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(54) **Title:** EXHAUST SILENCER SYSTEM, ARMORED MULTI-PURPOSE VEHICLE, AND METHOD

(54) **Bezeichnung:** ABGASSCHALLDÄMPFERANLAGE, GESCHÜTZTES FAHRZEUG UND VERFAHREN

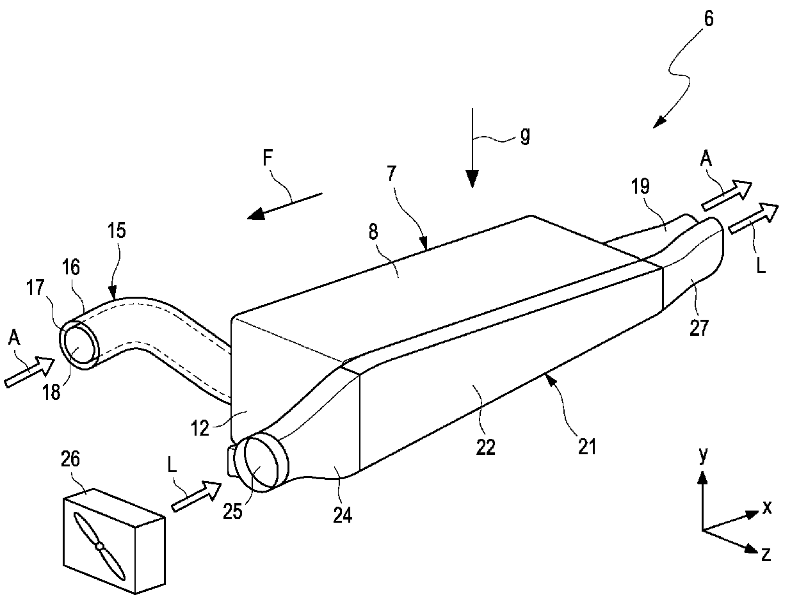

Fig. 2

(57) **Abstract:** The invention relates to an exhaust silencer system (6) for an armored multi-purpose vehicle (1), comprising: an exhaust silencer (7); a cooling-air guide housing (21) attached to the exhaust silencer (7); and an electrothermal converter device (30) attached to the outside of the exhaust silencer (7) and the inside of the cooling-air guide housing (21) for actively withdrawing heat (W) from the exhaust silencer (7) which the converter device (30) supplies to cooling air (L) flowing through the cooling-air guide housing (21) in order to influence a heat signature (S) of the exhaust silencer system (6).

(57) **Zusammenfassung:** Abgasschallschalldämpferanlage (6) für ein geschütztes Fahrzeug (1), mit einem Abgasschalldämpfer (7), einem an dem Abgasschalldämpfer (7) angebrachten Kühlluftführungsgehäuse (21), und einer außenseitig an dem Abgasschalldämpfer

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(7) und innerhalb des Kühlluftführungsgehäuses (21) angebrachten elektrothermischen Wandlereinrichtung (30) zum aktiven Entziehen von Wärme (W) aus dem Abgasschalldämpfer (7), welche die Wandlereinrichtung (30) an durch das Kühlluftführungsgehäuse (21) strömende Kühlluft (L) abgibt, um eine Wärmesignatur (S) der Abgasschallschalldämpferanlage (6) zu beeinflussen.

EXHAUST GAS MUFFLER SYSTEM, PROTECTED VEHICLE, AND METHOD

The present invention relates to an exhaust gas muffler system for a protected vehicle, a protected vehicle comprising such an exhaust gas muffler system, and a method for operating such an exhaust gas muffler system.

In military vehicles, great importance is attached to signature reduction in all respects. One problem that can arise in this context is the discharge of hot exhaust gases from an internal combustion engine from the vehicle. Due to mostly short and direct exhaust gas paths, a so-called hot spot can occur at the point of an exhaust gas exit from the vehicle, which is only slightly colder than an exit temperature of the exhaust gas from the internal combustion engine itself. In addition, the exhaust gas path also heats up surrounding components of the vehicle and thus also a vehicle hull itself.

This heating results in a characteristic pattern for each type of vehicle, in particular a characteristic heat signature, which can be used by enemy reconnaissance to accurately determine the type of vehicle. In the case of a hybrid powertrain, there is also the fact that the internal combustion engine does not run during the entire operation of the vehicle, but instead runs through a start-stop cycle as needed. This creates the problem of recurring accumulated heat in an exhaust tube, which heats up disproportionately as a result and thus increases the hotspot problem even further.

According to internal findings, attempts are made on military vehicles to artificially lengthen the exhaust gas line and surround it with a shell of heat-insulating material. The longer exhaust gas section means that more heat is dissipated into the surroundings, which reduces the exhaust gas temperature at the exhaust gas outlet. It is also possible to mix the exhaust gas with a cooling air stream or an additional air stream from the vehicle before it leaves the exhaust gas outlet.

However, the aforementioned solution approaches are associated with a lot of installation space and high masses. The problem of releasing the characteristic heat signature is only inadequately solved. In particular, after the internal combustion engine has been switched off and cooled down, the escaping heat spreads uncontrollably and heats up the entire vehicle. This must be improved.

Against this background, one object of the present invention is to provide an improved exhaust gas muffler system for a protected vehicle.

Accordingly, an exhaust gas muffler system for a protected vehicle is proposed. The exhaust gas muffler system comprises an exhaust gas muffler, a cooling air guidance housing mounted at the exhaust gas muffler, and an electrothermal converter apparatus mounted at an outside of the exhaust gas muffler and mounted within the cooling air guidance housing for actively extracting heat from the exhaust gas muffler which the converter apparatus delivers to cooling air flowing through the cooling air guidance housing to affect a heat signature of the exhaust gas muffler system.

The fact that the heat signature of the exhaust gas muffler system can be affected or modified with the aid of the converter apparatus means that it is no longer possible to clearly identify the vehicle type of a vehicle with such an exhaust gas muffler system. The exhaust gas muffler system thus contributes to the survivability of the vehicle as well as its crew members. The exhaust gas muffler system can be used to actively prevent thermal hotspots on the vehicle from revealing its position on the one hand and its identity on the other.

The exhaust gas muffler system can in particular be a rear muffler. The exhaust gas muffler system can, for example, be arranged in a rear area, a front area or a side area of the vehicle. The exhaust gas muffler is in particular a resonance exhaust gas muffler. However, the exhaust gas muffler can also be an absorption exhaust gas muffler. The exhaust gas muffler is preferably cuboidal or cylindrical in design and comprises an exhaust gas feed tube for supplying exhaust gas from an internal combustion engine to the exhaust gas muffler and an exhaust gas discharge tube for discharging the exhaust gas from the exhaust gas muffler.

The exhaust gas muffler encloses a volume which is preferably divided into several chambers. For example, the exhaust gas feed tube opens into one of the chambers and the exhaust gas discharge tube opens into another of the chambers. The exhaust gas thus flows from the exhaust gas feed tube through the chamber to the exhaust gas discharge tube, with sound being reflected in the chambers. This results in sound reduction.

The exhaust gas muffler may comprise a cover facing away from a surface on which the vehicle is traveling, a bottom facing the surface, two side walls facing each other, a front wall and a rear wall. The exhaust gas muffler may be made of sheet steel, in particular stainless-steel sheet.

