breaker device are described and the mechanism to generate electricity using rack, pinion and speed increasing gear box and generator and store compressed air with the help of piston cylinder compressor arrangement. Whenever the vehicle is allowed to pass over the speed breaker dome, it gets pressed downwards. As the springs are attached to the dome, they get compressed and the rack, which is attached to the bottom of the dome, moves down in reciprocating motion. Since rack has teeth connected to pinion there is conversion of reciprocating motion of rack in to rotary motion of pinion, but the two gears rotate in opposite direction. So that shafts will rotate with certain RPM these shafts are connected through a belt drive to the generators, which converts the mechanical energy into electrical energy. The rack is attached to piston rod of cylinder so downward stroke of rack we can use for air compression in reservoir, with help of piston cylinder arrangement. Simultaneously reciprocating piston cylinder arrangement compresses the air and stores it in the reservoir. We can use the generated electricity and compressed air for different purpose.*

Keywords*- Speed Breaker, Rack &Pinion, Gear, Air Compressor, Generator, Electricity Generation.*

I. INTRODUCTION

On road vehicles waste a tremendous amount of energy on speed breakers, where there is a necessity to provided speed breaker to control the speed of the vehicles. The annual rate of growth of motor vehicle population in India has been almost 20 percent during the last decade. There is tremendous vehicular growth in year by year. The increasing traffic and number speed breakers on roads motivate to manufacture an innovative device which can channelize the energy of vehicles that is wasted on speed breakers to some useful work. In this practical manufacturing processes and steps of speed breaker device for generation of compressed are described which can be used to generate compresses air on highways in remote areas. The reciprocating air compressors are used for pressurized air generation taking advantage of design simplicity and also these are the most common type of compressors found in various applications. This paper based on the principle of reciprocating air compressor in which compressor compresses the air by reducing the volume of air that has been isolated. we put our machine underground of road exactly below speed barker, the head of piston rod is bring up to level of road surface. When vehicles move on rack it will be pushed down. The piston is reciprocating in the cylinder. The piston and cylinder arrangement convert reciprocating motion in to air compression. The second part is specially planned to design and fabricate the conversion unit for utilizing the available unconventional energy source. That is tremendously available energy in low intensity with ample quantity can be utilized. This machine converts reciprocating motion in to rotary motion. The rotational power is converted into the electrical energy by using speed increasing gear box and generator that generate electricity. And this generated electricity is used in various applications.

II. SYSTEM REPRESENTATION

Block diagram of electricity generation and air compression by using speed breaker is shown in figure 2.1. First part is air compression by using speed breaker is shown as vertical block diagram and electricity generation is shown in horizontal block diagram. It indicates both electricity generation and air compression are occurs simultaneous when vehicle passes over speed breaker. It is main advantages of such arrangement of components.

