COMPRESSED AIR DRIVEN ENGINE

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ABSTRACT: The Air Driven Engine is an eco-friendly engine which operates with compressed air. An Air Driven Engine uses the expansion of compressed air to drive the pistons of an engine An Air Driven Engine is a pneumatic actuator that creates useful work by expanding compressed air. There is no mixing of fuel with air as there is no combustion. An Air Driven Engine makes use of Compressed Air Technology for its operation The Compressed Air Technology is quite simple. If we compress normal air into a cylinder the air would hold some energy within it. This energy can be utilized for useful purposes. When this compressed air expands, the energy is released to do work. So this energy in compressed air can also be utilized to displace a piston.

KEYWORDS: Prototype, Compressed Air, Experiment, Performance

I. INTRODUCTION

At first glance the idea of running an engine on air seems to be too good to be true. Actually, if we can make use of air as an aid for running an engine it is a fantastic idea. As we all know, air is all around us, it never runs out, it is non-polluting and it is free.An Air Driven Engine makes use of Compressed Air Technology for its operation. Compressed Air Technology is now widely preferred for research by different industries for developing different drives for different purposes. The Compressed Air Technology is quite simple. If we compress normal air into a cylinder the air would hold some energy within it. This energy can be utilized for useful purposes. When this compressed air expands, the energy is released to do work.So this energy in compressed air can also be utilized to displace a piston. This is the basic working principle of the Air Driven Engine. It uses the expansion of compressed air to drive the pistons of the engine. So an Air Driven Engine is basically a pneumatic actuator that creates useful work by expanding compressed air. This work provided by the air is utilized to supply power to the crankshaft of the engine.In the case of an Air Driven Engine, there is no combustion taking place within the engine. So it is non-polluting and less dangerous. It requires lighter metal only since it does not have to withstand elevated temperatures.As there is no combustion taking place, there is no need for mixing fuel and air. Here compressed air is the fuel and it is directly fed into the piston cylinder arrangement. It simply expands inside the cylinder and does useful work on the piston. This work done on the piston provides sufficient power to the crankshaft.

II. HISTORY

Compressed air has been used since the 19th century to power mine locomotives and trams in cities such as Paris (via a central, city-level, compressed air energy distribution system), and was previously the basis of naval torpedo propulsion. In 1863, Jules Verne wrote a novel called Paris in the 20th Century about a world of glass skyscrapers, high-speed trains, and air-powered automobiles. In 1903, the Liquid Air Company located in London England manufactured a number of compressed air and liquefied air cars. The major problem with these cars and all compressed air cars is the lack of torque produced by theengines, and the cost of compressing the air. Reference: http://www.didik.com/ev_hist.htm Recently several companies have started to develop compressed air cars, although none have been released to the public, or have been tested by third parties.

1. COMPRESSED AIR TECHNOLOGY

Air can be compressed into small volumes and can be stored in suitable containers at high pressures. Such air compressed into containers is associated with an amount of energy. When the stored compressed air is released freely it expands thereby releasing the energy associated with it. This energy released can be utilized to provide useful work.The compression, storage and release of the air together are termed as the Compressed Air Technology. This technology has been utilized in different pneumatic systems. This technology has been undergoing several years of research to improve its applications. Compressed air is regarded as the fourth utility, after electricity, natural gas, and water. Compressed air can be used in or for:

- Pneumatics, the use of pressurized gases to do work.
- Vehicular transportation using a compressed air vehicle
- Scuba diving
- To inflate buoyancy devices
- Cooling using a vortex tube
- Gas dusters for cleaning electronic components that cannot be cleaned with water.
- Air brake (rail) systems
- Air brake (road vehicle) systems
- starting of diesel engines (an alternative to electric starting)
- Compressed air breathers (such as Suisse Air)
- Pneumatic air guns
- Pneumatic screwdrivers

2. SOLENOID VALVE

A solenoid valve is an electromechanical valve for use with liquid or gas. The valve is controlled by an electric current through a solenoid coil. Solenoid valves may have two or more ports: in the case of a two-port valve the flow is switched on or off; in the case of a three-port valve, the outflow is switched between the two outlet ports. Multiple

solenoid valves can be placed together on a manifold.Solenoid valves are the most frequently used control elements in fluidics. Their tasks are to shut off, release, dose, distribute or mix fluids. They are found in many application areas. Solenoids offer fast and safe switching, high reliability, long service life, good medium compatibility of the materials used, low control power and compact design.A solenoid valve has two main parts: the solenoid and the valve. The solenoid converts electrical energy into mechanical energy which, in turn, opens or closes the valve mechanically. A direct acting valve has only a small flow circuit, shown within section E of this diagram. This diaphragm piloted valve multiplies this small flow by using it to control the flow through a much larger orifice.Solenoid valves may use metal seals or rubber seals, and may also have electrical interfaces to allow for easy control. A spring may be used to hold the valve opened or closed while the valve is not activated.