The cooling air guidance housing surrounds or encloses the exhaust gas muffler at least in sections. For example, the cooling air guidance housing covers one of the side walls and the bottom of the exhaust gas muffler. However, the cooling air guidance housing may also completely enclose or envelop the exhaust gas muffler. A cooling air guidance housing is formed between the exhaust gas muffler and the cooling air guidance housing, in which the converter apparatus is placed. Cooling air flows through the cooling air duct. In particular, the cooling air guidance housing is fixedly connected to the exhaust gas muffler. For example, the cooling air guidance housing is riveted, screwed, or welded to the exhaust gas muffler.

The fact that the converter apparatus is mounted "on the outside" of the exhaust gas muffler means in the present case that the converter apparatus is not arranged in the volume enclosed by the exhaust gas muffler but outside the volume, for example on one of the side walls and/or the bottom of the exhaust gas muffler. "Within" the cooling air guidance housing means in particular in the present case that the converter apparatus is placed inside the previously mentioned cooling air duct. That is, the cooling air guidance housing covers the converter apparatus. The exhaust gas muffler system may comprise several converter apparatuses. For example, a separate converter apparatus is placed at the bottom and at one of the side walls, respectively.

An "electrothermal converter apparatus" is understood to be a component or apparatus configured to transport heat or convert heat into electrical energy by supplying electrical energy. An example of such a converter apparatus is a so-called

Peltier element. A control and/or regulating apparatus is preferably provided for controlling the converter apparatus.

The fact that the converter apparatus "actively" extracts the heat from the exhaust gas muffler means in particular that energy, in particular electrical energy, is supplied to the converter apparatus so that the converter apparatus extracts the heat from the exhaust gas muffler. The exhaust gas muffler itself is heated by the exhaust gas. Thus, the converter apparatus extracts the heat from the exhaust gas indirectly via the exhaust gas muffler.

The "heat signature" of the exhaust gas muffler system can be understood here as the heat radiation, in particular the infrared radiation, which the exhaust gas muffler system emits, and which can be detected in particular by a photo receiver of a thermal imaging device and displayed on a screen, for example. The heat signature results in particular from the fact that the exhaust gas muffler system emits heat, in particular in the form of infrared radiation. Furthermore, the heat signature also results from heating of components of the vehicle surrounding the exhaust gas muffler system, which also emit heat.

As previously mentioned, the heat signature may be characteristic of a particular type of vehicle. This characteristic results from a two-dimensional geometry, in particular an outline, of the heat signature and a pattern of the heat signature. By a "pattern" it is to be understood in the present context that the heat signature comprises areas with large heat radiation and areas with heat radiation that is smaller than that of the former areas. The heat signature can include any number of different areas that have different heat fluxes or different intensities of radiation.

The term "affecting" or "modifying" the heat signature means in particular that the radiated heat radiation is reduced, for example, or that it is no longer radiated at certain characteristic areas of the vehicle. For example, the two-dimensional geometry and/or the pattern of the heat signature can be influenced. In particular, by affecting or modifying the heat signature, a thermal signature reduction or signature control can be achieved.

The cooling air can, for example, be forced through the cooling air guidance housing by the airstream generated when the vehicle is moving. Alternatively, a ventilation apparatus can be provided which forcibly flows the cooling air through the cooling air guidance housing. This has the advantage that the cooling air continues to flow through the cooling air guidance housing even when the vehicle and/or the internal combustion engine is at a standstill. The ventilation apparatus can also be controlled by the control and/or regulating apparatus.

According to one embodiment, the converter apparatus can be switched from a first operating state, in which the converter apparatus emits heat to the cooling air flowing through the cooling air guidance housing, to a second operating state in which the converter apparatus interrupts a heat flow from a hot face of the converter apparatus facing the exhaust gas muffler to a cold face of the converter apparatus facing away from the exhaust gas muffler.

For switching the converter apparatus, the exhaust gas muffler system comprises the aforementioned control and/or regulating apparatus. The control and/or regulating apparatus is suitable, for example, for energizing the converter apparatus. The control and/or regulating apparatus may comprise a computer unit. Preferably, the converter apparatus comprises a plurality of converter elements, each converter element comprising a hot face and a cold face. The hot face may also be referred to as the hot face of the converter apparatus, and the cold face may also be referred to as the cold face of the converter apparatus. In particular, for switching the converter apparatus from the first operating state to the second operating state, a voltage applied to the converter apparatus in the first operating state is reversed so that the converter apparatus no longer conducts heat away from the exhaust gas muffler but interrupts the heat flow. In particular, the converter apparatus can supply heat to the exhaust gas muffler in the second operating state. In particular, this means that in the second operating state the converter apparatus can absorb heat from the cooling air and deliver it to the exhaust gas muffler. In the second operating state, the exhaust gas muffler is thus prevented from releasing heat. In particular, the heat is actively retained in the exhaust gas muffler with the aid of the converter apparatus. This is particularly advantageous if the vehicle is a hybrid vehicle, and the internal combustion engine is not running all the time.

According to another embodiment, the converter apparatus can be switched from the first operating state or from the second operating state to a third operating state in which the converter apparatus converts thermal energy into electrical energy with the aid of a temperature difference between the hot face of the converter apparatus and the cold face of the converter apparatus.

This switching can also be performed with the aid of the control and/or regulating apparatus. In particular, the converter apparatus also extracts heat from the exhaust gas muffler in the third operating state. However, less heat is extracted in the third operating state than in the first operating state. In particular, no additional electrical energy is expended in the third operating state to extract the heat. The electrical energy extracted in the third operating state can be fed into an energy storage, in particular an accumulator, of the vehicle. The conversion of thermal energy into electrical energy takes place with the aid of the so-called Seebeck effect. This means that part of the energy that is converted into heat can be recovered. If the vehicle is a hybrid vehicle, this effect can be used in particular to extend purely electric operation. This can, for example, extend the duration of use of the vehicle.

According to another embodiment, the converter apparatus comprises a plurality of electrothermal converter elements which are individually controllable to generate a predetermined pattern in the heat signature of the exhaust gas muffler system.

The converter elements are preferably Peltier elements. The converter elements can, for example, each have dimensions of 20 to 90 mm x 20 to 90 mm with a thickness of 3 to 5 mm. The fact that the converter elements can be controlled "individually" means in the present case that each converter element can be controlled, for example energized, independently of all the other converter elements. For example, the control and/or regulating apparatus can be used to switch any converter element to any operating state. The predetermined pattern can be, for example, a heat signature of another vehicle whose heat signature is to be simulated. The converter elements of the converter apparatus are preferably arranged in a grid-like, pattern-like or checkerboard-like manner. That is, the converter elements are placed in rows and columns. The totality of all converter elements together forms the converter apparatus.

According to another embodiment, the converter elements can be controlled in such a way that the heat signature of the exhaust gas muffler system adapts to a heat signature of a surroundings of the exhaust gas muffler system.