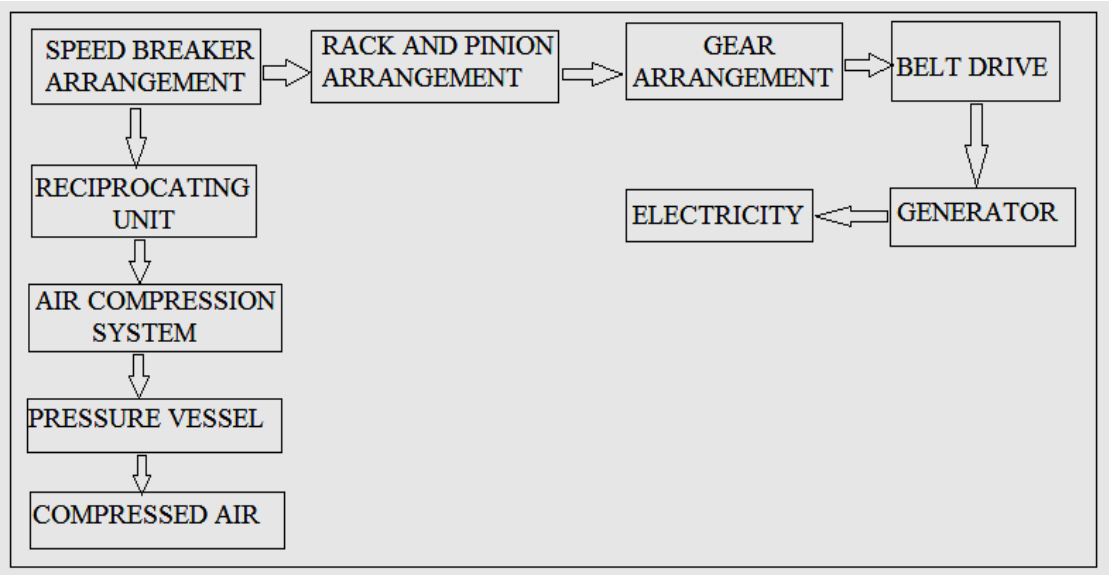

Figure 2.1: Block Diagram of Electricity Generation and Air Compressor by using Speed Breaker

III. CONSTRUCTION DETAILS

The following elements are used for construction of 'speed breaker air compressor and energy generation' model. Specification of this equipment is as per requirement amount of energy generation and air compression as shown in Table No.3.1.

The welding is used in fabricating the device is shielded metal arc welding by using the flux coated electrode. Another part welded on the bottom of the mild steel plate and in the middle of the plate. It is welded to give support and adjusts the reciprocating air compressor head.

Table3.1: Specification of Components

SR. NO	***COMPONENT***	***MATERIAL***	***SIZE***	***MATERIAL***
1	Piston	C-40	50mm x 25mm	EN34 with coating hard
2	Cylinder	C-40	80mm x100mm	Cast iron
3	Piston rod	C-40	20mm x 150mm	Plain carbon steel
4	Angles	C-25	25x 25 x 800mm in length	Plain carbon steel
5	Rack	C-30	20mm square	Plain carbon steel
6	Receiver tank	C-40	6 bar	EN8
7	Spring	C-40	4 x 20 x 140mm in length	Spring Steel
8	Nut bolts	C-25	10 x 5mm	Plain carbon steel
9	Washer	C-25	40 x 12 x 4mm	Plain carbon steel
10	Bearing	C-25	skf 6204, I.D 20mm	Plain carbon steel
11	Flexible pipes	_	Inner diameter 10mm	PVC rubber
12	Pinion gear	C-30	50mm diameter 22teeth	Plain carbon steel
13	Spur Gear	C-30	200mm diameter 70teeth	Plain carbon steel
14	Belt	Rubber	V belt	_

IV. PROPOSAL WORK

4.1 SPEED BREAKER AIR COMPRESSOR

4.1.1 WORKING PRINCIPLE

It works on the principle of reciprocating air compressor in which compressor compresses the air by reducing the volume of air that has been isolated. Here, first important point is how we get reciprocating motion, which is prime input in the system for that we use weight of moving vehicles that run on roads.