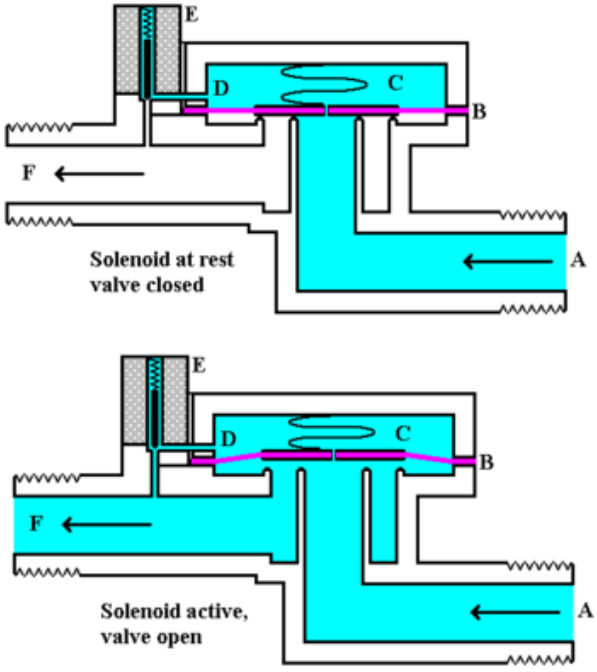


Fig. 2.1Working of solenoid valve

A- Input side
B- Diaphragm
C- Pressure chamber
D- Pressure relief conduit
E- Solenoid
F- Output side

The diagram above shows the design of a basic valve.

3. AIR COMPRESSOR

An air compressor is a device that converts electrical power or gas into kinetic energy by pressurizing and compressing air, which is then released in quick bursts. There are numerous methods of air compression, divided into either positive-displacement or non-positive displacement types.Positive-displacement air compressors work by forcing air into a chamber whose volume is reduced to effect the compression. Piston-type air compressors use this principle by pumping air into an air chamber through the use of the constant motion of pistons. They use unidirectional valves to guide air into a chamber, where the air is compressed. Rotary screw compressors also use positive-displacement compression by matching two helical screws that, when turned, guide air into a chamber, the volume of which is reduced as the screws turn. Vane compressors use a slotted rotor with varied blade placement to guide air into a chamber and compress the volume.Non-positive-displacement air compressors include centrifugal compressors. These devices use centrifugal force generated by a spinning impeller to accelerate and then decelerate captured air, which pressurizes it.

The air compressors seen by the public are used in 5 main applications:

- To supply a high-pressure clean air to fill gas cylinders
- To supply a moderate-pressure clean air to supply air to a submerged surface supplied diver
- To supply a large amount of moderate-pressure air to power pneumatic tools
- For filling tires
- To produce large volumes of moderate-pressure air for macroscopic industrial processes (such as oxidation for petroleum coking or cement plant bag house purge systems).

Most air compressors are either reciprocating piston type or rotary vane or rotary screw. Centrifugal compressors are common in very large applications. There are two main types of air compressor's pumps: Oil lubed and oils. The oils system has more technical development, but they are more expensive, louder and last less than the oiled lube pumps. But the air delivered has better quality. The best choice depends of the application that the user needs.

4. INFRARED PAIR

The infrared pair mainly consists of an infrared emitter and an infrared sensor. The infrared emitter emits the infrared rays to the infrared sensor. The sensor senses the infrared rays which are emitted by the emitter. Both the emitter and the sensor are LEDs of same rating. They are placed in correct position face to face and are aligned in a straight line. They are also placed close together and are enclosed by a covering with an opening for the rays to pass. This helps to increase the accuracy of the sensing of the sensor to its maximum.

Fig.4.1 IR pair

5. SOLAR ENERGY

Solar energy is radiant light and heat from the Sun that is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaics', solar thermal energy, solar architecture, molten salt power plants and artificial photosynthesis. It is an important source of renewable energy and its technologies are broadly characterized as either passive solar or active solar depending on how they capture and distribute solar energy or convert it into solar power. Active solar techniques include the use of photovoltaic systems, concentrated solar power and solar water heating to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light-dispersing properties, and designing spaces that naturally circulate air. The large magnitude of solar energy available makes it a highly appealing source of electricity. Thus adding a solar panel to the battery would be very good, as it will charge the battery automatically.