In particular, the heat signature of the exhaust gas muffler system may adapt to the surroundings of the vehicle and/or to a surface on which the vehicle travels. For example, the heat signature of the exhaust gas muffler system can adapt to a building or other vehicle before which the vehicle with the exhaust gas muffler system is standing. This allows the vehicle to be well camouflaged. The exhaust gas muffler system may include sensor technology that can detect the heat signature of the surroundings and/or the surface. For example, the sensor technology may comprise an infrared sensor. The sensor technology may provide sensor signals to the control and/or regulating apparatus. The control and/or regulating apparatus can then control the converter apparatus or the individual converter elements based on the sensor signals in such a way that the heat signature of the exhaust gas muffler system adapts to the heat signature of the surroundings and/or the surface.

According to another embodiment, the converter apparatus comprises a heat sink which projects into a cooling air duct provided between the exhaust gas muffler and the cooling air guidance housing.

Preferably, the converter elements have a common heat sink. However, each converter element can also have its own heat sink. The heat sink is thermally conductively bonded to the converter elements in particular with the aid of a layer of a material with high thermal conductivity, in particular a layer of heat-conducting paste. The converter elements, in turn, are bonded to the exhaust gas muffler with their hot face with the aid of a further layer of the material with high thermal conductivity, in particular a further layer of heat-conducting paste. The heat sink is preferably made of aluminum. The heat sink comprises cooling fins through which the cooling air flows. The cooling fins are arranged in such a way that the cooling air flows through them parallel to the cooling fins. The cooling fins extend from a plate-shaped basic section of the heat sink. The basic section is connected to the converter elements in a thermally conductive manner.

According to another embodiment, the converter apparatus is mounted to a bottom and to a side wall of the exhaust gas muffler.

For example, the converter elements arranged on the bottom and the converter elements arranged on the side wall may each comprise a separate heat sink. However, the converter apparatus may also be attached to the cover, the second side wall, the front and/or the back of the exhaust gas muffler. Preferably, the converter apparatus is attached to those areas of the exhaust gas muffler that face outward toward the surroundings of the vehicle.

According to another embodiment, the exhaust gas muffler comprises an exhaust gas outlet, wherein the cooling air guidance housing comprises a cooling air outlet, and wherein the cooling air outlet is guided around the exhaust gas outlet at least in sections.

For example, the exhaust gas outlet is circular. The cooling air outlet can be curved in an arc or kidney shape. The cooling air leaving the cooling air outlet, which is colder than the cooled exhaust gas, thus forms a curtain or jacket flow around the outflowing cooled exhaust gas. This can again achieve a signature reduction at the exhaust gas outlet. The cooling air and the exhaust gas thus do not mix until a certain distance downstream of the exhaust gas outlet. The formation of a hot spot is prevented.

According to another embodiment, the cooling air guidance housing comprises a cooling air distributor for uniformly distributing the cooling air to the converter apparatus, wherein it is possible for the cooling air to be fed to the cooling air distributor with the aid of a cooling air inlet of the cooling air guidance housing.

The cooling air guidance housing also includes a cooling air collector that supplies the cooling air to the cooling air outlet after flowing around the heat sink or heat sinks. The cooling air may be supplied to the cooling air inlet using, for example, the previously mentioned ventilation apparatus. The control and/or regulating apparatus may also be suitable for controlling the ventilation apparatus so that it can be switched on and off and/or a volumetric flow rate of the cooling air can be regulated, for example.

Furthermore, a protected vehicle with such an exhaust gas muffler system is proposed.

In particular, the exhaust gas muffler system is located in a front area, a rear area or a side area of the vehicle. In particular, the exhaust gas muffler system is located under a bottom of the vehicle. In the present context, the fact that the vehicle is "protected" means that the vehicle is protected against shelling, booby traps, improvised explosive devices (IEDs), mines or the like. The vehicle is preferably a wheeled vehicle. However, the vehicle may also be a tracked vehicle. Preferably, the vehicle is a hull vehicle. Preferably, the vehicle comprises a passenger compartment, which is protected, in particular armored, and can accommodate crew members.

Furthermore, a method for operating such an exhaust gas muffler system for a protected vehicle is proposed. In this method, the exhaust gas muffler system comprises an exhaust gas muffler, a cooling air guidance housing mounted at the exhaust gas muffler, and an electrothermal converter apparatus mounted at an outside of the exhaust gas muffler and mounted within the cooling air guidance housing. The method comprises the steps of: a) actively extracting heat from the exhaust gas muffler with the aid of the converter apparatus, and b) releasing the heat to cooling air flowing through the cooling air guidance housing with the aid of the converter apparatus, thereby affecting a heat signature of the exhaust gas muffler system.

By extracting the heat from the exhaust gas muffler, the exhaust gas is cooled, resulting in a signature reduction, for example. In the present case, the fact that the converter apparatus "actively" extracts the heat means in particular that energy, in particular electrical energy, is supplied to the converter apparatus to transport the heat from the exhaust gas muffler to the cooling air. "Passively", in contrast, the heat can be dissipated, for example, by thermal radiation.

"Affecting" in the present case means in particular that the heat signature is controlled and/or reduced.

According to one embodiment, the converter apparatus can be switched from a first operating state, in which the converter apparatus emits the heat to the cooling air flowing through the cooling air guidance housing, to a second operating state in which the converter apparatus interrupts a heat flow from a hot face of the converter apparatus facing the exhaust gas muffler to a cold face of the converter apparatus facing away from the exhaust gas muffler.

In particular, in the second operating state, the heat flow from the hot face to the cold face is interrupted by reversing the polarity of a voltage applied to the converter apparatus in the first operating state. Thus, heat accumulation in the exhaust gas muffler is achieved. The heat can thus not be dissipated to the cooling air. Instead, in the second operating state, the converter apparatus transports heat from the cooling air to the exhaust gas muffler, if necessary.

According to another embodiment, the converter apparatus can be switched from the first operating state or from the second operating state to a third operating state in which the converter apparatus converts thermal energy into electrical energy with the aid of a temperature difference between the hot face of the converter apparatus and the cold face of the converter apparatus.

The so-called Seebeck effect is used for this purpose. The electrical energy can be temporarily stored in the vehicle's energy storage system. This makes it possible to extend the service life of the vehicle, particularly if it is a hybrid vehicle. The energy storage can also be used to supply energy to the control and/or regulating apparatus and the converter apparatus.

According to another embodiment, the converter apparatus comprises a plurality of electrothermal converter elements which are individually controlled so that a predetermined pattern is produced in the heat signature of the exhaust gas muffler system.

The converter elements are individually controlled by the aid of the aforementioned control and/or regulating apparatus. Each converter element can thus be switched as desired to the first operating state, the second operating state or the third operating state. The predetermined pattern can, for example, be stored on a data carrier of the control and/or regulating apparatus.

According to another embodiment, the converter elements are controlled in such a way that the heat signature of the exhaust gas muffler system is adapted to a heat signature of a surroundings of the exhaust gas muffler system.

In particular, the heat signature of the exhaust gas muffler system can also be adapted to the surface on which the vehicle is moving. For example, the heat signature of the exhaust gas muffler system can be adapted to a building or a vehicle in front of which the vehicle with the exhaust gas muffler system is standing. Excellent camouflage of the vehicle is thus possible. "Adapting" in the present context means, in particular, that the heat signature of the exhaust gas muffler system is matched to the heat signature of the surroundings of the exhaust gas muffler system. As previously mentioned, the control and/or regulating apparatus can control the converter apparatus for this purpose based on sensor signals from the sensor technology of the exhaust gas muffler system.

