Design of Compressed Air Engine, Producing Electricity and Refrigeration effect based on ERS System

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Abstract— As we all know that in the industries, hotels and even in our house there is requirement of electricity, refrigeration and air conditioning system for preserving foods, Medicines and for comfort. There is also problem of energy storage in the form of batteries for emergency purposes, since the life of batteries is 2 to 3 years and their cost is very high. They cannot store large amount of energy to run our Air conditioning system, mixture grinder etc. To get from above problem we have designed a system in which we firstly store compressed air in a tank with the help of available source of power such as wind, hydrel, solar and electricity itself that installed at the basement. Then we will expand compressed air through engine which will expand and provide us electricity and the coming output gas can be utilised for refrigeration and air conditioning. Our system will require some nominal maintenance and its life 25 to 30 years. Our system is pollution free. Although our system initial cost is high but one time investment.

Key words: Compressed Air Engine, Producing Electricity, Refrigeration effect, ERS System

I. INTRODUCTION

Introduction: Renewable energy resources, such as wind energy, solar energy and ocean energy, are quickly developed in recent years. Today, the fast growing renewable energy has been recognized as the promising power resource throughout the world. ERS System is considered as a most promising storage option due to its high reliability, environmental friendliness, economic feasibility, and safe and simple operation. Usually, the compressed air is stored in different sources like wind energy, hydrel Energy, solar energy and directly from electrical energy.

A. Sources of Compressed Air

There are different ways to compress air which can discuss in detail.

- Through wind mill
- Through Hydrel Energy
- Through solar energy
- Through Electric Energy

1) Through Wind Mill

The vertical axis wind turbine can run irrespective of the direction of the incoming wind. It is mounted on the top of the building to receive uninterrupted wind. The shaft axis stays vertical. Through a reduction gear mechanism, high torque can be obtained. This torque is used to run the compressor turbine. Speed although is slow, but the running can be continuous; at times very fast depending upon the prevailing weather - calm or stormy. The energy so obtained is collected and stored to be capitalised later, as and when needed.

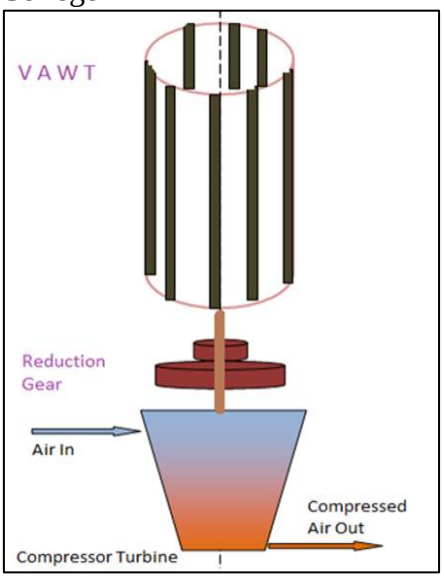

Fig. 1: Through Wind Mill

2) Through Hydrel Energy

We can also produce compressed air through hydrel power plant. Firstly we will run a pelton wheel through a jet of water then through the obtained shaft power we will compress air. To decrease the rpm and increase the torque we can also use gear reduction.

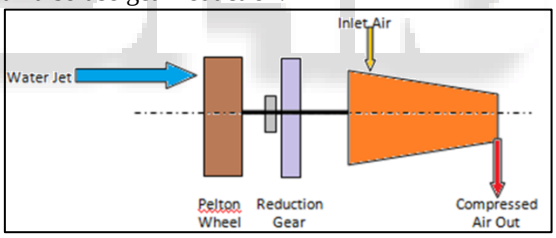

Fig. 2: Through Hydrel Energy

3) Through Solar Energy

We can also use solar energy to compress air. Firstly through the reflection of big concave mirrors, we will converse solar radiations over the mess of copper tuber to increase their temperature. As the temp. Increases pressure inside the tube increases. Two spring Controlled valves are fitted at the inlet and storage chamber which maintains the circulation of air inside the tubes.

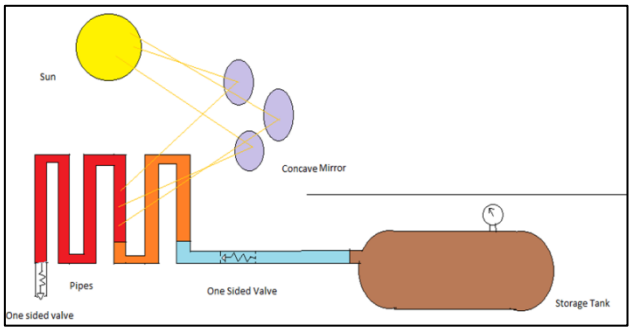

Fig. 3: Through Solar Energy

4) Through Electric Energy

By electricity itself we can compress air by running compressor through a electric motor. Through Electric motor we get shaft power. And through some coupling we attach compressor with shaft. And when compressors work it will compress the air.

