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PAPER ON

"COMPRESSED AIR CAR'S TECHNOLOGY"

Delivered By

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ABSTRACT

In this modern era we want more comfortable life & to achieve this, there are many inventions and researches are going on in the field of engineering but as each action having there some opposite reaction that may be good or bad. Some achievements may lead to problems in future and one of these achievements is fossil fuel engines which were a good achievement for us before 30-40 years but now they are one of the sources of contributor of global worming and pollution with fossil fuel crises.

To cope up with this problem we have to use such engines which emits less or zero COx & NO_x particles, for that one of the solutions is hybrid electrical vehicle but again they emit some CO_x & NO_x so this is not a complete solution for this problem. The best feasible solution is Zero Emission Vehicle i.e. Compressed Air Technology (CAT) which does not require any type of fossil fuel. The gasoline-powered engine requires 4 Rs/mile where as for air powered engines it is 75% less i.e. 1 Rs/mile with no emission CO_x & NO_x pollutants. The cost the hybrid electric vehicle is approximately $50,999 which requires the charging period of 5 to 6 hours whereas the cost of air powered vehicle $14,000 i.e. less than half which requires only 3 to 4 minutes for recharging.

INTRODUCTION

We are confident that Compressed Air Technology (CAT) holds the key to the automobile's future. At the same time, though we are aware that no one type of vehicle can meet all society's needs. That's why we are pushing ahead with research on a range of vehicle propulsion technologies.

Our environment must be protected against various anthropogenic contaminations, among which the emission of large amounts of CO, NO_x, hydrocarbons and soot produces some of the most adverse environmental effects. These emissions, which are above all caused by road traffic and power plants, damage the flora and fauna and deteriorate human health. NO_x, for example, after oxidation forming nitric acid, contributes to the acid rain which has caused severe forest damage in the past decades. On the other hand, the photolysis of NO_2 leads to the formation of ozone which, in elevated concentration, can cause diseases of the human lung and bronchial system. For this reason, the legal emission standards have recently been repeatedly tightened up.

The internal combustion engine is still the predominant means of propulsion, and we have made great strides in reducing its impact on the environment. We have also come a long way in solving the practical problems of electric vehicles, and in developing applications that make full use of their potential. And of course, need leads the world in hybrid technology. Hybrid vehicles have been contributing to a cleaner environment since 1997. Finally, Compressed Air Technology (CAT), which is the zero emission vehicle , may become the ultimate power source of the 21st century.

The ultimate eco fuel will combine high efficiency with minimal environmental impact. It must be available in sufficient quantities, and it must be possible to harness and refine economically. Further, there needs to be an adequate distribution infrastructure in place. But what about the 700 million conventional vehicles already on the road and the many more to come these vehicles need cleaner-burning fuels, too. Hydrogen may indeed turn out to be the ultimate eco fuel, but we must also consider the alternatives, and arrive at creative solutions to help solve the problems of today which is Compressed Air Technology (CAT).

In order to comply with the increasingly stringent standards in the field of emissions from road traffic, the automobile industry as well as other firms and research institutions have increasingly placed emphasis on the development of zero emission vehicles i.e. Compressed Air Technology (CAT) .

COMPRESSED AIR TECHNOLOGY (CAT)

Compressed Air Technology (C.A.T.) uses compressed air as its energy source and requires no gasoline or batteries to drive the engine. C.A.T. is developed by Mr. Guy Negre to run engines with compressed air. Although the technology is new, the idea isn't completely unknown to Formula One Cars & those interested in engine technology. In fact, every Formula One engine starts with a shot of compressed-air as an Energy-Booster. Guy Negre has simply extended its potential by turning it into a single source of energy for running the engine.

