Cars in compressed air: the pros and cons

A few years ago, the world circled the news that the Indian company Tata is going to launch a series of cars working in compressed air. Plans have remained plans, but pneumatic cars have clearly become a trend: every year several viable projects appear, and Peugeot in 2016 planned to put an air hybrid on the conveyor. Why did the pneumocars suddenly become fashionable?

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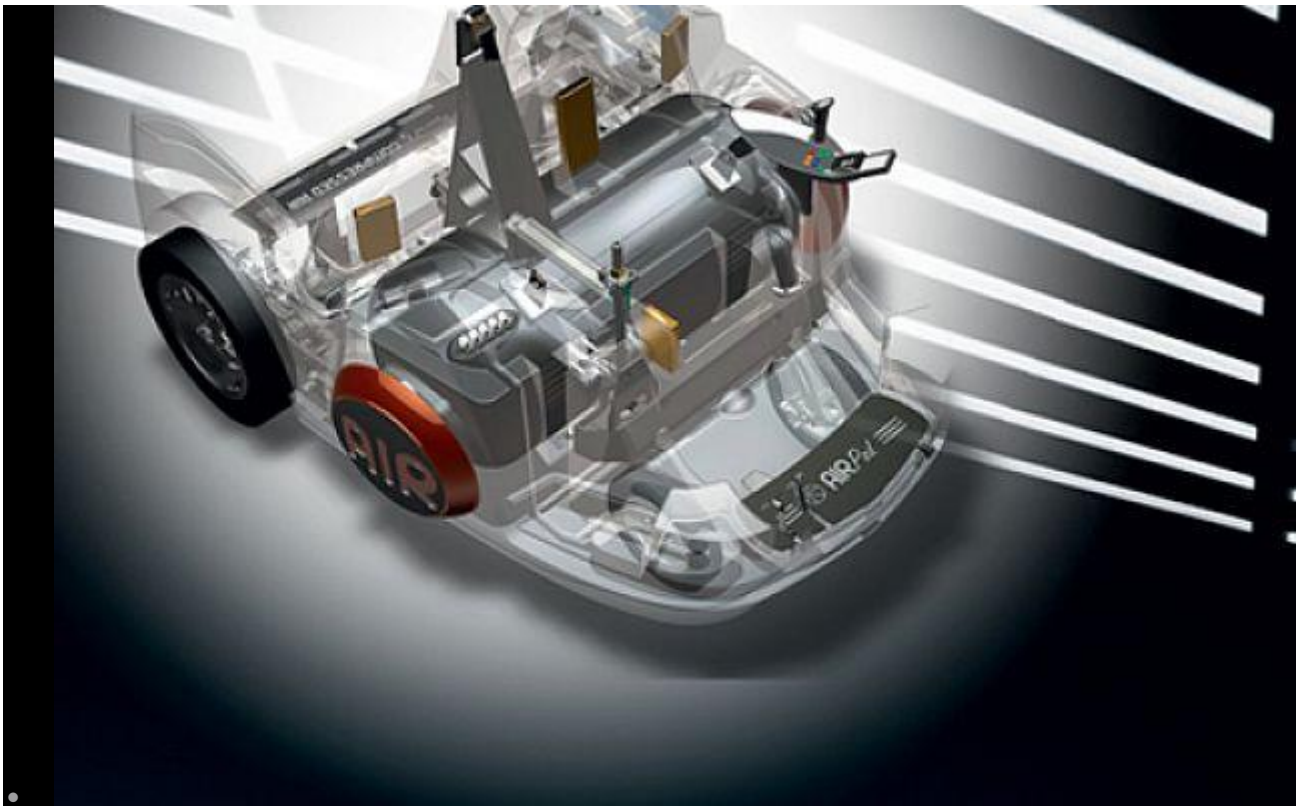


Audio version of the article:

Everything new is a well-forgotten old. So, electric cars at the end of the XIX century were more popular than gasoline brothers, then they survived a century of oblivion, and then again "rose from the ashes." The same applies to pneumatic equipment. As early as 1879, the French aviation pioneer Viktor Taten designed the aircraft A? Roplane, which was supposed to go up in the air thanks to a compressed air engine. The model of this machine successfully flew, although in full size the aircraft was not built.

