German utility model no. DE202023100127U1

Power and Heat Generation Using Shape Memory Alloys Utilizing Ambient Temperature

Description

Shape memory alloys (also known as memory metals or shape memory metals) have been known for a long time. These are mostly metals or alloys that can exist in two different crystal structures. The standard form is created at very high temperatures. After deformation, the original shape is resumed above the transformation temperature. The basic shape is assumed even against a significant mechanical resistance.

One of the best-known representatives of these alloys is Nitinol, which was manufactured in 1958. The name Nitinol is an acronym derived from the metals and the location of the laboratory: Nickel Titanium Naval Ordnance Laboratory.

Other "memory materials" are, for example, from copper-zinc (possibly with aluminum) alloys, copper-aluminum and nickel, iron-nickel and aluminum, etc., as well as nowadays also from plastics.

The production of Nitinol, for example, is still quite expensive and complex, as a vacuum is needed and high purity is required. Another disadvantage is that the efficiency, for example, is still quite low at 16%. Furthermore, a temperature difference is needed for power generation, as usual. However, the ambient air at, for example, around 10°C (283 Kelvin) generally has an underestimated energy content and is unlimitedly available.

It has also long been known that gases experience a temperature increase when compressed. Depending on the pressure and material-specific adiabatic exponent, the necessary temperature difference between the compressed gas and the ambient air required by shape memory alloys can be generated with a manageable energy expenditure.

Such power or heat generation is independent of the time of day and season. Solar cells/photovoltaics and wind power plants are sustainable and renewable but are not always available.

The goal is decentralized power generation that has no disruptive infrastructure, requires no new buildings, and causes low environmental impact. Instead of extremely complex fusion power plants or other large power plants, local alternatives should be used. There are many other reasons why locally generated energy is better than large power plants.

My invention is based on the further development of machines with shape memory alloys that generate electricity and heat day and night.

There are some solutions related to the invention, such as:
- JP0000S5990777A, including a piston and Freon in the cooling cycle,
- US000004325217A, including a piston and cold and hot water,
- US000004434618A, including a heat pump via a crankshaft,
- US000004646523A, including a heat and water pump,
- US000004938026A, including a heat pump and Nitinol as a flexible spring on a gear,
- US000011028836B2, including a piston and two media,
- US020060144048A1, including a piston and solar collector heat as well as magnetocaloric effect,
- WO001984004947A1, converting heat into mechanical energy including round wire for engines and ships,
- WO001986004960A1, including a linear motor and switching between hot and cold baths,
- WO002000072783A1, including pumps as a medical device for spines and hearts,
- WO002003089789A2, including a heat and micropump,
- WO002011163259A2, including a heat pump and motor via a crankshaft,
- WO002017156371A1, including pistons, pressure, and mechanical energy storage.

The existing solutions fulfill their function according to the circumstances or are still in development but do not have the possibilities of the aforementioned invention.

A universally placeable solution is desired, and the invention of power and heat generation using so-called shape memory alloys by utilizing ambient temperature, as specified in Claim 1, meets these requirements.

An Example Embodiment:

In Fig. 1 (according to Claim 2), a machine with two interconnected pistons 3 is shown (connected via 6) that move parallel to the left and right. Two Nitinol hollow springs (1 and 2) are connected to the partition wall and the pistons. At the ends of the two hollow springs, there are cycle-controlled valves 4, which are installed in the partition wall and both pistons. The Nitinol has a low transformation temperature of, for example, 45°C. The valves alternately allow warm gas (e.g., air) that is significantly warmer than the transformation temperature or a liquid or cold gas (e.g., ambient air or a liquid with the same temperature) into the hollow springs. With a warm medium, the hollow springs shorten with great force; with a cold medium, the hollow spring can be stretched with little force through the connection with the other piston.

The connected pistons' work can drive a generator, thereby producing electricity. This electricity, in turn, can operate a heat pump that provides heating.

Possible Options:

As shown in Claim 3, different shape memory materials, including plastics, are possible.

Multiple springs and/or a rack are conceivable according to Claim 4.

As shown in Claim 5, a combination with a flywheel is an option.

For primarily heat generation, only the necessary heat of the compressed gas for the shape memory alloys is used (according to Claim 6), and the rest of the heat is directly dissipated to a heater via a heat exchanger. When the pressure is released, the air or liquid becomes cold, and the shape memory spring can be extended without much force.

As shown in Claim 7, the machine can be equipped with many pistons and operated with longer heat exchanger exposure.

Two springs are combined (according to Claim 8): one spring optimized for generator drive, the second spring optimized for heat generation.

As shown in Claim 9, cold or hot magnetic fluids can be used, allowing the medium change to occur faster through a magnet.

At the end of the working chamber, there is a smaller recess according to Claim 10, into which only the spring and not the entire piston fits.