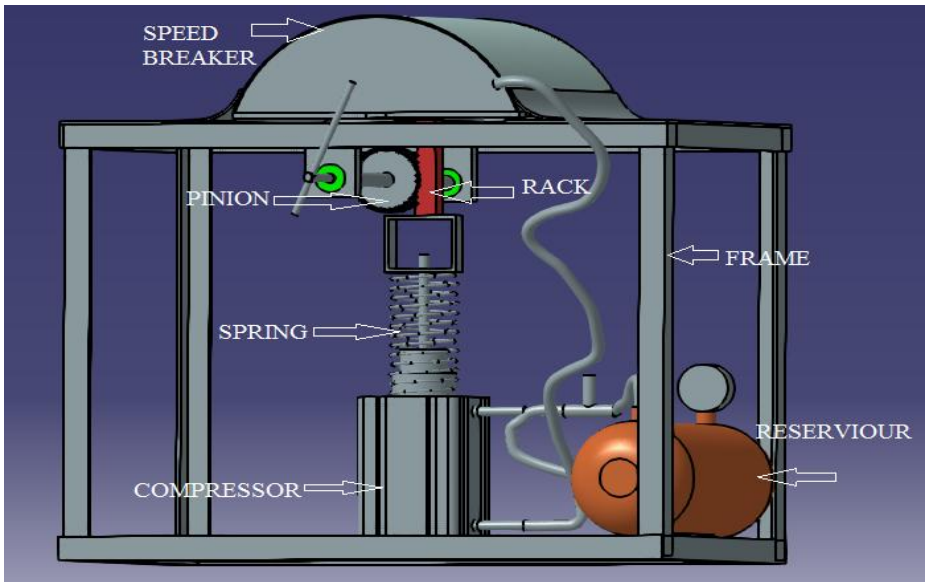

Figure 4.1: Speed Breaker Air Compressor

These machine unit kept underground of road exactly below speed breaker , the head of piston rod is bring up to level of road surface. When vehicles move on speed breaker it will be pushed down so rack move downward and rack is jointed to piston rodso the piston is reciprocating in the cylinder. The piston and cylinder arrangement convert reciprocating motion in to air compression. Now during the dome shaped part press stroke, the piston is coming towards or away direction pressing the already admitted air to be compressed. Thus the pressure or air increases due to compaction of air in the restricted air i.e. more amount of air packed in the low volume area caused by the sweeping of the piston inside the cylinder. The principle parts of kinetically operated reciprocating air compressor are same as that for the I.C. Engine. Inlet and delivery valves Automatic in their operation being spring loaded. They are operated and closed due to the difference of pressure created on either side and a spring provided to close the valve at its seat. [2]

In Working there are two strokes

1. Suction Stroke. 2. Delivery Stroke

During the suction stroke, piston moves down ward due to which pressure in cylinder falls down below atmospheric pressure. Intake value opens and the atmospheric air is taken inside during the whole stroke. In delivery stroke the piston moves inward with the compression of air in cylinder. Both the inlet and delivery are closed and compression proceeds. At the end of compression strokes, the pressure increases above the receiver pressure. The high pressure air overcomes the spring force on delivery valve and the air is discharged to the receiver tank.

4.1.2COMPRESSED AIR

Compressed air a mixture of all gases contained in the atmosphere. In this paper compressed air is referred to a gas when it is used as a fluid medium. The unlimited supply of air and the ease of compression make compressed air the most widely used fluid for pneumatic system although moisture and solid particles must be removed from the air it does not require the extensive distillation or separation process required in the production of other gases. Compressed air has most of the desired properties and characteristics of a gas for pneumatic system. It is nonpoisonous and non –flammable but does contain oxygen, which supports combustion .One of the most undesirable qualities of compressed air as a fluid medium for pneumatic systems is moisture content. The atmosphere contains varying amount of moisture in vapor from. Changes in the temperature of compressed air will cause condensation of moisture in the pneumatic system. This condensed moisture can be very harmful to the system, as it increases corrosion, dilutes lubricants, and may freeze in lines and compressed air lines to minimize or eliminate moisture in systems where moisture would deteriorate system performance. The supply of compressed air at the required volume and pressure is providing by an air compressor.The normal type of compressor will be of the multi stage, reciprocating piston type (displacement of time the diver must carry with him a supply of breathing gas, usually compressed air. A single cylinder compressor capable of charging a scuba cylinder to 300bar would have compression ratio of 300:1 it would require massive construction and use colossal power to drive it.To simplify the compressor, improve efficiency and reduce power requirements manufacturers use a multi stage arrangement. The following theoretical example is a 3 stage (3 cylinders) compressor with a compression ratio of 1:9 or 1:7 per stage. This would provide us an output

pressure of 441barin practice compressor manufactures may install four or more stages use different compressor ratios to arrive at the desired output pressure and will arrange for the air to be cooled as it passes from one stage to another. [5] The volume of gas contained within a diving cylinder can be calculated using Boyle's law e.g.: A 10 liter cylinder charged to 200bar contains 2000 liters. Notes that the amount of air that a cylinder will hold when charged to its working pressure is known as its working pressure is known as its free air capacity i.e. if discharged to atmospheric pressure the volume to which the compressed air would expand .The size of compressor will depend upon the desired duty. A scuba cylinder of 12 liter working capacity and 240 bar working pressure will hold 2880 liters when charged. A portable compressor of 2 cfm (60 1/ min) will take over 45 minutes to fill the cylinder from empty. It is obvious that a machine with such a slow delivery would be useless in a dive center. [5] When air is compressed considerable heat is generated. If no attempt is made to cool it, the air will contain all the heat generated. Air, which contains all the heat in this way, is said to have undergone adiabatic compression (sometimes termed isentropic).