The ancestor of air motors on land transport was another Frenchman, Louis Mekarski, who developed a similar power unit for Paris and Nantes trams. In Nantes machines were tested in the late 1870s, and by 1900, Mekarski owned a fleet of 96 trams, which proved the effectiveness of the system. Subsequently, the pneumatic "fleet" was replaced by an electric one, but the beginning was laid. Later, pneumatic locomotives found themselves a narrow sphere of universal application - mine business. At the same time, attempts to put an air engine on the car began. But before the beginning of the XXI century, these attempts remained isolated and not worth attention.

Benefits of air

The pneumatic motor (or, as they say, the pneumatic cylinder) converts the energy of expanding air into mechanical work. According to the principle of action, it is similar to the hydraulic one. The "heart" of the air motor is the piston to which the rod is attached; Around the rod, a spring is wound. The air entering the chamber, with increasing pressure, overcomes the resistance of the spring and moves the piston. In the exhaust phase, when the air pressure drops, the spring returns the piston to its original position - and the cycle repeats. Pneumatic cylinder can be called "engine internal combustion."

More common membrane scheme, where the role of the cylinder performs a flexible membrane, to which the same rod is attached with a spring. Its advantage lies in the fact that such high accuracy of landing of movable elements is not needed, lubricants are not required, and the tightness of the working chamber is increased. There are also rotor (plate) pneumatic motors - analogues of the Wankel engine.

The main advantages of the air motor are its ecological compatibility and low cost of "fuel". Actually, because of the wastelessness of pneumatic locomotives and have become widespread in the mine business - when using ICE in confined space, air quickly becomes dirty, dramatically worsening working conditions. The exhaust gases of the air motor are ordinary air.

One of the disadvantages of a pneumatic cylinder is the relatively low energy density, that is, the amount of energy produced per unit volume of the working fluid. Compare: air (at a pressure of 30 MPa) has an energy density of about 50 kWh per liter, and ordinary gasoline - 9411 kWh per liter! That is, gasoline as a fuel is more effective almost 200 times. Even taking into account the not very high efficiency of the gasoline engine, it "produces" as a result about 1600 kWh per liter, which is much higher than the performance of the air cylinder. This limits all operational characteristics of air motors and the machines they drive (power reserve, speed, power, etc.). In addition, the air motor has a relatively low efficiency - about 5-7% (against 18-20% for ICE).

pros

+ No harmful emissions
+ Ability to refuel the car at home
+ Low cost due to the simplicity of the engine design
+ The possibility of using an energy recuperator (for example, compression and accumulation of additional air due to braking the car)

Minuses

- Low efficiency (5-7%) and energy density
- The need for an external heat exchanger, since when the air pressure is reduced, the engine is greatly supercooled
- Low performance of pneumatic vehicles.

Pneumatics of the XXI century

The urgency of environmental problems of the 21st century forced engineers to return to the long-forgotten idea of using a pneumatic cylinder as an engine for a road vehicle. In fact, a pneumatic car is more environmentally friendly than an electric vehicle, the elements of its construction contain substances harmful to the environment. In the air cylinder there is air and nothing but air.

Therefore, the main engineering task was to bring the pneumocar to the kind in which it could compete with electric vehicles in terms of performance and cost. There are many potholes in this matter. For example, the problem of dehydration of air. If there is at least a drop of liquid in the compressed air, then due to strong cooling, when the working medium expands, it will turn into ice, and the engine will simply decay (or even require repair). The usual summer air contains about 10 g of liquid per 1 m^3, and when filling one cylinder it is necessary to expend additional energy (about 0.6 kWh) on dehydration - and this energy is irreplaceable. This factor negates the possibility of high-quality home refueling - equipment for dehydration can not be installed and operated at home. And this is just one of the problems. Nevertheless, the topic of the car was too attractive to forget about it.

Immediately into the series?

One of the solutions to minimize the disadvantages of the air motor is the car's relief. Indeed, the city minicar does not need a large power reserve and speed, but the ecological indicators in the megalopolis play a significant role. This is what the engineers of the French-Italian company Motor Development International, who at the Geneva Motor Show in 2009, presented to the world MDI AIRPod and its more serious version of MDI OneFlowAir. MDI began to "fight" for the pneumocar in 2003, showing the concept Eolo Car, but only after ten years, having filled a lot of cones, the French came to an acceptable for the conveyor solution.

