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Design and Fabrication of Pneumatic Air Vehicle

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Abstract: ***This paper work deals with the Compressed- air vehicle as a pneumatic actuator that converts one form of energy into another. The Air Driven Vehicle is an eco-friendly vehicle which operates with compressed air. This Vehicle uses the expansion of compressed air to drive the pistons of the vehicle. An Air Driven Vehicle 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 Vehicle 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. Compressed air propulsion may also be incorporated in hybrid systems, e.g., battery electric propulsion and fuel tanks to recharge the batteries. This kind of system is called hybrid-pneumatic electric propulsion. Additionally, regenerative braking can also be used in conjunction with this system.***

Keywords: Air, Compressed, Vehicle, Energy, Propulsion, Pneumatic

I. INTRODUCTION

A Compressed-air vehicle is a pneumatic actuator that creates useful work by expanding compressed air. A compressed-air vehicle is powered by an air vehicle, using compressed air, which is stored in a tank. Instead of mixing fuel with air and burning it in the vehicle to drive pistons with hot expanding gases, compressed air vehicles (CAV) use the expansion of compressed air to drive their pistons. They have existed in many forms over the past two centuries, ranging in size from hand held turbines up to several hundred horsepower. For example, the first mechanically-powered submarine, the 1863 Plongeur, used a compressedairvehicle. The laws of physics dictate that uncontained gases will fill any given space. The easiest way to see this in action is to inflate a balloon. The elastic skin of the balloon holds the air tightly inside, but the moment you use a pin to create a hole in the balloon's surface, the air expands outward with so much energy that the balloon explodes. Compressing a gas into a small space is a way to store energy. When the gas expands again, that energy is released to do work. That's the basic principle behind what makes an air car go. Some types rely on pistons and cylinders, others use turbines. Many compressed air vehicles improve their performance by heating the incoming air, or the vehicle itself. Some took this a stage further and burned fuel in the cylinder or turbine, forming a type of internal combustion vehicle. One manufacturer claims to have designed anvehicle that is 90 percent efficient. Compressed air propulsion may also be incorporated in hybrid systems, e.g., battery electric propulsion and fuel tanks to recharge the batteries. This kind of system is called hybrid-pneumatic electric propulsion. Additionally, regenerative braking can also be used in conjunction with this system.

A compressed-air vehicle is powered by an air engine, using compressed air, which is stored in a tank. Instead of mixing fuel with air and burning it in the engine to drive pistons with hot expanding gases, compressed air engine (CAE) uses the expansion of compressed air to drive their pistons. They have existed in many forms over the past two centuries, ranging in size from hand held turbines up to several hundred horsepower. For example, the first mechanically-powered submarine, the 1863 Plan gear, used a compressed air engine. The laws of physics dictate that uncontained gases will fill any given space. The easiest way to see this in action is to inflate a balloon. The elastic skin of the balloon holds the air tightly inside, but the moment you use a pin to create a hole in the balloon's surface, the air expands outward with so much energy that the balloon explodes. Compressing a gas into a small space is a way to store energy. When the gas expands again, that energy is released to do work. That's the basic principle behind what makes an air car go. Some types rely on pistons and cylinders, others use turbines. Many compressed air engines improve their performance by heating the incoming air, or the engine itself. Some took this a stage further and burned fuel in the cylinder or turbine, forming a type of internal combustion engine. One manufacturer claims to have designed an engine that is 90 percent efficient. Compressed air propulsion may also be incorporated in hybrid systems, e.g., battery electric propulsion and fuel tanks to recharge the batteries. Additionally, regenerative braking can also be used in conjunction with this system.

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II. COMPONENTS

1) Square Tube
2) Pneumatic Cylinder
3) Pneumatic Hose
4) Nipple
5) Wheel
6) Pre Wheel
7) 5/2 DCV Solenoid
8) Compressor Tank

Types

- *Single Acting Cylinders:* A single-acting cylinder (SAC) has one port, which allows compressed air to enter and for the rod to move in one direction only. The high pressure of the compressed air causes the rod to extend as the cylinder chamber continues to fill. When the compressed air leaves the cylinder through the same port the rod is returned to its original position.
- *Double Acting Cylinders:* Double-acting cylinders (DAC) use the force of air to move in both extend and retract strokes. They have two ports to allow air in, one for outstroke and one for instroke. Stroke length for this design is not limited, however, the piston rod is more vulnerable to buckling and bending. Additional calculations should be performed as well.