The embodiments and features described for the proposed exhaust gas muffler system apply mutatis mutandis to the proposed protected vehicle and/or the proposed method, and vice versa.

In the present context, "one" is not necessarily to be understood as being limited to exactly one element. Rather, several elements, such as two, three or more, may also be provided. Also, any other counting word used herein is not to be understood as limiting to exactly the number of elements mentioned. Rather, numerical deviations upward and downward are possible, unless otherwise indicated.

Further possible implementations of the exhaust gas muffler system, the protected vehicle and/or the method also include combinations of features or embodiments not explicitly mentioned above or below with regard to the embodiments. In this context, the skilled person will also add individual aspects as improvements or additions to the respective basic form of the exhaust gas muffler system, the protected vehicle and/or the method.

Further advantageous embodiments and aspects of the exhaust gas muffler system, the protected vehicle and/or the method are the subject of the subclaims and of the embodiments of the exhaust gas muffler system, the protected vehicle and/or the method described below. Furthermore, the exhaust gas muffler system, the protected vehicle and/or the method are explained in more detail on the basis of preferred embodiments with reference to the accompanying figures.

Fig. 1 shows a schematic side view of one embodiment of a protected vehicle;

Fig. 2 shows a schematic perspective view of one embodiment of an exhaust gas muffler system for the protected vehicle according to Fig. 1;

Fig. 3 shows another schematic perspective view of the exhaust gas muffler system according to Fig. 2;

Fig. 4 shows a schematic rear view of the exhaust gas muffler system according to Fig. 2;

Fig. 5 shows a highly simplified schematic sectional view of the exhaust gas muffler system according to Fig. 2; and

Fig. 6 shows a schematic block diagram of one embodiment of a method for operating the exhaust gas muffler system according to Fig. 2.

In the figures, identical or functionally identical elements have been given the same reference signs unless otherwise indicated.

Fig. 1 shows a schematic side view of an embodiment of a protected vehicle 1. The protected vehicle 1 is hereinafter referred to simply as the vehicle. The vehicle 1 may be a military vehicle, in particular a military utility vehicle. The vehicle 1 may be a hull vehicle. The vehicle 1 may be armed or unarmed.

The vehicle 1 includes a protected passenger compartment 2. The passenger compartment 2 is protected against fire, booby traps, improvised explosive devices (IEDs), mines or the like. The passenger compartment 2 encloses an inner space I, in which crew members can stay. The inner space I of the passenger compartment 2 can be entered and exited from a surroundings U of the vehicle 1 via hatches or doors.

The vehicle 1 may be a wheeled vehicle. Alternatively, the vehicle 1 may be a tracked vehicle. The vehicle 1 comprises a plurality of wheel axles on which wheels 3, 4 are provided. The number of wheel axles is basically arbitrary. For example, two, three or four wheel axles may be provided. At least one of the wheel axles is steered. Several wheel axles may also be steered. Preferably, the vehicle 1 comprises an all-wheel drive system. That is, all wheel axles are driven. The vehicle 1 is suitable for off-road use and can therefore also be referred to as an off-road vehicle.

The vehicle 1 comprises an internal combustion engine 5 for driving the wheel axles or wheels 3, 4. The vehicle 1 can be driven exclusively by the internal combustion engine 5. Alternatively, the vehicle 1 can also be a hybrid vehicle. In this case, the vehicle 1 comprises one or more electric motors in addition to the internal combustion engine 5. In this case, the internal combustion engine 5 and the electric motor or motors are part of a hybrid powertrain or hybrid powertrain of the vehicle 1.

With the aid of the wheels 3, 4 driven by the internal combustion engine 5, the vehicle 1 can move in a drive direction F on a surface O. The surface O can be a road, a gravel road, or any other terrain. The vehicle 1 can have a reverse gear, so that the vehicle 1 can also move in the opposite direction to the drive direction F.

An exhaust gas system with an exhaust gas muffler system 6 is associated with the internal combustion engine 5. The exhaust gas muffler system 6 can be a rear muffler. The exhaust gas muffler system 6 may be arranged on the side of the passenger compartment 2, in a front area or in a rear area of the passenger compartment 2. The exhaust gas muffler system 6 can be covered at least in sections by an outer hull, for example by a side wall, of the passenger compartment 2.

The exhaust gas muffler system 6 generates a heat signature S or comprises a heat signature S. The heat signature S results from the fact that the exhaust gas muffler system 6 emits heat, in particular in the form of infrared radiation. Furthermore, the heat signature S also results from heating of components of the vehicle 1 surrounding the exhaust gas muffler system 6, which also emit heat. The heat signature S is characteristic for the vehicle 1, which means that the vehicle 1, in particular a vehicle type of the vehicle 1, can be identified with the aid of the heat signature S.

In Fig. 1, the heat signature S is shown in a highly simplified form as a rectangle. The heat signature S can have any geometry or outline. Within this aforementioned rectangle, there are areas that emit more heat, and areas that emit less heat compared to the former areas. In particular, this means that there are areas where the heat flux is higher, and areas where the heat flux is lower compared to the former areas. Thus, the heat signature S exhibits a characteristic pattern. The heat signature S can be detected by the aid of an infrared sensor, for example, and displayed on a screen.

The vehicle 1 is assigned a coordinate system with a width direction or x-direction x, a height direction or y-direction y and a depth direction or z-direction z. The directions x, y, z are oriented perpendicular to each other. A direction of gravity g may be oriented opposite to the y-direction y. The direction of gravity g is oriented perpendicular to the surface O.

Particularly in the case of military vehicles 1, great importance is attached to signature reduction in all respects. In addition to the heat signature S, this can also include a noise signature, for example. The discharge of hot exhaust gases from the internal combustion engine 5 from the vehicle 1 can be problematic in this respect. Due to mostly short and direct exhaust gas paths, a so-called hot spot occurs at the location of an exhaust gas outlet, which is only immediately colder than an exit temperature of the exhaust gas from the internal combustion engine

5 itself. In addition, the exhaust gas muffler system 6 also heats surrounding components and thus also the outer hull of the vehicle 1 itself. This heating results in a pattern of the heat signature S that is characteristic for the particular type of vehicle, which can be used by enemy reconnaissance to accurately determine the type of vehicle.

In the case of a hybrid powertrain, there is the additional factor that the internal combustion engine 5 does not run during the entire operation of the vehicle 1, but instead runs through a start-stop cycle as required. This gives rise to the problem of recurring accumulated heat in an exhaust tube, which heats up disproportionately as a result, thus exacerbating the hotspot problem mentioned earlier.

In accordance with in-house findings, an attempt is therefore made in vehicles 1 of this type to artificially lengthen the exhaust section and surround it with a jacket of heat-insulating material. Due to the longer exhaust gas section, more heat is dissipated to the surroundings U, which reduces the temperature of the exhaust gas at the exhaust gas outlet. In addition, it is possible to mix the exhaust gas upstream of the exhaust gas outlet with a cooling air stream or an additional air stream from the vehicle 1.

However, the aforementioned approaches often involve a lot of installation space and high masses. However, they only inadequately release the actual problem of the characteristic heat signature S. In particular, after the internal combustion engine 5 has been switched off and cooled down, the escaping residual heat can spread in an uncontrolled manner and heat up the entire vehicle 1. This needs to be improved.