MDI AIRPOD

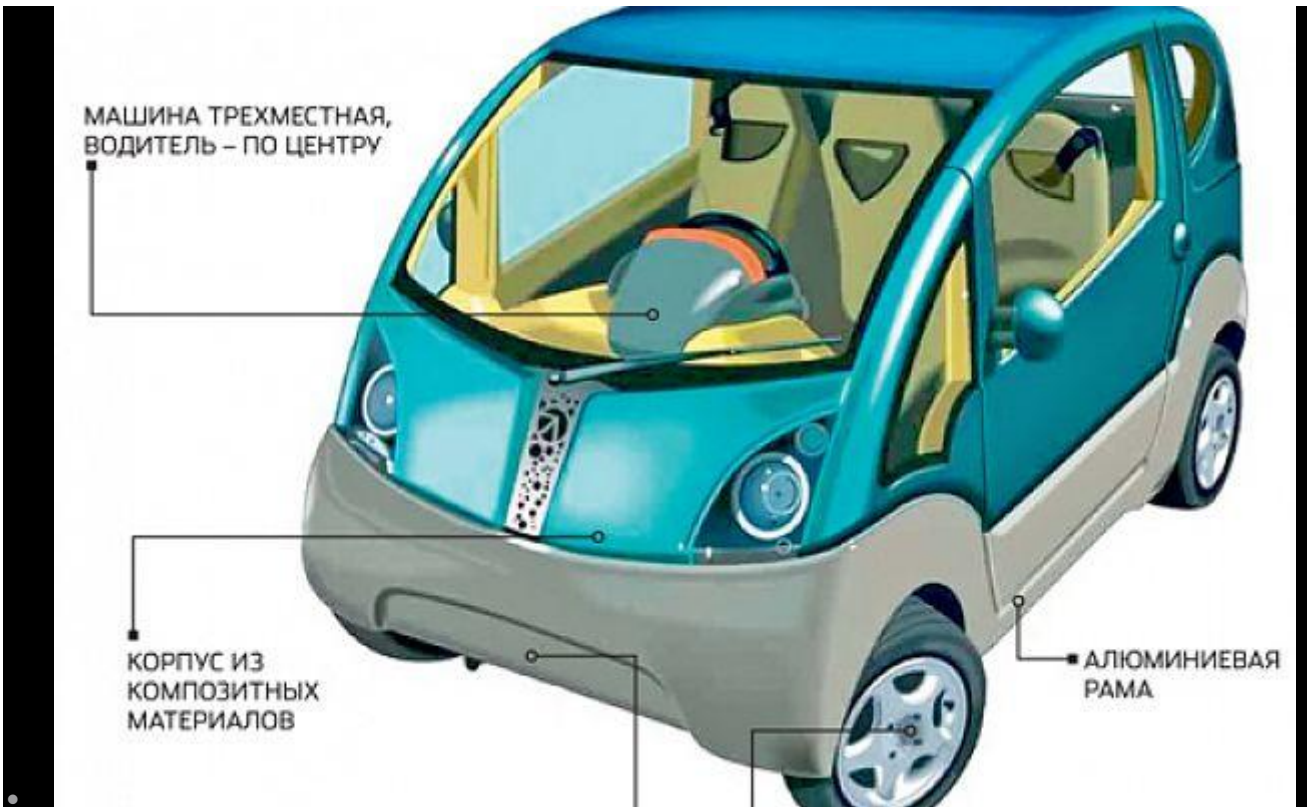
The tiny three-seater pneumatic car of the French MDI was introduced to the general public at the 2009 Geneva Motor Show. He has the right to move around the designated bike paths and does not require a driver's license. Perhaps the most promising pneumocar.

MDI AIRPOD - it's something between the car and a motorcycle, a direct analog of a wheelchair-"invalid", as it was often called in the USSR. Thanks to a 5.45-horsepower air engine, a three-wheel compact car weighing only 220 kg can accelerate to 75 km / h, and the reserve of its travel is 100 km in the basic version or 250 km in a more serious configuration. Interestingly, AIRpod does not have a steering wheel at all - the car is controlled by a joystick. In theory, it can move both on public roads and on bicycle paths.

AIRpod has all chances for mass production, since in cities with a developed cycling structure, for example in Amsterdam, such machines can be in demand. One refueling by air at a specially equipped station takes about one and a half minutes, and the cost of transportation is in the order of? 0.5 per 100 km - it's cheaper simply nowhere. Nevertheless, the announced deadline for mass production (spring 2014) has already passed, and it is still there. Perhaps MDI AIRpod will appear on the streets of European cities in 2015.