- *Telescoping Cylinder*



Pneumatic telescoping cylinder, 8-stages, single-acting, retracted and extended

Telescoping cylinders, also known as telescopic cylinders can be either single or double-acting. The telescoping cylinder incorporates a piston rod nested within a series of hollow stages of increasing diameter. Upon actuation, the piston rod and each succeeding stage "telescopes" out as a segmented piston. The main benefit of this design is the allowance for a notably longer stroke than would be achieved with a single-stage cylinder of the same collapsed (retracted) length. One cited drawback to telescoping cylinders is the increased potential for piston flexion due to the segmented piston design. Consequently, telescoping cylinders are primarily utilized in applications where the piston bears minimal side loading.

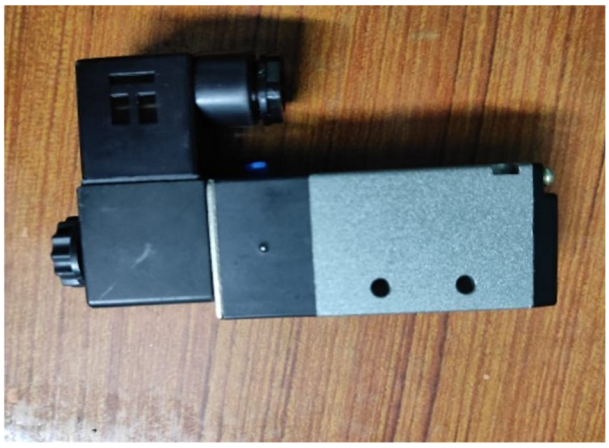
- *Others:* Although SACs and DACs are the most common types of pneumatic cylinder, the following types are not particularly rare:

- Through rod air cylinders: piston rod extends through both sides of the cylinder, allowing for equal forces and speeds on either side.
- Cushion end air cylinders: cylinders with regulated air exhaust to avoid impacts between the piston rod and the cylinder end cover.
- Rotary air cylinders: actuators that use air to impart a rotary motion.
- Rodless air cylinders: These have no piston rod. They are actuators that use a mechanical or magnetic coupling to impart force, typically to a table or other body that moves along the length of the cylinder body, but does not extend beyond it.
- Tandem air cylinder: two cylinders assembled in series

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A. 5/2 DCV

Directional control valves (DCVs) are one of the most fundamental parts of hydraulic and pneumatic systems. DCVs allow fluid flow (hydraulic oil, water or air) into different paths from one or more sources.



DCVs will usually consist of a spool inside a cylinder which is mechanically or electrically actuated. The position of the spool restricts or permits flow, thus it controls the fluid flow.

Directional control valves can be classified according to:

- Number of ports
- Number of positions
- Actuating methods
- Type of spool

Example: A 4/2 directional control valve would have four ports and two spool positions.

Ports are located on the manifold to which the directional control valve is mounted, and are used as connection points to the system. While working with layouts of hydraulic machinery it is cumbersome to draw actual picture of every valve and other components. Instead of pictures, symbols are used for variety of components in the hydraulic system to highlight the functional aspects. The symbol for directional control valve is made of number of square boxes adjacent to each other depending on the number of positions. Connections to the valve are shown on these squares by capital letters. usually they are named only in their normal position and not repeated in other positions. actuation system of the valve is also designated in its symbol. Directional control valves are generally specified using the number of ports and the number of switching positions. It can be represented in general form as np/ns, where np is the number of ports connected to the direction control valve and ns the number of switching positions.