As shown in Claim 11, the machine can work with air, other gases, water, other liquids, or other heat carriers as a medium (for liquids, additional heat exchangers: air-water or gas-liquid heat exchangers).

According to Claim 12, Nitinol or other shape memory materials can operate as wire, springs, hollow springs, spring tubes/tube springs/pipes/rods/bars, or other retractable and extendable components.

As shown in Claim 13, a rigid connection between two pistons or a flexible connection via pulleys or another connection is possible.

With an insulating ball, work can be done in a tube or hollow spring that separates cold and warm and, if necessary, pressure (according to Claim 14).

As shown in Claim 15, a shape memory material spring can be used in a small surrounding cylinder or, better, in a hollow cylinder, so that only a small amount of warm gas/warm liquid is needed for the transformation.

When using a hollow cylinder, an insulating ring can be used instead of an insulating ball (according to Claim 16).

As shown in Claim 17, a vertical arrangement of the machine can be advantageous so that the insulating ball/insulating ring moves back automatically.

The hollow spring/spring tube, etc., can have insulation made of flexible plastic foam (according to Claim 18).

As shown in Claim 19, insulating the temporarily hot piston part can generally be advantageous.

Precisely cycle-controlled or time-controlled valves, also depending on pressure, are necessary according to Claim 20.

As shown in Claim 21, another option is heat storage for the shape memory alloys. These would include latent heat storage/phase change storage. Heat storage can be equipped with various materials (water, gravel, earth, steel, stone, lava rock, concrete, (liquid) salt, etc.) or also be designed as latent heat storage/chemical storage (e.g., sodium acetate, calcium hydroxide - calcium oxide).

According to Claim 22, solar collectors and other heat sources, such as waste heat from industry, can also be used for the shape memory alloys.

As shown in Claim 23, common technical alternatives to the piston can be used for compressing the gas.

In Fig. 2, according to Claim 24, another construction with a piston is shown that has two valves. Left and right are two walls of the support structure 5 with pass-through valves for cold gas/ambient air. If there is no external connection of the piston, magnets can be used, or the induction principle can be utilized.

As shown in Claim 25, in Fig. 3, another option is a piston with a pass-through valve for cold gas/ambient air. On the left is a heat pressure reservoir 7 with an additional valve for cold gas/ambient air. To the right of the piston is a return spring 8 made of normal material that extends the Nitinol hollow spring below the transformation temperature.

Thus, shape memory generators/modules can be used day and night. In the future, it should be even better possible to generate electricity locally with optimized technology and new, more affordable materials.

List of Reference Signs

1. Compressed hollow spring above the transformation temperature
2. Extended hollow spring below the transformation temperature
3. Piston
4. Cycle-controlled valve
5. Support structure
6. Rigid connection between two pistons
7. Heat and pressure reservoir
8. Return spring, e.g., made of normal metal

Claims

1. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, characterized in that gases are compressed by shape memory alloys above the transformation temperature.

2. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to Claim 1, characterized in that a machine with two interconnected pistons operates through one or more pistons. Two shape memory hollow springs are connected to the partition wall of the

support structure and the pistons. At the ends of the two hollow springs, there are cycle-controlled valves installed in the partition wall and both pistons. The shape memory alloy has a low transformation temperature. The valves alternately allow warm gas (e.g., air) that is significantly warmer than the transformation temperature or a liquid or cold gas (e.g., ambient air or a liquid with the same temperature) into the hollow springs.

3. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to one of the preceding claims, characterized in that different shape memory materials/alloys, including plastics, can be used.

4. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to one of the preceding claims, characterized in that multiple springs and/or one or more racks are combined.

5. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to one of the preceding claims, characterized in that the machine operates in combination with a flywheel.

6. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to one of the preceding claims, characterized in that for primary heat generation, only the necessary heat of the compressed gas for the shape memory alloys is used, and the rest of the heat is directly dissipated to a heater via a heat exchanger.

7. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to one of the preceding claims, characterized in that the machine can operate with many pistons and longer heat exchanger exposure.

8. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to one of the preceding claims, characterized in that two springs are combined: one spring optimized for generator drive, the second spring optimized for heat generation.

9. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to one of the preceding claims, characterized in that cold or hot magnetic fluids are used in combination with a magnet for the medium change.

10. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to one of the preceding claims, characterized in that a smaller recess in the size of the spring is present at one end of the working chamber.

11. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to one of the preceding claims, characterized in that the machine operates with air, other gases, water, other liquids, or other heat carriers as a medium. For liquids, additional heat exchangers are installed: air-water heat exchangers or gas-liquid heat exchangers.

12. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to one of the preceding claims, characterized in that the shape memory materials operate in the form of wires, springs, hollow springs, spring tubes/tube springs/pipes/rods/bars, or other retractable and extendable components.

13. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to one of the preceding claims, characterized in that there is a rigid connection between two pistons or a flexible connection via pulleys or another connection.

14. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to one of the preceding claims, characterized in that work is done with an insulating ball in a hollow spring/tube or similar.

15. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to one of the preceding claims, characterized in that a small surrounding cylinder or a hollow cylinder is used with a shape memory material spring.

16. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to one of the preceding claims, characterized in that an insulating ring is used when using a hollow cylinder.

17. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to one of the preceding claims, characterized in that the machine is arranged vertically.

18. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to one of the preceding claims, characterized in that the hollow spring/spring tube has insulation made of flexible plastic foam.

19. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to one of the preceding claims, characterized in that the temporarily hot piston part is insulated.

20. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to one of the preceding claims, characterized in that precisely cycle-controlled or time-controlled valves are installed, also depending on the pressure.

21. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to one of the preceding claims, characterized in that heat storage for the shape memory alloys is installed. These would include latent heat storage/phase change storage. Heat storage can be equipped with various materials (water, gravel, earth, steel, stone, lava rock, concrete, (liquid) salt, etc.) or also be designed as latent heat storage/chemical storage (e.g., sodium acetate, calcium hydroxide - calcium oxide).

22. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to one of the preceding claims, characterized in that solar collectors and other heat sources, such as waste heat from industry, are used for the shape memory alloys.

23. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to one of the preceding claims, characterized in that common technical alternatives to the piston are used for compressing the gas.

24. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to one of the preceding claims, characterized in that a piston is combined with two valves. Left and right are two walls of the support structure with pass-through valves for cold gas/ambient air. If there is no external connection of the piston, magnets can be used, or the induction principle can be utilized.

25. Power and heat generation using so-called shape memory alloys utilizing ambient temperature, according to one of the preceding claims, characterized in that a piston with a pass-through valve for cold gas/ambient air is installed. On one side, there is a heat pressure reservoir with an additional valve for cold gas/ambient air. On the other side of the piston, there is a return spring made of normal material that extends the shape memory hollow spring below the transformation temperature.