6. THE ENGINE

The basic engine that we are going to use in the project is a normal two stroke petrol engine. We only need a simple piston-cylinder arrangement with an outlet and an exhaust. But as we know a normal two stroke engine contains several ports and it also has a spark plug which we do not require. So, several modifications will be done on the engine to suit our purpose.

7. VALVE ACTUATION SYSTEM

The valve actuation system is the system used to actuate the valve mechanism. The valve we are going to use here is a 3/2 solenoid valve. This valve is an always closed valve. This valve works only when a high voltage is applied to it. The high voltage for the opening of the valve will be given by the circuit. When a high voltage is applied to the valve it gets open.

The main components of the valve actuation system will be

1. Infrared pair
- Infrared emitter
- Infrared sensor
2. Electronic circuit
3. Batteries
4. Wiring system
5. Valve Timing Disc

7.2. THE ELECTRONIC CIRCUIT

The electronic circuit will consist of the following components

1. Power supply
2. Power supply connector
3. Voltage regulator
4. Resistors
5. Voltage divider
6. Infrared emitter connector
7. Infrared sensor connector
8. Transistor
9. Valve connector
10. Comparator

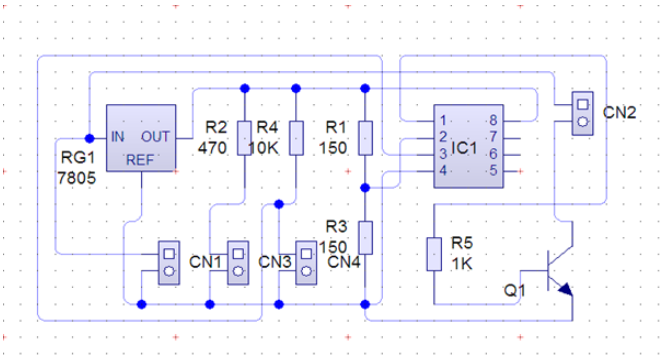


Fig. 7.2 The circuit

7.2.1. POWER SUPPLY

The power supply used here will be 24v supply. This voltage is provided by two batteries each of 24v and 2.5A rating. These batteries are connected in series.

7.2.2. POWER SUPPLY CONNECTORS

The circuit is provided with a connector which is a two socket connector. The male connector is placed in the electronic circuit and the female connector is provided at the other end. The power supply connectors are soldered to the circuit.

7.2.3. VOLTAGE REGULATOR

The voltage regulator used here is going to be RG 7805. This voltage regulator has three terminals namely

- Reference
- Input
- Output

The reference terminal is grounded and the input terminal is provided with the supply. This circuit converts the 24v dc into 5v dc. All the components in this circuit only work on 5v. Thus the 24v need to be stepped down to 5v in order to avoid burning of the circuit components. This 5v is taken out through the output terminal.

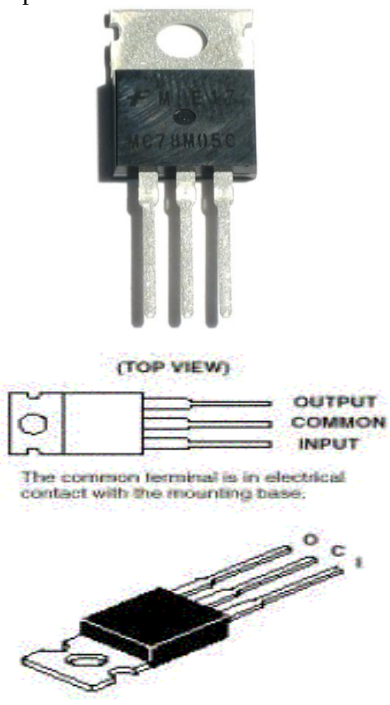


Fig.7.4 Voltage Regulator

7.2.4. RESISTORS

The resistors are used to step down the current from the main supply. The main resistors used are the following.

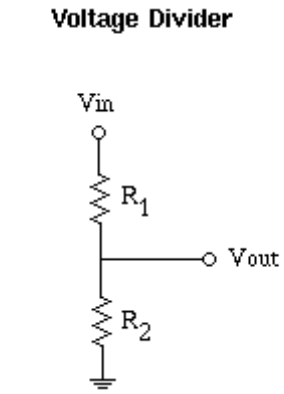
- 100K
- 470
- 10K
- 1K
- 150*2

Fig. 7.5 Resistors

The figure shows the 100K resistor. This component will be connected before the voltage regulator to step down the high current of 24 v supply.