B. Pneumatic Hose



Pneumatic hose generally consists of an inner tube, one or more layers of reinforcing braided or spiral-wound fiber, and an outer protective cover. In broad terms, hose is more rugged than tubing but costs more. The air supply and application set a baseline for the necessary product performance. THE basic function of pneumatic tubing and hose is to convey pressurized air to actuators, valves, tools and other devices. But there are countless types and sizes of tubing and hose on the market, so vehicleers should consider a number of important factors to select the right one for a given task.

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Start with construction. Tubing for air applications may be extruded of a single material or reinforced internally, typically with textile fibers for higher strength. Pneumatic hose generally consists of an inner tube, one or more layers of reinforcing braided or spiral-wound fiber, and an outer protective cover. In broad terms, hose is more rugged than tubing but costs more.

The air supply and application set a baseline for the necessary product performance. Flow requirements help determine hose or tubing size.

Regardless, choosing too small an inner diameter "chokes" flow and results in pressure losses, inefficiency and excessive fluid velocity that can shorten service life. Too large a diameter, on the other hand, results in higher than necessary weight, size and cost.

C. Pneumatic Nipple



In plumbing and piping, a nipple is a fitting, consisting of a short piece of pipe, usually provided with a male pipe thread at each end, for connecting two other fittings.

The length of the nipple is usually specified by the overall length with thread. It may have a hexagonal section in the center for a wrench to grasp (sometimes referred to as a "hex nipple"), or it may simply be made from a short piece of pipe (sometimes referred to as a "barrel nipple" or "pipe nipple"). A "close nipple" has no unthreaded area; when screwed tightly between two female fittings, very little of the nipple remains exposed. A close nipple can only be unscrewed by gripping one threaded end with a pipe wrench which will damage the threads and necessitate replacing the nipple, or by using a specialty tool known as a nipple wrench (or known as an internal pipe wrench) which grips the inside of the pipe, leaving the threads undamaged. When the ends are of two different sizes it is called a reducer or unequal nipple.

Threads used on nipples are BSP, BSPT, NPT, NPSM and Metric. A chase nipple is a short pipe fitting, which creates a path for wires between two electrical boxes. A chase nipple has male threads on one end only. The other end is a hexagon. The chase nipple passes through the knockouts of two boxes, and is secured by an internally threaded ring called a lock nut. Chase-Shawmut Company, of Boston, is the company which first produced chase nipples.

D. Compressor Tank

A pressure vessel is a container designed to hold gases or liquids at a pressure substantially different from the ambient pressure.

Construction methods and materials may be chosen to suit the pressure application, and will depend on the size of the vessel, the contents, working pressure, mass constraints, and the number of items required.

Pressure vessels can be dangerous, and fatal accidents have occurred in the history of their development and operation. Consequently, pressure vessel design, manufacture, and operation are regulated by engineering authorities backed by legislation. For these reasons, the definition of a pressure vessel varies from country to country.

Design involves parameters such as maximum safe operating pressure and temperature, safety factor, corrosion allowance and minimum design temperature (for brittle fracture). Construction is tested using nondestructive testing, such as ultrasonic testing, radiography, and pressure tests. Hydrostatic pressure tests usually use water, but pneumatic tests use air or another gas. Hydrostatic testing is preferred, because it is a safer method, as much less energy is released if a fracture occurs during the test (water does not greatly increase its volume when rapid depressurization occurs, unlike gases, which expand explosively). Mass or batch production products will often have a representative sample tested to destruction in controlled conditions for quality assurance. Pressure relief devices may be fitted if the overall safety of the system is sufficiently enhanced.

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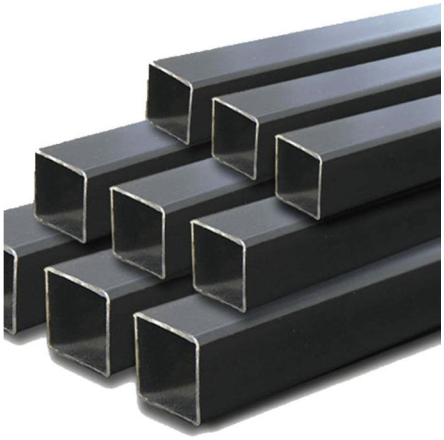
E. Wheel

A wheel is a circular component that is intended to rotate on an axle bearing. The wheel is one of the key components of the wheel and axle which is one of the six simple machines. Wheels, in conjunction with axles, allow heavy objects to be moved easily facilitating movement or transportation while supporting a load, or performing labor in machines. Wheels are also used for other purposes, such as a ship's wheel, steering wheel, potter's wheel, and flywheel.