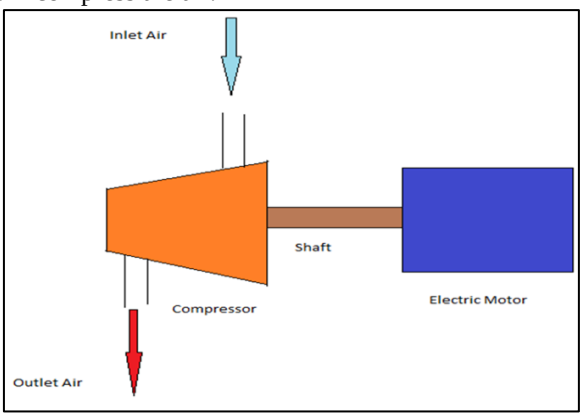

Fig. 4: Through Electric Energy

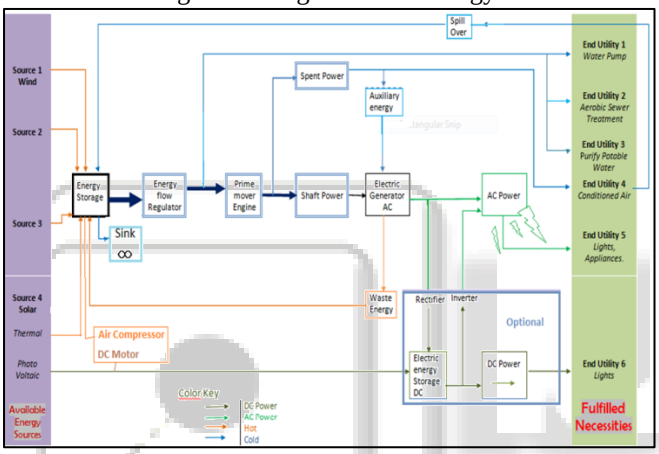

Fig. 5: Flow chart ERS System

Let us start from the left side in which available source of energy through which we can compress air has been written. We can compress air from wind energy, Hydrel Energy, solar energy and directly from electrical energy. After compressing air in a tank we will pass air through flow regulator to the prime mover Engine. Engine will run through compressed air and produce shaft work and due to expansion of air in the cylinder dead the outlet air will get cooled enough that it can be used for air conditioning purposes. The shaft power of the engine is provided to the alternator which will produce electricity.

B. Design of Engine

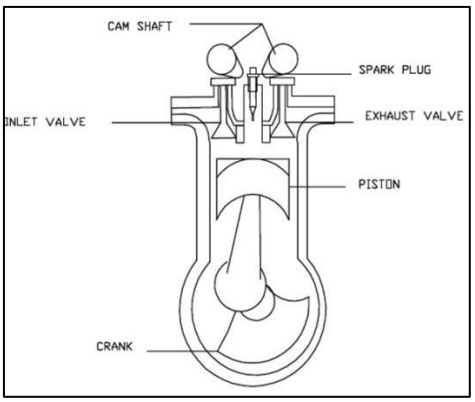

Fig. 6: Design of engine

The design is simple but a modified form of a four stroke petrol engine. A four stroke engine has an inlet valve, an exhaust valve, a spark plug. Here the inlet valve has been permanently closed and the exhaust valve works with an altered timing.

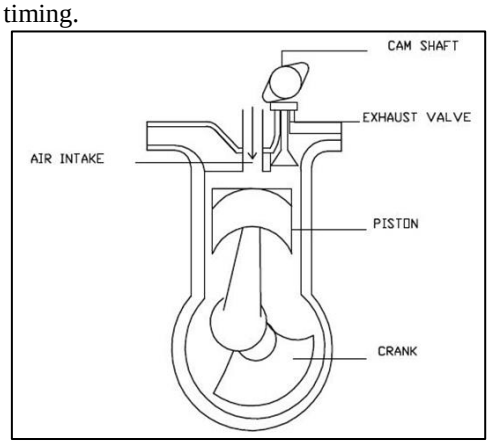

Fig. 7: Modified design of engine

C. Design of Camshaft

The cam shaft originally had two cams with one lobe each which were mutually perpendicular to each other. The crank rotates due to the movement of the piston; the camshaft is attached with the crankshaft by a timing chain or a timing belt. And as the crank rotates the camshaft also rotates and hence the timing of the valves is managed. In the traditional camshaft the inlet n exhaust valve both functions.

Fig. 8: Camshaft

In the modified camshaft the lobe of the cam working for the inlet valve was filed and cam was made circular, also the cam working for the exhaust valve was provide with another lobe right opposite to the lobe already present. This ensured the inlet valve to be closed and exhaust valve to work with changed timing.