Fig. 2 shows a schematic perspective view of an embodiment of an improved exhaust gas muffler system 6 for the vehicle 1. Fig. 3 shows a further schematic perspective view of the exhaust gas muffler system 6. Fig. 4 shows a schematic rear view of the exhaust gas muffler system 6 looking in the opposite direction to the x-direction x. Fig. 5 shows a highly simplified schematic sectional view of the exhaust gas muffler system 6. In the following, reference is made to Figs. 2 to 5 simultaneously.

The exhaust gas muffler system 6 can be arranged on the side of the vehicle 1, in a front area or in a rear area of the vehicle 1. This means that the exhaust gas muffler system 6 can in principle be oriented anywhere in space. For Figs. 2 to 5, however, it is assumed that the exhaust gas muffler system 6 extends in the drive direction F or along the x-direction x.

The exhaust gas muffler system 6 comprises an exhaust gas muffler 7 which is essentially cuboid in shape. The exhaust gas muffler 7 may be a rear muffler. The exhaust gas muffler 7 comprises a cover 8, which faces the passenger compartment 2, for example, and a bottom 9 arranged opposite the cover 8, which faces away from the passenger compartment 2 and faces the surface O, for example.

Furthermore, the exhaust gas muffler 7 comprises two side walls 10, 11 arranged opposite each other, in particular a first side wall 10 and a second side wall 11. The first side wall 10 can face the passenger compartment 2, for example, and the second side wall 11 can face away from the passenger compartment 2. On its face sides, the exhaust gas muffler 7 is closed by a front wall 12 and a rear wall 13, respectively. The exhaust gas muffler 7 thus encloses a volume 14 (Fig. 5), which may be divided into several chambers. In particular, the exhaust gas muffler 7 is a resonance muffler.

The exhaust gas muffler 7 further comprises an exhaust gas feed tube 15, by the aid of which hot exhaust gas A from the internal combustion engine 5 can be supplied to the exhaust gas muffler system 6. Between the internal combustion engine 5 and the exhaust gas muffler system 6, further components of the previously mentioned exhaust gas system of the vehicle 1 may be arranged, but are not shown. These components may include, for example, a manifold attached to the internal combustion engine 5, a catalytic converter, a pre-muffler, a mid-muffler or the like.

The exhaust gas feed tube 15 comprises an outer tube 16 and an inner tube 17 arranged coaxially with the outer tube 16. An insulating air gap is provided between the outer tube 16 and the inner tube 17. This prevents the hot exhaust gas A in the area of the exhaust gas feed tube 15 from giving off heat to the surroundings U. Instead of the double-walled structure with the outer tube 16 and the inner tube 17, the exhaust gas feed tube 15 can also be single-walled and have insulation on the outside. The exhaust gas feed tube 15, in particular only the inner tube 17 of the exhaust gas feed tube 15, is guided into the exhaust gas muffler 7 through the first side wall 10. Alternatively, the exhaust gas feed tube 15 may, for example, also be led into the exhaust gas muffler 7 through the front wall 12. The exhaust gas feed tube 15 comprises an exhaust gas inlet 18 through which the exhaust gas A flows into the exhaust gas feed tube 15, in particular into the inner tube 17.

In addition to the exhaust gas feed tube 15, the exhaust gas muffler 7 comprises an exhaust gas discharge tube 19, which is led out of the exhaust gas muffler 7 at the rear wall 13, for example. The exhaust gas feed tube 15 and the exhaust gas discharge tube 19 are not directly connected to each other. As previously mentioned, the volume 14 may be divided into a plurality of chambers. For example, the exhaust gas feed tube 15, in particular the inner tube 17 of the exhaust gas feed tube 15, opens into one of the chambers, and the exhaust gas discharge tube 19 opens into another of the chambers. The exhaust gas A then flows from the exhaust gas feed tube 15 via the individual chambers to the exhaust gas discharge tube 19.

In particular, the exhaust gas A is accumulated in the exhaust gas muffler 7 for homogenizing a flow of the exhaust gas A. The sound is reflected in the chambers, at the cover 8, the bottom 9, the side walls 10, 11, the front wall 12 and the rear wall 13, resulting in sound reduction. The exhaust gas discharge tube 19 comprises an exhaust gas outlet 20 through which the exhaust gas A leaves the exhaust gas muffler 7 again. The hot exhaust gas A heats up the exhaust gas muffler 7.

In addition to the exhaust gas muffler 7, the exhaust gas muffler system 6 comprises a cooling air guidance housing 21, which is not shown in Fig. 3. The cooling air guidance housing 21 is fixedly connected to the exhaust gas muffler 7. For example, the cooling air guidance housing 21 is screwed, riveted, or welded to the exhaust gas muffler 7. The cooling air guidance housing 21 covers the bottom 9, the second side wall 11 and the front wall 12 at least in sections.

The cooling air guidance housing 21 comprises a side wall 22 placed, for example, parallel to and spaced apart from the second side wall 11 of the exhaust gas muffler 7. Further, the cooling air guidance housing 21 comprises a bottom 23 placed spaced apart from and parallel to the bottom 9 of the exhaust gas muffler 7. The cooling air guidance housing 21 may also be configured to additionally also enclose the cover 8 and/or the first side wall 10.

On the front side, i.e. associated with the front wall 12, the cooling air guidance housing 21 comprises a cooling air distributor 24 for uniformly distributing cooling air L, which is supplied to the cooling air distributor 24 via a cooling air inlet 25. The cooling air L can be supplied to the cooling air inlet 25 passively, for example, by the airstream when the vehicle 1 is moving in the drive direction F. Particularly preferably, however, a ventilation apparatus 26 is provided which enables the cooling air L to be forced to flow through the cooling air guidance housing 21. The ventilation apparatus 26 can, for example, be an electrically driven fan which supplies the cooling air L to the cooling air inlet 25 via suitable piping.

The cooling air guidance housing 21 further comprises a cooling air collector 27 comprising a cooling air outlet 28 from which the cooling air L exits the cooling air guidance housing 21 again. As shown in Fig. 4, the cooling air outlet 28 comprises a kidney-shaped or arcuate curvature and runs at least in sections around the exhaust gas outlet 20 of the exhaust gas muffler 7. As a result, the cooling air L emerging from the cooling air outlet 28 forms a cooling air curtain extending at least in sections around the hot exhaust gas A flowing out of the exhaust gas outlet 20, which shields the exhaust gas A. Furthermore, with this arrangement, suitable mixing of the exhaust gas A with the cooling air L can also be achieved only at a certain distance from the exhaust gas outlet 20.

As Fig. 5 shows, a cooling air duct 29 is formed between the exhaust gas muffler 7, in particular between the bottom 9 and the second side wall 11 of the exhaust gas muffler 7, and the cooling air guidance housing 21, through which the cooling air L flows. In Fig. 5, the cooling air guidance housing 21 is only shown in very simplified form and does not cover the bottom 9.

The exhaust gas muffler system 6 comprises an electrothermal converter apparatus 30 mounted on the outside of the exhaust gas muffler 7 and inside the cooling air guidance housing 21. The converter apparatus 30 is suitable for extracting heat W from the exhaust gas muffler 7 and thus indirectly from the exhaust gas A and for discharging it to the cooling air L. Conversely, the converter apparatus 30 is also suitable for extracting heat W from the cooling air L and emitting it to the exhaust gas muffler 7. Furthermore, the converter apparatus 30 may also be suitable for converting heat W into electrical energy with the aid of a temperature difference between the exhaust gas muffler 7 and the cooling air L.