Common examples are found in transport applications. A wheel reduces friction by facilitating motion by rolling together with the use of axles. In order for wheels to rotate, a moment needs to be applied to the wheel about its axis, either by way of gravity or by the application of another external force or torque. Using the wheel, Sumerians invented a device that spins clay as a potter shapes it into the desired object.

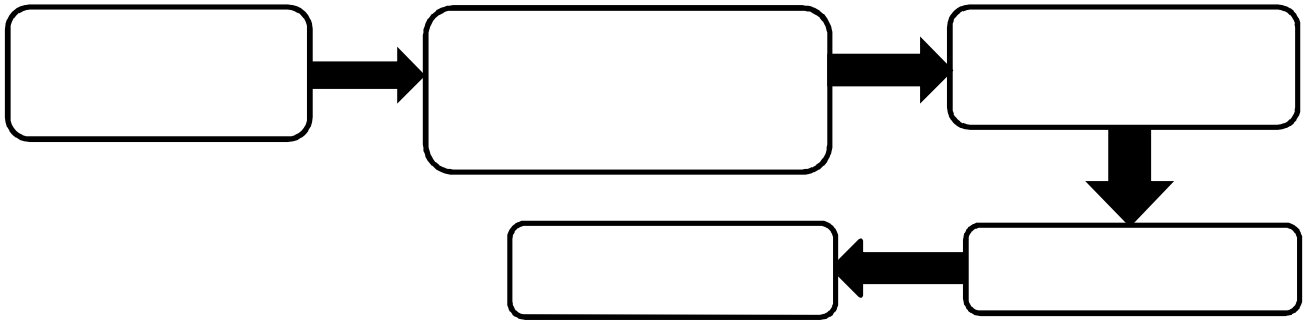
A wheeled vehicle requires much less work to move than simply dragging the same weight. The low resistance to motion is explained by the fact that the frictional work done is no longer at the surface that the vehicle is traversing, but in the bearings. In the simplest and oldest case the bearing is just a round hole through which the axle passes (a "plain bearing").

F. Square Tube



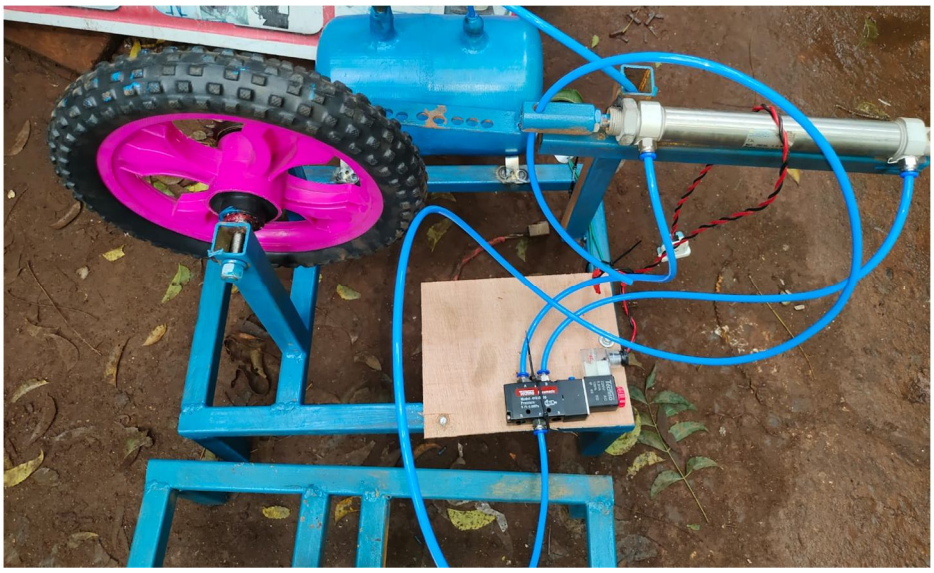
Rectangular and square HSS are also commonly called tube steel or box section. Circular HSS are sometimes mistakenly called steel pipe, although true steel pipe is actually dimensioned and classed differently from HSS. Square tubes are generally used for maintenance and structural purposes. Some examples of applications would be building construction, railings, and sign posts. They are measured by their outside dimensions and their wall thickness. Square Steel Tube is a welded structural grade tubing that is available in either type A513 or A500 Grade B, depending on it's size and wall thickness. Either grade is ideal for all structural applications, general fabrication, manufacturing and repairs.