CONSTRUCTIONAL DETAILS

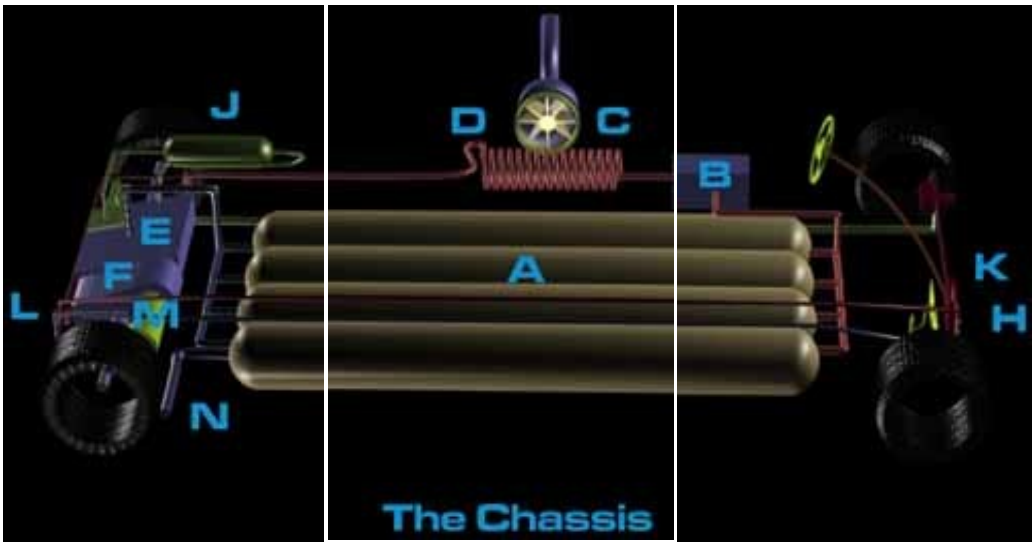

Fig.1:- Chassis of air powered car

In practical terms compressed air at 300 bars is stored in the carbon fibre tanks **A**. The air is released through the main line firstly to an alternator **B** where the first stage of decompression takes place. The now cold air passes through a heat exchanger **C** which adds thermal energy to the air and provides a convenient opportunity for air conditioning **D**. The warmed compressed air now passes to the motor **E**. where a two more stages of decompression and re-heating take place. The motor drives the rear axle **G** through the transmission **F**. Control of engine speed is through a conventional accelerator pedal **H** controlling a valve within the motor.

An energy recycler **J** is under test which uses engine braking **K** to recompress air during braking into a secondary storage facility, providing additional energy for re-start and acceleration. Conventional hydraulic braking **L** is supplied. The vehicle can be refilled by using the onboard compressor **M** or by refilling the tank at an air station at **N**. Ultimately the engine generates 37 Kilowatts, notwithstanding the small size of this unit.

The "exhaust" leaves the engine at about zero degrees Celsius, a result of the expansion and cooling action. The exhaust is totally pure and fit to breathe. A compressed air driven engine offers enormous benefits to the car designer. Because of its small size and weight, and the removal of a host of devices and parts not required, the designer has free rein to maximize his materials and space to provide a simple, economic platform for the vehicle.

WORKING OF C.A.T. ENGINES

In principle the technology is very similar to the internal combustion system in that compressed air is used to drive a piston in a barrel. The secret of the engine lies in the way it efficiently converts the energy stored in the tanks of compressed air.

By way of explanation, it has long been known that to compress air to high pressures a staged process should be used, compressing air to first 50 bars, then to 150 bars then three hundred and so on. This technique, commonly employed by the air and gas liquefaction industries, uses a fraction of the energy used to compress the gas in one operation. The secret of the compressed air motor is simply to reverse the process - decompress the air in stages and in so doing efficiently release energy at each point in the chain.

PROCESS DESCRIPTION

1. The first piston takes in ambient air compressed it to approximately 300psi and 200°F in the compression chamber during the first cycle of engine