The converter apparatus 30 is arranged in the cooling air duct 29. The converter apparatus 30 covers, for example, the bottom 9 and the second side wall 11 of the exhaust gas muffler 7 at least in sections. Two converter apparatuses 30 may be provided, one placed on the bottom 9 and the other placed on the second side wall 11. Furthermore, the converter apparatus 30 may also be provided on the cover 8, the first side wall 10, the front wall 12 and/or the rear wall 13 of the exhaust gas muffler 7. In particular, the cover 8, the first side wall 10, the front wall 12 and/or the rear wall 13 may each also have their own converter apparatus 30 associated therewith.

In the following, however, only one converter apparatus 30 is assumed. The converter apparatus 30 comprises a plurality of electrothermal converter elements 31, of which only one is shown in Fig. 5. The number of converter elements 31 is basically arbitrary. In the following, only one converter element 31 will be discussed.

For example, the converter element 31 has a dimension of 20 to 90 mm x 20 to 90 mm and a thickness of 3 to 5 mm. The converter element 31 comprises a hot face 32 facing the exhaust gas muffler 7 and a cold face 33 facing away from the exhaust gas muffler 7. A layer of a material 34 with high thermal conductivity, in particular a layer of thermal paste, is provided between the hot face 32 and the exhaust gas muffler 7. The material 34 with high thermal conductivity ensures good heat transfer from the exhaust gas muffler 7 to the hot face 32. The term "material with high thermal conductivity" can be replaced by the term "thermal conductive paste" and vice versa.

A heat sink 35 is provided on the cold face 33 and extends into the cooling air duct 29. Each converter element 31 may comprise its own heat sink 35. Preferably, however, a plurality of converter elements 31 share a common heat sink 35. For example, all converter elements 31 provided on the second side wall 11 may comprise a common heat sink 35. Accordingly, all converter elements 31 provided at the bottom 9 may also comprise a common heat sink 35.

The heat sink 35 includes a plate-shaped basic section 36 and a plurality of cooling fins 37 extending out of the basic section 36, between which the cooling air L flows. The heat sink 35 may be made of aluminum, for example. Between the cold face 33 and the heat sink 35, in particular the basic section 36 of the heat sink 35, a further layer of the material 38 with high thermal conductivity, in particular a further layer of thermal paste, is provided. The material 38 with high thermal conductivity ensures good heat transfer from the cold face 33 to the heat sink 35.

The exhaust gas muffler system 6 further comprises a control and/or regulating apparatus 39 for controlling the converter apparatus 30. The control and/or regulating apparatus 39 may also be suitable for controlling the ventilation apparatus 26, for example switching it on and off and/or controlling a volumetric flow rate of the cooling air L. The control and/or regulating apparatus 39 is particularly suitable for individually controlling each converter element 31. "Individually" means in the present context in particular that the control and/or regulating apparatus 39 can control each converter element 31 independently of all other converter elements 31, as will be explained below. For example, the controlling of the converter element 31 can be performed by the control and/or regulating apparatus 39 applying a voltage to the converter element 31.

The exhaust gas muffler system 6 may be covered at least in sections by an outer hull 40, in particular a side wall of the outer hull 40. The exhaust gas muffler 7 can heat the outer hull 40 at least in sections, causing it to radiate heat and thus contribute to the heat signature S. Towards the surface O, the outer hull 40 may be open.

The functionality of the exhaust gas muffler system 6 is explained below. With the aid of the converter apparatus 30, it is possible to influence the heat signature S of the exhaust gas muffler system 6, in particular of the exhaust gas muffler 7, in particular to reduce or control it. In the present case, the "heat signature" can be understood to mean the heat radiation or the infrared radiation that can be detected and displayed by a photodetector of a thermal imaging device.

As mentioned before, each vehicle type of the vehicle 1 comprises a characteristic heat signature S. As a result of the fact that the converter apparatus 30 influences the heat signature S of the exhaust gas muffler system 6, in particular of the exhaust gas muffler 7, either this characteristic assignment is no longer possible, or the vehicle 1 can no longer be detected at all. In this latter case, infrared camouflage is used in the form of stealth technology.

In Fig. 5, the temperature T is plotted in a diagram over the z-direction z. The hot exhaust gas A, which has a temperature of up to 700 °C, is fed through the exhaust gas feed tube 15 into the exhaust gas muffler 7. The exhaust gas muffler 7 accumulates the exhaust gas A to homogenize the flow of the exhaust gas A, causing the exhaust gas muffler 7 to heat up over the duration of operation of the internal combustion engine 5. A schematic curve of the temperature T shows only a slight cooling of the temperature of the exhaust gas A from the exhaust gas feed tube 15 to the side walls 10, 11 of the exhaust gas muffler 7 in this area.

By aid of the control and/or regulating apparatus 39, it is possible to put the converter apparatus 30 into different operating states. In a first operating state, shown in Fig. 5, the converter element 31 is subjected to a voltage which increases a transport of heat W from the hot face 32 to the cold face 33. In this case, the converter element 31 transfers the heat W to the cooling air L flowing through the cooling air duct 29 via the heat sink 35. As the diagram according to Fig. 5 shows, a drop in temperature T occurs via the converter element 31 and the cooling air duct 29, so that the cooling air guidance housing 21 has a significantly lower temperature T than the exhaust gas A flowing into the exhaust gas muffler 7.

The exhaust gas A or the exhaust gas muffler 7 is actively cooled. In this case, "active" means that heat W is extracted from the exhaust gas A or the exhaust gas muffler 7 by applying the voltage to the converter element 31 and is released to the cooling air L via the heat sink 35. "Active" also means, in particular, that energy is expended to transport the heat W away from the exhaust gas muffler 7.

The exhaust gas A is therefore actively cooled and exits the exhaust gas outlet 20 at a significantly lower temperature T compared to an exhaust gas muffler system without such a converter apparatus 30. At the same time, the heated cooling air L, which is, however, still cooler than the cooled exhaust gas A, exits from the cooling air outlet 28. In the process, the outgoing cooling air L shields the warmer exhaust gas A in the manner of a curtain due to the arcuate geometry of the cooling air outlet 28.

In a second operating state different from the first operating state, the converter apparatus 30 interrupts a heat flow from the hot face 32 to the cold face 33. This can be done by reversing the polarity of the voltage applied to the converter element 31 in the first operating state. In particular, heat W can also be transferred from the cooling air L to the exhaust gas muffler 7 in the second operating state.

This extensive prevention of heat transfer out of the exhaust gas muffler 7 keeps the heat W in the exhaust gas muffler 7 and thus prevents it from heating the outer hull 40 of the vehicle 1. This is particularly advantageous in a hybrid vehicle in which the internal combustion engine 5 is operated in start-stop cycles.

With the aid of the control and/or regulating apparatus 39, the converter apparatus 30 can be switched from the first operating state or from the second operating state to a third operating state different from the first operating state and the second operating state, in which the converter apparatus 30 converts thermal energy into electrical energy with the aid of the temperature difference between the hot face 32 and the cold face 33. Here, the so-called Seebeck effect is utilized.