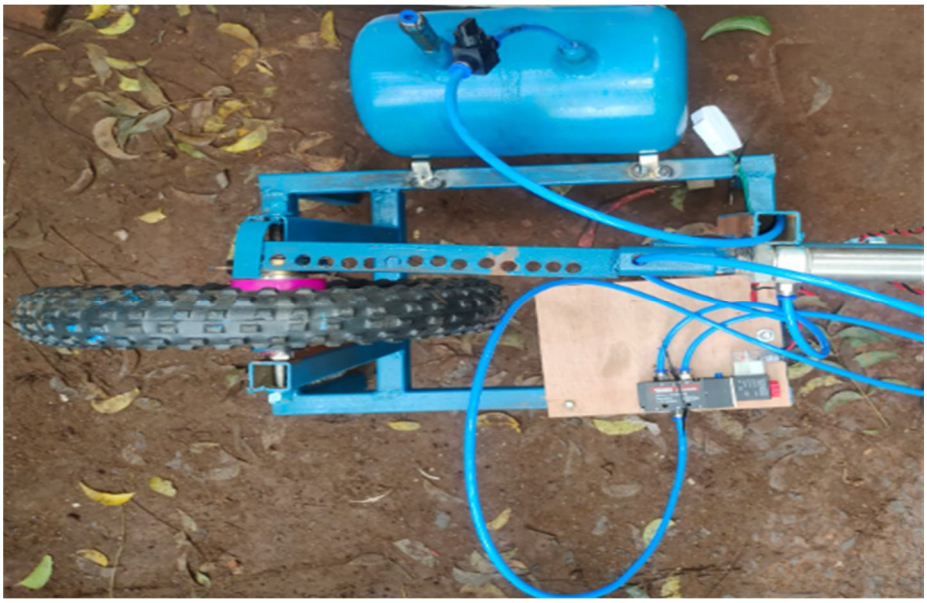
III. BLOCK DIAGRAM OF AIR OF PNEUMATIC AIR VEHICLE



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IV. FABRICATED SETUP





V. ADVANTAGES

1) Compressed air to store the energy instead of batteries.
2) Pollution created during fuel transportation would be eliminated.
3) Reducing pollution from one source, as opposed to the millions of vehicles on the road.
4) There is no need to build a cooling system, fuel tank, Ignition Systems or silencers.
5) The price of fueling air powered vehicles will be significantly cheaper than current fuels.

VI. DISADVANTAGES

1) The temperature difference between the incoming air and the working gas is smaller. In heating the stored air, the device gets very cold and may ice up in cool, moist climates.
2) Refueling the compressed air container using a home orlow- end conventional air compressor may take a long time.
3) Tanks get very hot when filled rapidly. It very dangerous if caution is not maintained.
4) Only limited storage capacity of the tanks. So we cannot opt for a long drive.