7.2.5. VOLTAGE DIVIDERS

The voltage dividers are used to divide the voltage according to the purpose. An equal amount of resistors can be used to divide the circuit. Here two 150K resistors are used to divide the 5v to 2.5v dc to be supplied to the comparator.



$$V_{out} = \frac{R_2}{R_1 + R_2} V_{in}$$

Fig 7.6 Voltage Divider

7.2.6. TRANSISTORS

The transistor will be 3035. This component is used as a switching device to switch the 5v to the solenoid valve. It consists of three terminals. The emitter is grounded. The base is connected to the output terminal (1) of the comparator and the collector terminal of the transistor is connected to the solenoid valve.

Fig 7.7 Transistor

7.2.7. COMPARATOR

The comparator here will be lm 528. It mainly consists of 8 terminals out of which 5 terminals are in use. The negative terminal is connected to the voltage divider and the positive terminal is connected to the sensor. The output is taken from the output terminal to the transistor which acts as a switching device. The fourth terminal is grounded and the eighth terminal is given the 5v supply.

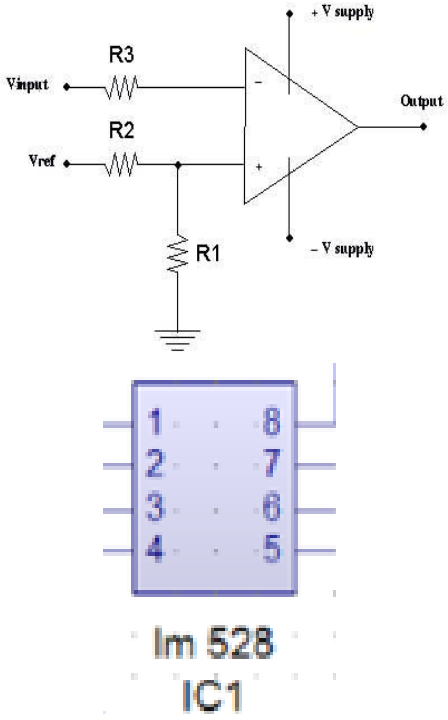


Fig 7.8

The 5 terminals used are the following

- Negative terminal(2)
- Positive terminal(3)
- Output terminal(1)
- Ground terminal(4)
- Supply terminal(8)

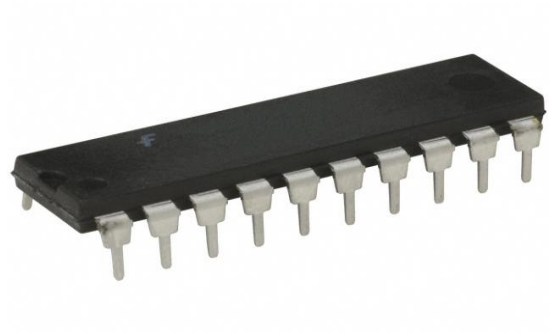


Fig 7.9 Comparator

7.3. BATTERIES

The batteries used here will be of rating 12v, 2.5A. The solenoid valve works only on 24v. Hence the batteries need to be connected in series to obtain 24v.

7.4. WIRING SYSTEM

The wiring system will mainly consist of wires that are used to connect the components in the actuation system

7.5VALVE TIMING DISC

The valve timing disc is used to represent the position of the piston inside the cylinder in a schematic manner. This helps to explain the piston position more accurately.