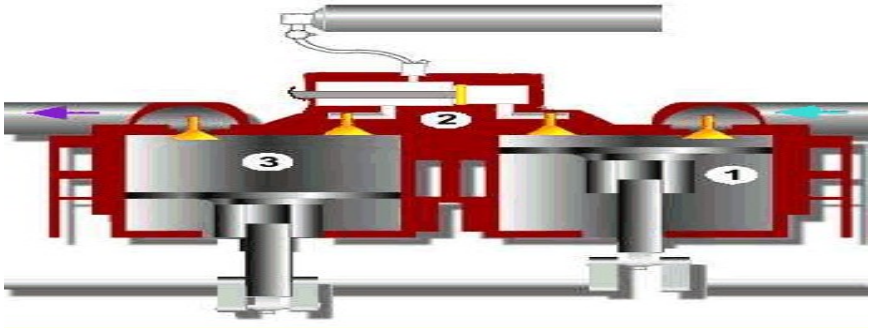

Fig.2:- working of air operated engine

2. When the piston pauses, a small amount of compressed air from the tanks is released into the expansion chamber to create a low pressured, low temperature volume of about 140 psi.

3. Shortly before the valve to the expansion cylinder is opened a high-speed shutter connects the compression and expansion chambers this sudden pressure and

temperature difference between the two chambers creates pressure waves in the expansion chamber, thereby producing work in the expansion cylinder that drives the piston to power the engine The air tanks for storing the compressed are located underneath the vehicle they are constructed of reinforced carbon fiber with a thermoplastic liner each tank can held 3180 ft^3 of air at a pressure of up to 4,300 psi when connected to a special compressor station the tanks can be recharged within 3-4 mints they can also be recharged using the on-board compressor within 3-4 hours after connection to standard power outlet.

Fig.3:- flow of air tank to exhaust

Compensate for the cooling effect that takes place, a thermal exchanger heats the compressed air using the warmth of external air. This process is repeated as many times as possible to extract the maximum energy efficiency from the compressed air. For the somewhat technically minded, the following drawing illustrates the theoretical explanation for this process.