4.2 SPEED BREAKER ELECTRICITY GENERATION

4.2.1 WORKING PRINCIPLE

Whenever the vehicle is allowed to pass over the dome shape speed breaker it gets pressed downwards. As the springs are attached to the dome, they get compressed and the rack, which is attached to the bottom of the dome, moves down in reciprocating motion. Since rack has teeth connected to gear there is conversion of reciprocating motion of rack in to rotary motion of gears, but the two gears rotate in opposite direction. Pinion and larger gear are mounted on same shaft and they rotate with same rpm larger gear is engaged to the small gear which is mounted on another shaft and which rotates with maximum rpm. So that shafts will rotate with certain rpm these shafts are connected through a belt drive to the generator, which converts the mechanical energy into electrical energy. The output of generator is given to the LED bulb which shows generation of electricity by blinking. For more simplification of working principle and construction the proposed model has been modeled using CATIA softwareas shown in figure 4.1 and 4.2.

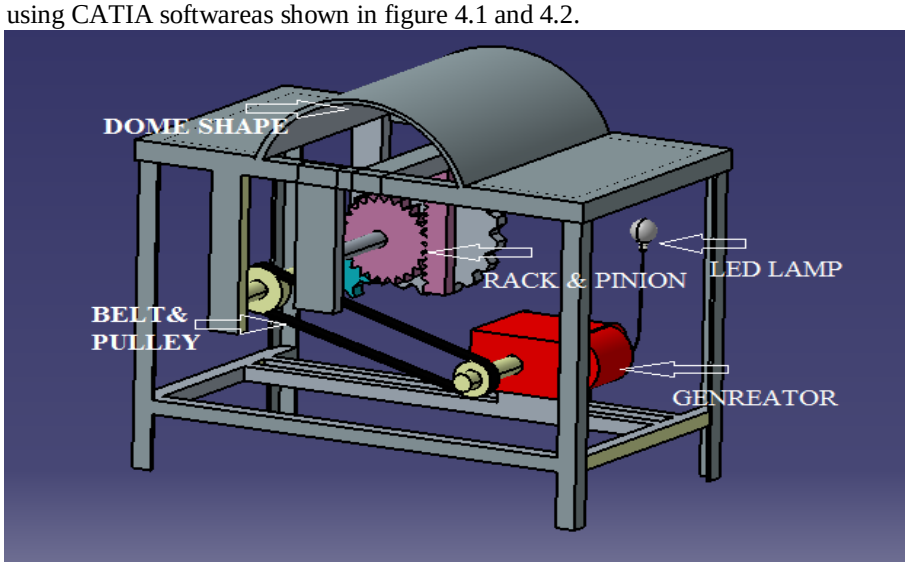

Figure 4.2: Electricity Generation by using Speed Breaker

4.2.2 MATHEMATICAL CALCULATION

Let consider,
The mass of a vehicle =400 Kg (Approximately)
Height of speed brake =8 cm
Work done=Force x Distance
But, here
Force =Weight of the Body
=400 Kg x 9.81
=3924 N
Distance traveled by the body = Height of the speed brake =8 m
Output power = Work done/Sec
= (3924 x 0.08)/60
= 5.232 W
Power developed for 1 vehicle passing over the speed breaker arrangement for one minute is 5.232 W,
Power developed for 60 minutes (1 hour) = 5.232 x60 =313.92

Power developed for 24 hours =313.92 x 24
=7.53408 KW

4.2.3 DC GENERATOR

The main function of Generator is to convert mechanical input energy into electrical output energy. A generator in basic form consists of a powerful field magnet between the poles of which a suitable conductor, usually in the form of a coil (armature), is rotated. The magnetic lines of force are cut by the rotating wire coil, which induces a current to flow through the wire.