7.6 THE WORKING OF THE CIRCUIT

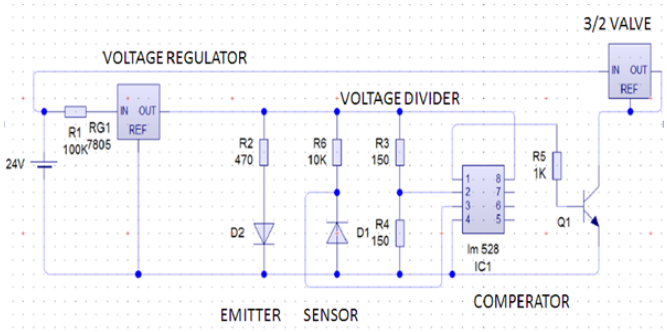


Fig 7.12 The Circuit

The supply voltage as shown in the figure is 24v dc. This high voltage will be supplied to the voltage regulator. A 100K resister is used before the voltage regulator inorder to reduce the high current to the circuit. The voltage regulator regulates the voltage and step down it to 5v dc, since all the components in the circuit works only on 5v dc. This 5v is given to all the components in the circuit. The emitter will be provided with a 470 ohm resistor and the collector is provided with a 10K resistor which reduces the voltage further. A voltage divider will be used in order to divide the 5v to 2.5v to provide it to the comparators. The transistor works as a switch. The emitter is forward biased and the collector is reversed biased. The emitter sends infrared radiations continuously and this is sensed by the sensor. Thus the circuit is short circuited. Hence low voltage is given to the comparator. When the power stroke region is reached the path gets cut off and as a result a high voltage is produced in the sensor circuit and this is given to the comparator. Comparator only provides the output when the input in the positive terminal is above 5v. Thus during the power stroke region the comparator is provided with a high voltage and thus it provides a high voltage at its output. This output is given to the transistor through a 1K resistor. The transistor acts as a switch. It conducts only when a high voltage is applied to it, and when this high voltage reaches it conducts it to the 3/2 solenoid valve.

The solenoid valve has three terminals namely

- Reference terminal
- Input terminal
- Output terminal

The input terminal will be connected to the supply and the output terminal and the reference terminal are shorted. The high voltage (5v) is given to the shorted circuit and thus the valve opens and the pressurized air is allowed to enter the cylinder of the engine. Thus the engine will work.

To inhibit the reverse flow of electric current and the unnecessary drain of the electric charge from battery in the case of absence of sunlight, four diode (IN4007) has been connected.

8. PRESSURE GAUGE SYSTEM

The pressure gauges are used to measure or display the pressure at the position at which the pressure gauge is installed. There are different ranges of the pressure gauges. The pressure gauge will be connected to the inlet of the solenoid valve. It will help to measure the pressure inlet to the solenoid valve.

9. ADVANTAGES OF AIR DRIVEN VEHICLE

- Less costly and more effective
- The air engine is an emission-free piston engine that uses compressed air as a source of energy.
- Simple in construction. The engine can be massively reduced in size
- Easy to maintain and repair.
- No fire hazard problem due to over loading. Air, on its own, is non-flammable.
- Low manufacture and maintenance costs
- Comparatively the operation cost is less.
- Light in weight and easy to handle. The engine runs on cold or warm air, so can be made of lower strength light weight material such as aluminum, plastic, low friction Teflon or a combination
- Compressed-air tanks can be disposed of or recycled with less pollution than batteries.
- Compressed-air engines are unconstrained by the degradation problems associated with current battery systems.
- The air tank may be refilled more often and in less time than batteries can be recharged automatically by the sunlight.
- Lighter vehicles cause less damage to roads
- The price of filling air tanks is significantly cheaper than petrol, diesel or biofuel.
- Quick response is achieved

III. CONCLUSION

The paper present the theoretical concept of designing an vehicle which can run on compressed air technology (CAE). Compressed air for vehicle propulsion is already beingexplored and now air powered vehicles are being developedas a more fuel-efficient means of transportation.

Some automobile companies are further exploring compressed air hybrids and compressed fluids to store energy for vehicleswhich might point the way for the development of a cost effective air powered vehicles design. Unfortunately thereare still serious problems to be sorted out before air powered vehicles become a reality for common use but there is a hopethat with the development in science & technology well supported by the environmental conscious attitude and need toreplace costly transportation methods, air-powered vehicles will definitely see the light of the day.The proposed concept design of CAE helps in solving the problem using a fuel which is renewable and at the same time cheaper in use.The paper also present an overview on the proposed future development of vehicle for making it more efficient for public use.

FUTURE SCOPE

- Design and fabrication of a new engine made of light metal will give better results.
- Usage of compressed air tanks for storage and supply will give it more scope in automobiles.
- Much like electrical vehicles, air powered vehicles would ultimately be powered through the electrical grid. This makes it easier to focus on reducing pollution from one source, as opposed to the millions of vehicles on the road. Transportation of the fuel would not be required due to drawing power off the electrical grid. This presents significant cost benefits. Pollution created during fuel transportation would be eliminated.
- Compressed-air vehicles operate to a thermodynamic process as air cools down when expanding and heats up when being compressed. As it is not possible in practice to use a theoretically ideal process, losses occur and improvements may involve reducing these, e.g., by using large heat exchangers in order to use heat from the ambient air and at the same time provide air cooling in the passenger compartment. At the other end, the heat produced during compression can be stored in water systems, physical or chemical systems and reused later.

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