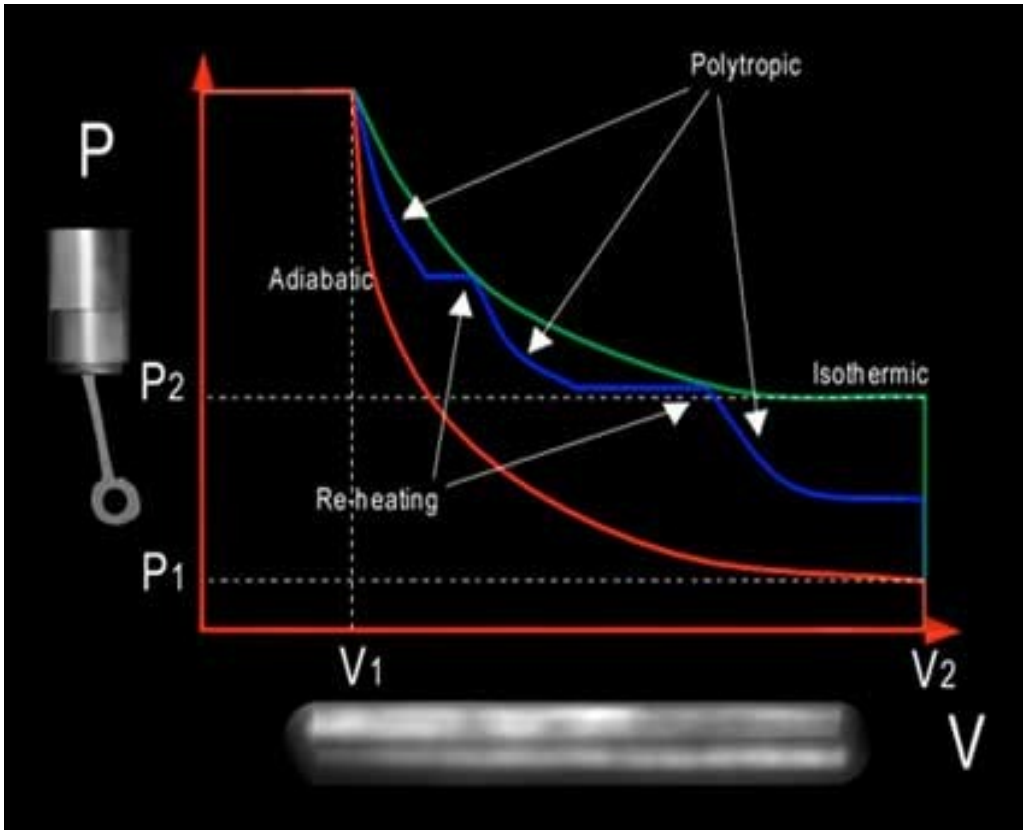

Fig.4:-P-V Diagram for air motor

The Isothermic the green line, represents the ideal transformation of the compressed air in effect, the air temperature is the same coming in and going out of the cylinder, and power is maximized. On the contrary, the worst transformation is the adiabatic transformation, represented by the red line. The derived power is minimal, and the air leaves the system at a very low temperature indeed. The blue line, or polytropic curve, represents the transformation and the individual stages outlined above can be seen. The transformation going through the first cylinder is represented by the polytropic line (somewhere between our ideal isotherm and the adiabatic curve). The following temperature rise brings the line closer to the isotherm, and allows the second and subsequent stages to produce more power.

In other words, if we realize an adiabatic transformation no heat is exchanged between the external air and the compressed air meaning that the power produced is minimal. On the contrary, following the isotherm means a maximum exchange and the power so produced are optimized.

In industry, cylindrical expansions are between the isothermal and the adiabatic. Isothermal expansion is defined by a constant temperature during the increase in volume. Adiabatic expansion is characterized by a lack of thermal exchange with the exterior. In our system, we use three polytropic expansions which correspond to real life, to which we added two thermal exchanges during the expansion phase to come as close as possible to

isothermal expansion which produces near-unity, avoiding friction.

The polytropic expansions work to the following formula:-

$$W=\frac{P_1 v_1 - P_0 V_0}{k-1}$$

And the volume after expansion is:-

$$V=V_0\left(\frac{P_0}{P_1}\right)^{\frac{1}{k}}$$

The energy used corresponds to the minimum energy a compressor uses to refill the tanks. This energy is that of isothermal transformation, being as it is the compressor efficiency. This work is obtained by:-

$$W=P_1 V_1 \ln\left(\frac{V_1}{V_0}\right)$$

Applying this formula to tanks of 300 liters at 300 bars results in 46 MJ (52.1 MJ with 340 liters at 300 bars).