Fig. 1

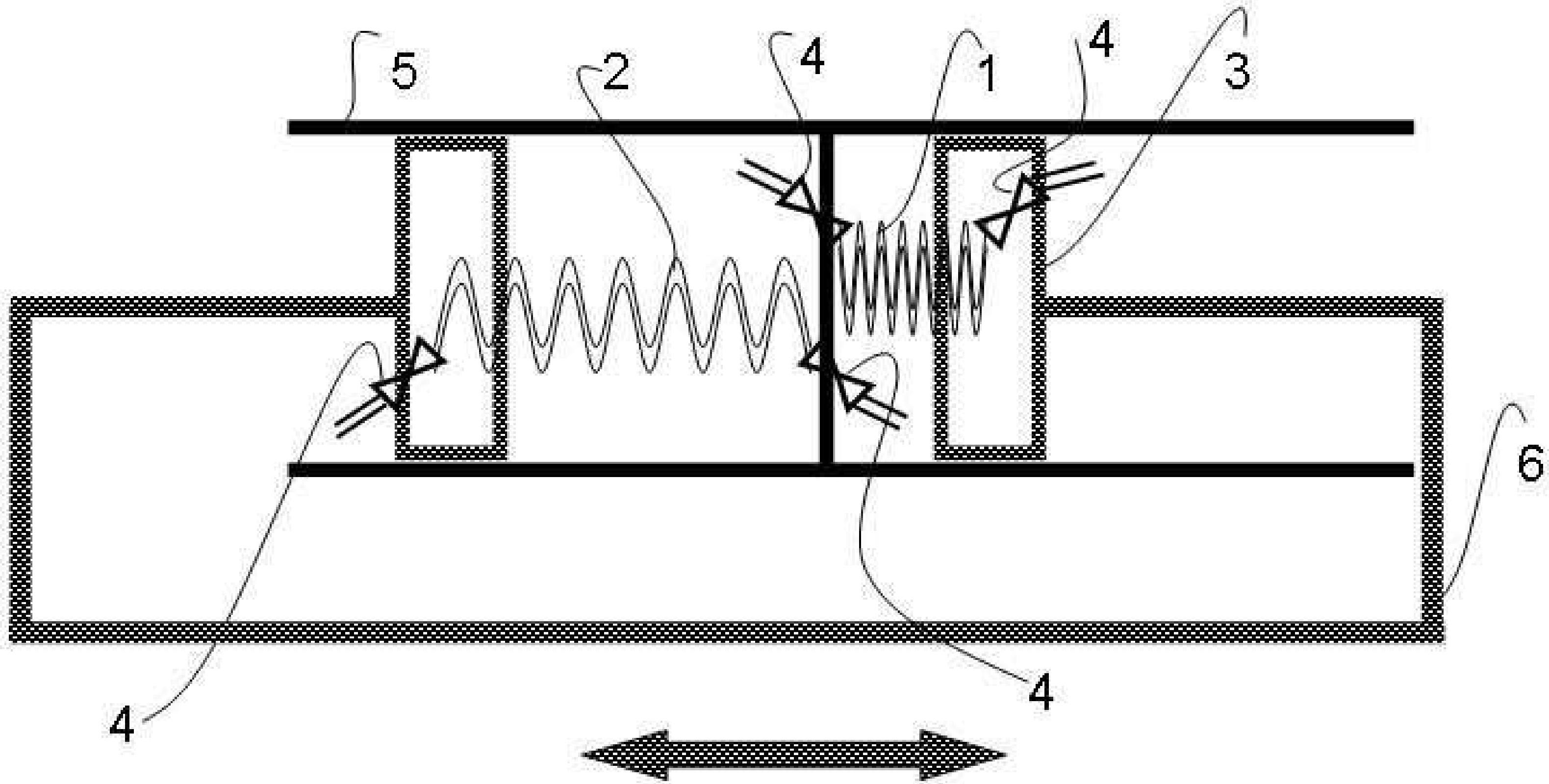

Fig. 2

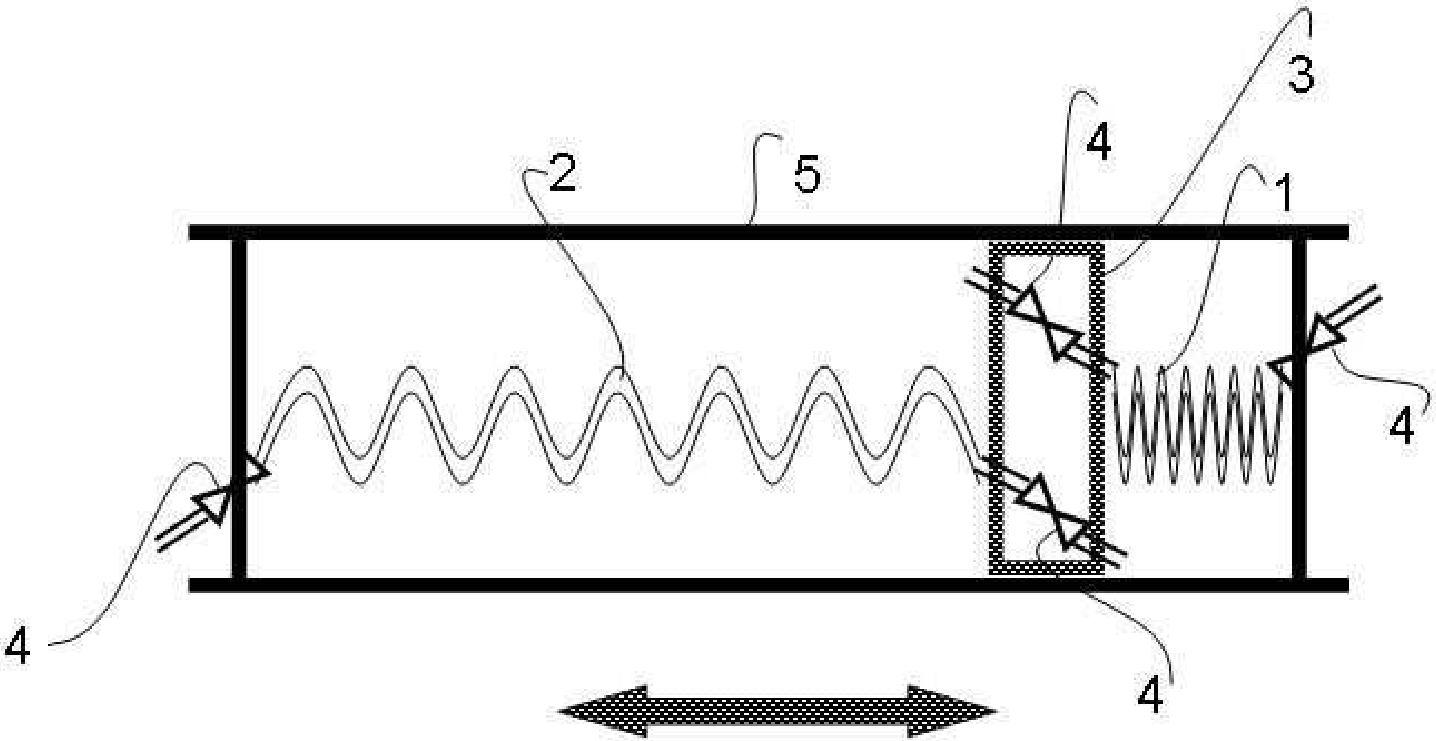

Fig. 3