In the third operating state, the converter element 31 acts as a thermoelectric generator, which converts the heat energy into electrical energy by aid of the resulting temperature difference between the exhaust gas muffler 7 and the heat sink 35. By extracting the heat W, the temperature of the exhaust gas A can additionally be reduced. However, the reduction in the temperature of the exhaust gas A is not as great in the third operating state as in the first operating state.

The electrical energy generated can be temporarily stored in an energy storage 41, for example an accumulator, of the vehicle 1. The energy storage 41 can also be used to supply energy to the control and/or regulating apparatus 39 and/or the converter apparatus 30. Due to the effect of the thermoelectric generator, some of the energy that has been converted into heat W can be recovered. In the case that the vehicle 1 is a hybrid vehicle, this effect can be used especially to extend the pure electric operation. For example, this can advantageously extend the operating time of the vehicle 1.

If the vehicle 1 is in a mission and is in a fixed position, the possibility of thermal signature reduction and/or control contributes decisively to the survivability of the vehicle 1 as well as its crew members. This actively prevents thermal hotspots on the vehicle 1 from giving away its position on the one hand and its identity on the other. Accordingly, the use of the exhaust gas muffler system 6 can have a positive impact on both safety and the duration of a mission.

As mentioned before, the converter elements 31 are individually controllable. Thus, it is possible to generate a predetermined pattern in the heat signature S of the exhaust gas muffler 7 with the aid of the control and/or regulating apparatus 39. The predetermined pattern can, for example, be a heat signature of another vehicle type stored in the control and/or regulating apparatus 39. Thus, deception about the identity of the vehicle 1 is possible. Furthermore, it is also possible to control the converter elements 31 in such a way that the heat signature S of the exhaust gas muffler system 6, in particular of the exhaust gas muffler 7, adapts to a heat signature of the surroundings U and/or of the surface O. For example, the heat signature S of the exhaust gas muffler system 6 can adapt to a building or another vehicle in front of which the vehicle 1 is standing.

The exhaust gas muffler system 6 may include sensor technology 42 capable of sensing the heat signature of the surroundings U and/or the surface O. The sensor technology 42 may comprise an infrared sensor. The sensor technology 42 may provide sensor signals to the control and/or regulating apparatus 39. The control and/or regulating apparatus 39 may then control the converter apparatus 30 based on the sensor signals such that the heat signature S of the exhaust gas muffler system 6 adapts to the heat signature of the surroundings U and/or the surface O.

Fig. 6 shows a schematic block diagram of an embodiment of a method for operating the exhaust gas muffler system 6. In the method, in a step S1 heat W is actively extracted from the exhaust gas muffler 7 and thus from the exhaust gas A with the aid of the converter apparatus 30. In a step S2, heat W is dissipated to the cooling air L flowing through the cooling air guidance housing 21. This is done with the aid of the heat sink 35. By actively extracting the heat W, the heat signature S of the exhaust gas muffler system 6 can be influenced. The active extraction of heat W takes place in the first operating state of the converter apparatus 30.

As mentioned before, in the second operating state, the heat flow from the hot face 32 of the converter apparatus 30 facing the exhaust gas muffler 7 to the cold face 33 of the converter apparatus 30 facing away from the exhaust gas muffler 7 is interrupted by the converter apparatus 30. This can be done by reversing the polarity of a voltage with which the converter apparatus 30 or the converter elements 31 are energized in the first operating state. In particular, heat W can also be transferred from the cooling air L to the exhaust gas muffler 7 in the second operating state.

In the third operating state, heat energy is converted into electrical energy with the aid of the converter apparatus 30 due to the temperature difference between the hot face 32 of the converter apparatus 30 and the cold face 33 of the converter apparatus 30 or the converter elements 31. This electrical energy can be temporarily stored in the energy storage 41.

By individually controlling the converter elements 31 of the converter apparatus 30, a predetermined pattern can be generated in the heat signature S of the exhaust gas muffler system 6, in particular of the exhaust gas muffler 7. In particular, the heat signature S of the exhaust gas muffler system 6 can be matched to the heat signature of the surroundings U and/or the surface O. This can provide an infrared camouflage of the vehicle 1.

Although the present invention has been described with reference to examples of embodiments, it can be modified in a variety of ways.

LIST OF REFERENCE SIGNS

1	Vehicle
2	Passenger compartment
3	Wheel
4	Wheel
5	Internal combustion engine
6	Exhaust gas muffler system
7	Exhaust gas muffler
8	Cover
9	Bottom
10	Side wall
11	Side wall
12	Front wall
13	Rear wall
14	Volume
15	Exhaust gas feed tube
16	Outer tube
17	Inner tube
18	Exhaust gas inlet
19	Exhaust gas discharge tube
20	Exhaust gas outlet
21	Cooling air guidance housing
22	Side wall
23	Bottom
24	Cooling air distributor
25	Cooling air inlet
26	Ventilation apparatus
27	Cooling air collector
28	Cooling air outlet
29	Cooling air duct
30	Electrothermal converter apparatus
31	Electrothermal converter element
32	Hot face
33	Cold face

34	Material with high thermal conductivity
35	Heat sink
36	Basic section
37	Cooling fin
38	Material with high thermal conductivity
39	Control and/or regulating apparatus
40	Outer hull
41	Energy storage
42	Sensor technology

A	Exhaust gas
F	Drive direction
g	Direction of gravity
I	Inner space
L	Cooling air
O	Surface
S	Heat signature
S1	Step
S2	Step
T	Temperature
U	Surroundings
W	Heat
x	x-direction
y	y-direction
z	z-direction

CLAIMS

1. Exhaust gas muffler system (6) for a protected vehicle (1), comprising an exhaust gas muffler (7),

a cooling air guidance housing (21) mounted at the exhaust gas muffler (7), and

an electrothermal converter apparatus (30) mounted at an outside of the exhaust gas muffler (7) and mounted within the cooling air guidance housing (21) for actively extracting heat (W) from the exhaust gas muffler (7) which the converter apparatus (30) delivers to cooling air (L) flowing through the cooling air guidance housing (21) to affect a heat signature (S) of the exhaust gas muffler system (6).

2. Exhaust gas muffler system according to claim 1,
characterized in that
the converter apparatus (30) can be switched from a first operating state, in which the converter apparatus (30) emits the heat (W) to the cooling air (L) flowing through the cooling air guidance housing (21), to a second operating state in which the converter apparatus (30) interrupts a heat flow from a hot face (32) of the converter apparatus (30) facing the exhaust gas muffler (7) to a cold face (33) of the converter apparatus (30) facing away from the exhaust gas muffler (7).

3. Exhaust gas muffler system according to claim 2,
characterized in that
the converter apparatus (30) can be switched from the first operating state or from the second operating state to a third operating state in which the converter apparatus (30) converts thermal energy into electrical energy with the aid of a temperature difference between the hot face (32) of the converter apparatus (30) and the cold face (33) of the converter apparatus (30).

4. Exhaust gas muffler system according to any one of claims 1 - 3,
characterized in that
the converter apparatus (30) comprises a plurality of electrothermal converter elements (31) which are individually controllable to generate a predetermined pattern in the heat signature (S) of the exhaust gas muffler system (6).