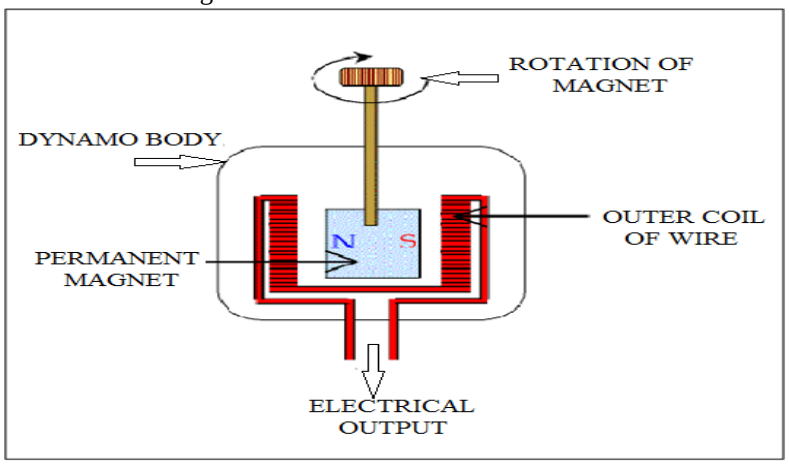

Figure 4.3: DC Generator

The mechanical energy of rotation is thus converted into an electric current in the armature. Present day generators work on the principles described by English physicist Michael Faraday in 1830, that an electromotive force is developed in a conductor when it is moved in a magnetic field. The generator that powers the lights on a bicycle is an example of an alternator, that is, it produces alternating current (AC).A generator produces direct current with the use of a commentator. Generators were the first electrical equipment, capable of delivering power for industry, and the foundation upon which many other later electric-power conversion devices were based, including the electric motor, the alternating-current alternator, and the rotary converter. They are rarely used for power generation now because of the dominance of alternating current, the disadvantages of the commentator, and the ease of converting alternating to direct current using solid state methods. [7].

V. MANUFACTURING AND SELECTION OF MATERIAL

The proper selection of material for the different part of a machine is the main objective in the fabrication of machine. For a design engineer it is must that he be familiar with the effect which the manufacturing process and heat treatment have on the properties of materials. The choice of material for engineering purpose depends upon the following factors.

1. Availability of the materials.
2. Suitability of materials for the working condition in service.
3. The cost of materials.
4. Physical and chemical properties of material.
5. Mechanical properties of material.

The mechanical properties of the metals are those, which are associated with the ability of the material to resist mechanical forces and load. We shall now discuss these prosperities as follows. Required properties for the selection of material are Strength, stress, stiffness, elasticity, plasticity, ductility, brittleness, toughness, resilience, creep, hardness. The science of the metal is a specialized and although it overflows in to realms of knowledge it tends to shut away from the general reader. The knowledge of material and their properties is of great significance for a design engineer. The machine elements should be a material which has properties suitable for the conditions of operations. In addition to this a design engineer must be familiar with the manufacturing processes and the heat treatments have on the properties of the materials. In designing the various part of the machine it is necessary to know how the material will function in service. For this certain characteristics or mechanical properties mostly used in mechanical engineering practice are commonly determined from standard tensile tests. In engineering practice, the machine parts are subjected to various forces which may be due to either one or more of the following. [4]

1. Energy transmitted
2. Weight of machine
3. Frictional resistance
4. Inertia of reciprocating parts
5. Change of temperature
6. Lack of balance of moving parts

The selection of the materials depends upon the various types of stresses that are set up during operation. The material selected should with stand it. Another criterion for selection of metal depends upon the type of load because a machine part resist load more easily than a live load and live more easily than a shock load. Selection of the material depends upon factor of safety which in turn depends upon the following factors. [3]

1. Reliabilities of properties.
2. Reliability of applied load.
3. The certainly as to exact mode of failure.
4. The extent of simplifying assumptions.
5. The extent of localized.
6. The extent of initial stresses set up during manufacturing.
7. The extent loss of life if failure occurs.
8. The extent of loss of property if failure occurs.
9. Materials selected in machine.

VI. ADVANTAGES

1. No fuel is required for its operation.
2. Uninterrupted power generation during day and night.
3. Easy for maintenance.
4. Nonpolluting energy sources.
5. Multipurpose.
6. It is cheap compared to the conventional power Generation units

VII. CONCLUSION

The growth of any nation depends on utilization of energy and this paper helps for that. It is successfully produced electricity and compressed air by using speed breaker. This electricity can store in battery in day time and we can use it in night time for high way illumination, signal system on road, tollbooth or any other useful work. And compressedair can use for cleaning purpose in tollbooth and refilling of air in tires. This paper helps for conservation of natural resources.

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