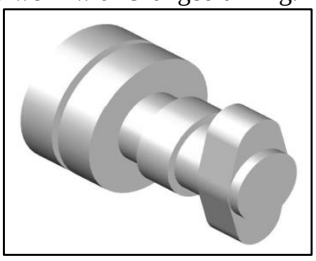

Fig. 9: Modified Camshaft

D. Mechanism of Compressed Air Engine

In any engine the charge enters from the inlet valve known as suction stroke then it is compressed by the piston due to crank rotation which is the compression stroke, then sparking takes place through the spark plug, the fuel ignites and combustion process takes place known as expansion stroke and finally the combustion product are let out of the engine by the exhaust stroke. Here air is initially taken up from the atmosphere, then it is compressed with the help of a compressor and sent to the engine cylinder. Piston is assumed to be at TDC, the inlet valve is closed permanently

and initially exhaust valve also remains closed. The compressed air gets filled in the clearance volume and when a small rotation is given to the crank this piston starts to slide down, the compressed air tends to expand and pushes the piston downwards. The piston moves from TDC to BDC in one stroke. Now the exhaust valve opens and due to pressure difference the air filled in the volume of the cylinder moves out and piston moves up from BDC to TDC. In this manner one cycle gets completed in two strokes again the same process takes place and output is obtained.

Fig. 10: Experimental Setup

Pressure(Psi)	Mass (ρ * V)	Overall efficiency
100	1.176	30.02
200	2.352	33.05
300	3.528	38.03
400	4.04	40.26
500	5.88	38.01
600	7.056	37.03

Table 1: Property

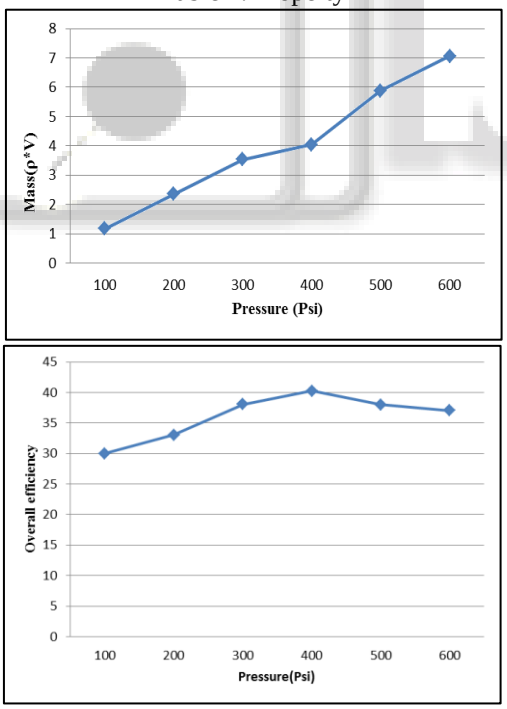

Fig. 11: Graphs

From above graph we get following points firstly graph increase due to increase in pressure after that decrease due to increase in friction losses to get decrease heat losses.

Here due to the presence of fins on the cylinder head energy is directly absorbed by the fins. Therefore nearly 5% to 8% is wasting which can be utilised by making certain modification in the design of engine.

Here Energy is also wasting due to frictional resistance of piston, bearings and also of belt drive. Here we are assuming that 10 % to 15% of energy is wasting in the above form.

The main loss here is during compression process which is nearly 40 % to 45%. So, overall if we made our system as a compact unit by using latest Technology then 55 to 60% Overall Efficiency can easily be achieved which is comparable to batteries. But main advantage of our model is that its life is nearly 25 to 30 years. Compared to batteries whose life is nearly 2 to 3 years.

II. Result & Discussion

- Our system is better than batteries to store energy. Since batteries life is only 2 to 3 years. Their cost is also very high. They also can no run heavy electrical appliances such as Air conditioner, Mixer Grinder etc. On the other hand our system will run for 25 to 30 years easily by doing some regular maintenance.
- It is difficult to dispose battery waste since they contain harmful chemicals such as lead, cadmium, Mercury which get mixed with air and water and reach to our body by ingestion and inhalation. Therefore creating various diseases such as headache, asthma, decreased IQ in children and even cancer.
- Our system is providing air conditioning system which is also our requirement. If we use renewable sources of energy to compress air then our system will not pollute surrounding environment at all.
- Large amount of energy can be stored.
- Heavy electrical systems can also be used.

III. Conclusions

Nowadays the need for energy continuously increases, and we are using the conventional resources at an alarming rate hence an alternative fuel is much required and Compressed Air Technology can be one of the best alternative, as the pollution caused is zero and it is also cost efficient. The Experiment has also proved that overall max Efficiency of 50 to 60% can be achieved by our system which can also be increased if we utilise the heat which generates during compression process. Hence this technology is the future once we should do our best to install it and test it.

IV. Future Scope

- Here if we will use latest technology and compare alternator and engine on a single shaft then we can reduce some frictional losses.
- Here we are using Bike engine in which fins are present which are absorbing heat from surrounding. If we proper design cylinder head then this loss can also be minimised.
- In our system compressed air is not expanding completely due to continuous mass flow rate. We can also do interrupted supply by designing a new cam shaft mechanism by the help of which inlet and outlet valve will operate.

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