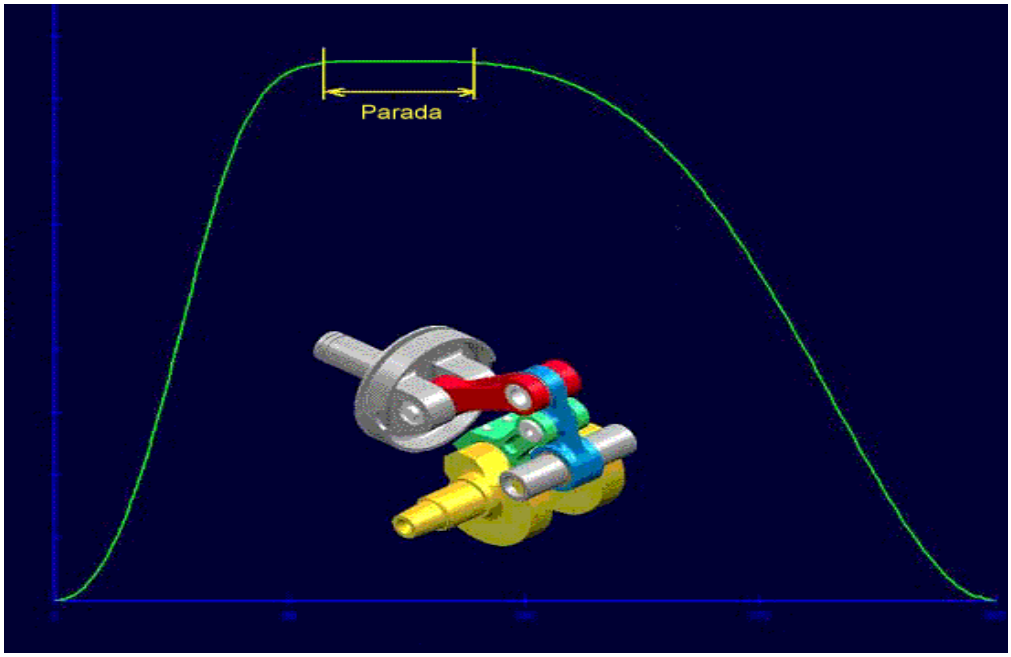

Fig.5:-Graph of crank angle vs. stroke length

The con-rod system allows the piston to "pause" at top dead centre during approximately 70 degrees of the rotation of the crankshaft. This gives enough time to establish the required pressure in the cylinder, including while the RPM is increased.

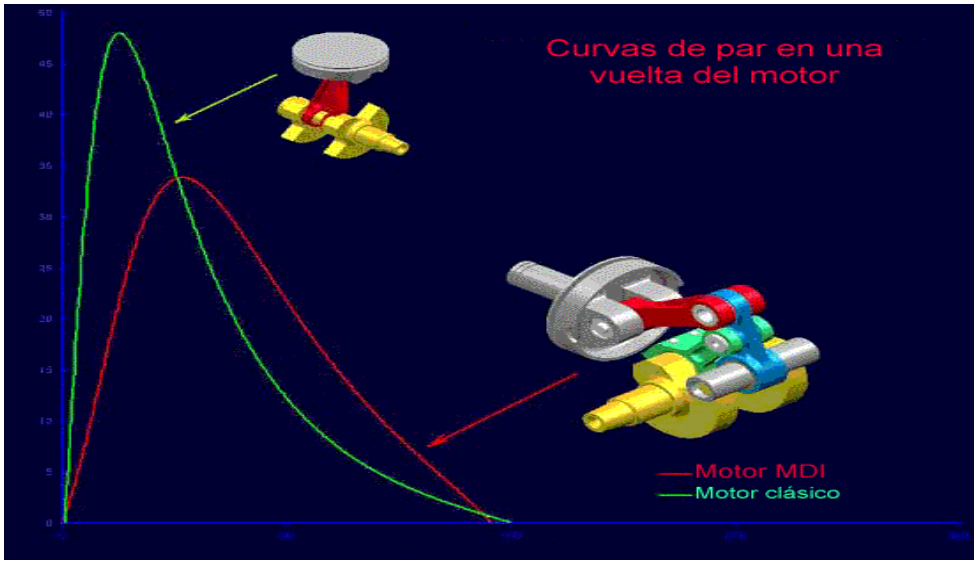

Fig.6:-Graph of crank rpm vs. torque

The torque obtained by this system is equal to that of a conventional system. It only changes the distribution of force in the cycle. This produces a torque curve (in one rotation of the engine) with a maximum value only slightly below that of a conventional system, at equal pressures. The surfaces at the bottom of the curves are identical, but the system which allows the piston "pause" at top dead centre, among other advantages, diminishes cyclic effects produced by top dead center in a conventional engine.