The second pre-series concept is the famous project of the Indian giant Tata, the MiniCAT car. The project was launched simultaneously with AIRpod, but, unlike Europeans, Indians laid in the program a normal, high-grade microcar with four wheels, a luggage carrier and a traditional layout (in AIRpod, note, the passengers and the driver are sitting with their backs to each other). The weight of the Tata is a bit bigger, 350 kg, the maximum speed is 100 km / h, the power reserve is 120 km, that

is, the MiniCAT is generally similar to a car, not a toy. Interestingly, in the company Tata did not suffer from the development of an air engine from scratch, and for $ 28 million acquired the rights to use the MDI developments (which allowed the latter to stay afloat) and improved the engine to drive a larger vehicle. One of the chips of this technology is the use of heat generated during the cooling of the expanding air, to heat the air when refilling the cylinders.



Tata MiniCAT

Initially, Tata was going to put MiniCAT on the conveyor in mid-2012 and produce about 6000 units a year. But the break-in continues, and mass production is postponed until better times. During the development of the concept managed to change the name (previously it was called OneCAT) and design, so that what version of it will go on sale in the end, no one knows. It seems, even representatives of Tata.

On two wheels

The lighter the car in compressed air, the more effective it is in terms of operational and economic indicators. The logical conclusion from this statement is why not make a scooter or a motorcycle?

A photo

The cross-country motorcycle built by Australian Dean Bensted on the Yamaha chassis is capable of accelerating to 140 km / h and non-stop for three hours at a speed of 60 km / h.The air engine of the Angelo di Pietro system weighs only 10 kg.

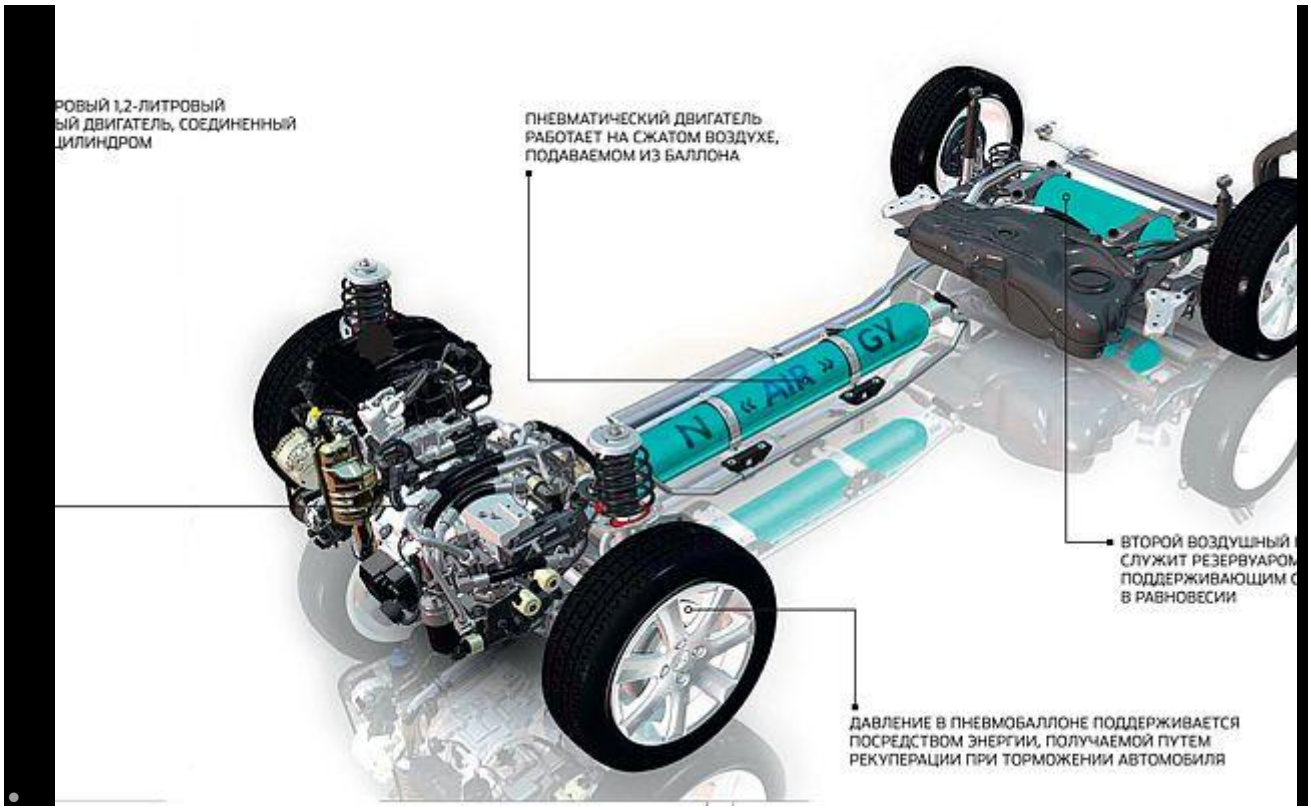
This concerned the Australian Dean Bensted, who in 2011 demonstrated to the world a cross-country motorcycle O $_2$ Pursuit with a power unit developed by Engineair. The latter specializes in the already mentioned rotor air engines developed by Angelo di Pietro. In fact, this is a classic arrangement of "wankel" without combustion - the rotor is set in motion by supplying air to the chambers. Bensted went in the design from the opposite. First he ordered the Engineair engine, and then built a motorcycle around it, using the frame and part of the elements from the serial Yamaha WR250R. The car turned out to be surprisingly energy efficient: at one gas station it runs 100 km and in theory develops a top speed of 140 km / h. These indicators, by the way, exceed those of many electric motorcycles. Bensted wittily played on the form of the balloon, having inscribed it into the frame, it helped to save space; The engine is twice as compact as its gasoline colleague, and the free space allows you to install a second cylinder, increasing the mileage of the motorcycle by half.
But, unfortunately, O $_2$ Pursuit remained only a one-time toy, although it was nominated for a prestigious inventive prize, established by James Dyson. Two years later Bensted's idea was picked up by another Australian, Darby Bicheno, who suggested creating a motorcycle rather than a city car, a purely urban vehicle, a scooter. Its EcoMoto 2013 should be made of metal and bamboo (no plastic), but the renders and drawings have not progressed further.