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VII. APPLICATIONS

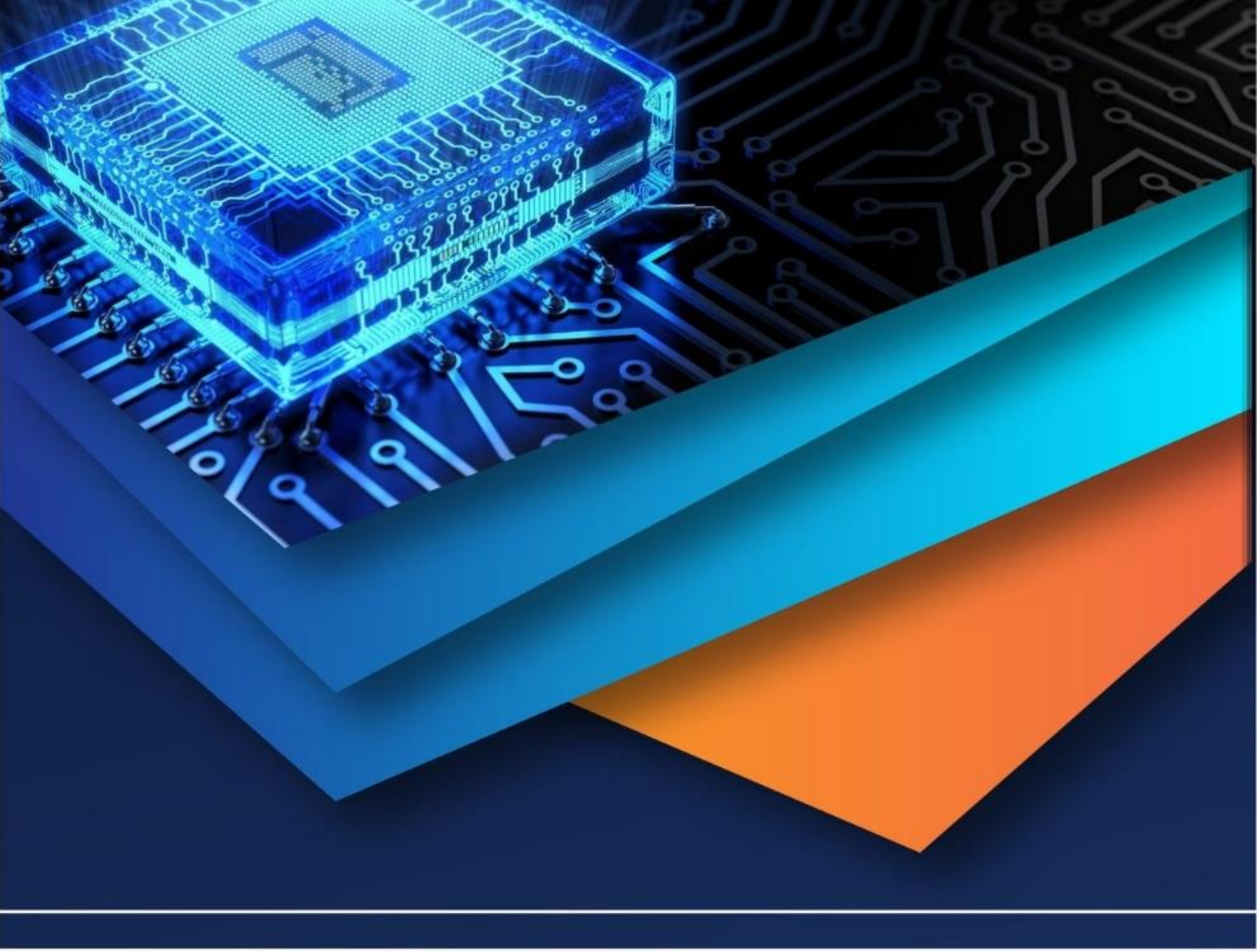
Compressed air vehicles were used in trams and shunters, and eventually found a successful niche in mining locomotives
Transport category airplanes, such as commercial airliners, use compressed air starters to start the main vehicles.

VIII. CONCLUSION

1) Efficiency of the system will higher than conventional systems.
2) The mechanism designed is pollution free.
3) Compressed air is non-conventional energy and it is abundant in nature Due to global warming it is demand of time to adopt green technology.
4) With some modifications it will give better performance than the conventional vehicles. This vehicle having minimum disadvantages. It is cheaper than any other technology.
5) From the observation it will be concluded that compressed air power vehicle can prove to the future vehicle which is ecofriendly, pollution free, but also very economical. This redresses both the problems of fuel crises and pollution

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