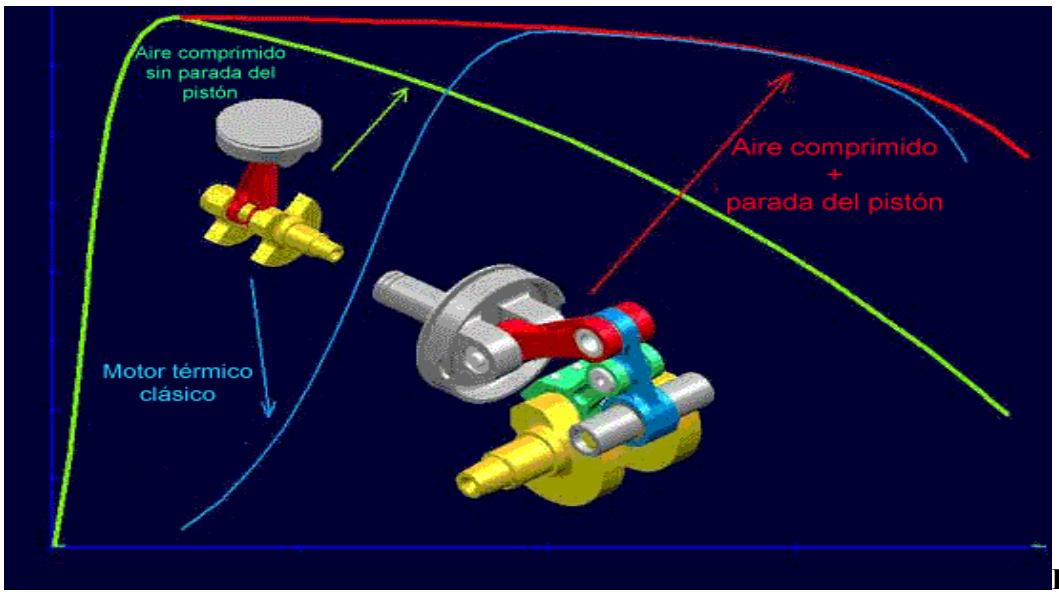

Fig. 7:-Graph of crank rpm vs. torque

Using a conventional con-rod crankshaft system, the torque curve falls when the RPM is increased. In our case, due to the piston pause at the TDC and having sufficient time to establish the correct pressure gives us a high torque at high RPM.

COMPARISON WITH ELECTRICAL VEHICLE'S

Comparison Chart	2000 Nissan Altra EV	2001 Toyota Rav4 EV	2001 CityC.A.T.®
Fuel Type	Electric	Electric	Compressed Air
MPG Avg	123	104	198
Annual Fuel Cost[1]	$331.00	$391.00	$220.00
Annual Green House Gas Emissions[2]	3.5	4.1	1.2
Range	129	126	120
Top Speed	75 MPH	78 MPH	60 MPH
Engine Characteristics	62 KW AC Induction	50 KW DC	Compressed Air
Recharge Time	5 Hours	6.75 Hrs[3]	3 Minutes or 4 Hours[4]
Price(MSRP)[5]	$50,999	$42,000	$14,000

Table 1:- Comparison between air car and electric vehicle

SPECIFICATIONS

Power source

Electronically injected compressed air

Compressed air: 3200 cubic ft at 4500psi

Recharge

Charger: On board 5.5kwh 220 volt compressor

Recharge time: Less than 3 minutes at Compressed air station

Alternative Recharge Outlet: 220V electric outlet less than 4 hours

Oil change: 0.8 liters per 50,000 miles

Engine

Intake and compression cylinder: 230 c.c.

Expansion and exhaust cylinder: 500 c.c.

Power max. HP (kW): 25(18.3) at 3000 rpm

Torque max. Kgm (NM): 6.3(61.7) at 500-2500 rpm

Performance

Maximum speed: 60 mph

Range: 120 miles or 10 hours

Acceleration times: 0-30 mph in less than 3 seconds

Exterior and Body

Overall length: 151 in.
Overall width: 68 in.
Overall height: 69 in.
Weight: 1543 lbs.

Light weight provides Good road-holding due to low center of gravity and low energy consumption.

Engine Mount: Rear

Suspension: Front coil springs, rear pneumatic

Steering mechanism: Rack and pinion

Body materials: Aluminum & fiberglass, Ensures good shock absorption.

Compressed Air Tanks: Composite fiberglass

ADVNATAGES AND DISADVANTAGES

ADVANTAGES

- Zero emission vehicle
- No fossil fuel required.
- Operating cost 75% less as compare to the gasoline engines.
- Price is also less then half of the electric vehicles.
- The recharging time is much more less that EV.
- The recharging of tank can be done at house.

DISADVANTAGES

- It can't give much higher speed.
- The recharging stations.

CONCLUSION

Nowadays the earth is facing the biggest problem of global warming. The major cause for this is the environmental pollution. Fossil fuel vehicles are the major contributors to this pollution. In order to irradiate this problem the solution is hybrid electrical vehicles but again they emit some pollutants, hence it is not a complete solution. The compressed air technology i.e. zero emission vehicles is the best feasible alternative and hence the complete solution of this problem.

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- **htto://zevcat.com/**