In addition to Bensted and Bicheno, a similar machine was built in 2010 by Evin Yang (his project was called Green Speed Air Motorcycle). All three designers, by the way, were students of the Royal Melbourne Institute of Technology, and therefore their projects are similar, they use the same engine and ... do not have a chance on the series, remaining research work.

Corporations at the start

The above confirms that there is a future for air cars, but, most likely, not in a "pure form". Still, they have their limitations. The same MDI AIRPod failed absolutely all crash tests, because its ultralight design did not allow to properly protect the driver and passengers.

But using pneumotechnology as an additional source of energy in a hybrid car is quite feasible. In this regard, the company Peugeot announced that in 2016 part of the Peugeot 2008 crossovers will be produced in a hybrid version, one of the elements of which will be the installation of Hybrid Air. This system was developed in cooperation with Bosch; Its essence is that the energy of the engine will not be stored in the form of electricity (as in conventional hybrids), but in compressed air cylinders. Plans, however, and remained plans: at the moment, the serial cars are not installed.



Chassis Peugeot 2008 Hybrid Air

On a full tank and a full refueling with air Peugeot 2008 Hybrid Air can drive up to 1300 km.

Peugeot 2008 Hybrid Air will be able to move using the energy of the engine, air power unit or a combination thereof. The system itself will recognize which of the

sources is more energy efficient in a given situation. In the urban cycle, in particular, 80% of the time will be used energy compressed air - it drives the hydraulic pump, which rotates the shaft when the engine is off. The total fuel economy under such a scheme will be up to 35%. When working in clean air, the maximum speed of the car is limited to 70 km / h.
The Peugeot concept looks absolutely viable. Given the environmental benefits of such hybrids will be able to push the electric within the next five to ten years. And the world will become a little cleaner. Or will not.

Competition for speed

In 2011, the Toyota Ku: Rin sports car set a world speed record for vehicles powered by compressed air. Typically, pneumatic cars do not accelerate to more than 100-110 km / h, the concept Toyota also showed an official result of 129.2 km / h. Due to the "sharpness" of the speed, Ku: Rin could only run 3.2 km on one charge, but it was not required for a three-wheeled single-seat car. The record is set. Interestingly, before that the record was only 75.2 km / h and was installed in Bonneville Silver Rod car of the design of American Derek McLeish in the summer of 2010.
The article "Energy of the Air" was published in the magazine "Popular Mechanics" (No. 146, December 2014).