5. Exhaust gas muffler system according to claim 4, characterized in that the converter elements (31) can be controlled in such a way that the heat signature (S) of the exhaust gas muffler system (6) adapts to a heat signature of a surroundings (U) of the exhaust gas muffler system (6).

6. Exhaust gas muffler system according to any one of claims 1 - 5, characterized in that the converter apparatus (30) comprises a heat sink (35) which projects into a cooling air duct (29) provided between the exhaust gas muffler (7) and the cooling air guidance housing (21).

7. Exhaust gas muffler system according to any one of claims 1 - 6, characterized in that the converter apparatus (30) is mounted to a bottom (9) and to a side wall (11) of the exhaust gas muffler (7).

8. Exhaust gas muffler system according to any one of claims 1 - 7, characterized in that the exhaust gas muffler (7) comprises an exhaust gas outlet (20), wherein the cooling air guidance housing (21) comprises a cooling air outlet (28), and wherein the cooling air outlet (28) is guided around the exhaust gas outlet (20) at least in sections.

9. Exhaust gas muffler system according to any one of claims 1 - 8, characterized in that the cooling air guidance housing (21) comprises a cooling air distributor (24) for uniformly distributing the cooling air (L) to the converter apparatus (30), wherein it is possible for the cooling air (L) to be fed to the cooling air distributor (24) with the aid of a cooling air inlet (25) of the cooling air guidance housing (21).

10. Protected vehicle (1) comprising an exhaust gas muffler system (6) according to any of claims 1 - 9.

11. Method for operating an exhaust gas muffler system (6) for a protected vehicle (1), wherein the exhaust gas muffler system (6) comprises an exhaust gas muffler (7), a cooling air guidance housing (21) mounted at the exhaust gas muffler (7), and an electrothermal converter apparatus (30) mounted at an outside of the exhaust gas muffler (7) and mounted within the cooling air guidance housing (21), comprising the following steps:

a) actively extracting (S1) heat (W) from the exhaust gas muffler (7) with the aid of the converter apparatus (30), and

b) releasing (S2) the heat (W) to cooling air (L) flowing through the cooling air guidance housing (21) with the aid of the converter apparatus (30), thereby affecting a heat signature (S) of the exhaust gas muffler system (6).

12. Method according to claim 11,
characterized in that
the converter apparatus (30) can be switched from a first operating state, in which the converter apparatus (30) emits the heat (W) to the cooling air (L) flowing through the cooling air guidance housing (21), to a second operating state in which the converter apparatus (30) interrupts a heat flow from a hot face (32) of the converter apparatus (30) facing the exhaust gas muffler (7) to a cold face (33) of the converter apparatus (30) facing away from the exhaust gas muffler (7).

13. Method according to claim 12,
characterized in that
the converter apparatus (30) can be switched from the first operating state or from the second operating state to a third operating state in which the converter apparatus (30) converts thermal energy into electrical energy with the aid of a temperature difference between the hot face (32) of the converter apparatus (30) and the cold face (33) of the converter apparatus (30).

14. Method according to any one of claims 11 - 13,
characterized in that
the converter apparatus (30) comprises a plurality of electrothermal converter elements (31) which are individually controlled so that a predetermined pattern is produced in the heat signature (S) of the exhaust gas muffler system (6).

15. Method according to claim 14,
characterized in that
the converter elements (31) are controlled in such a way that the heat signature (S) of the exhaust gas muffler system (6) is adapted to a heat signature of a surroundings (U) of the exhaust gas muffler system (6).

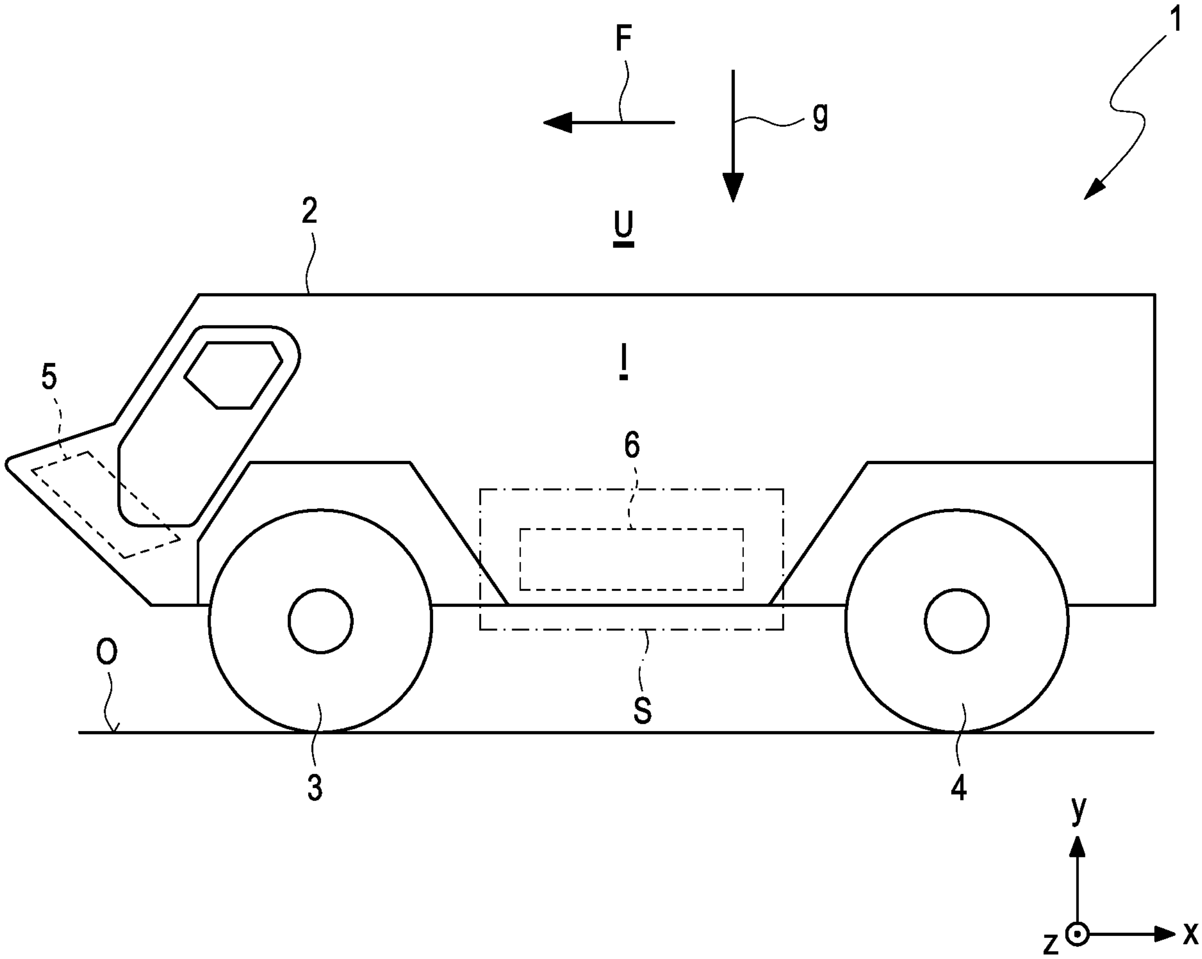

Fig. 1

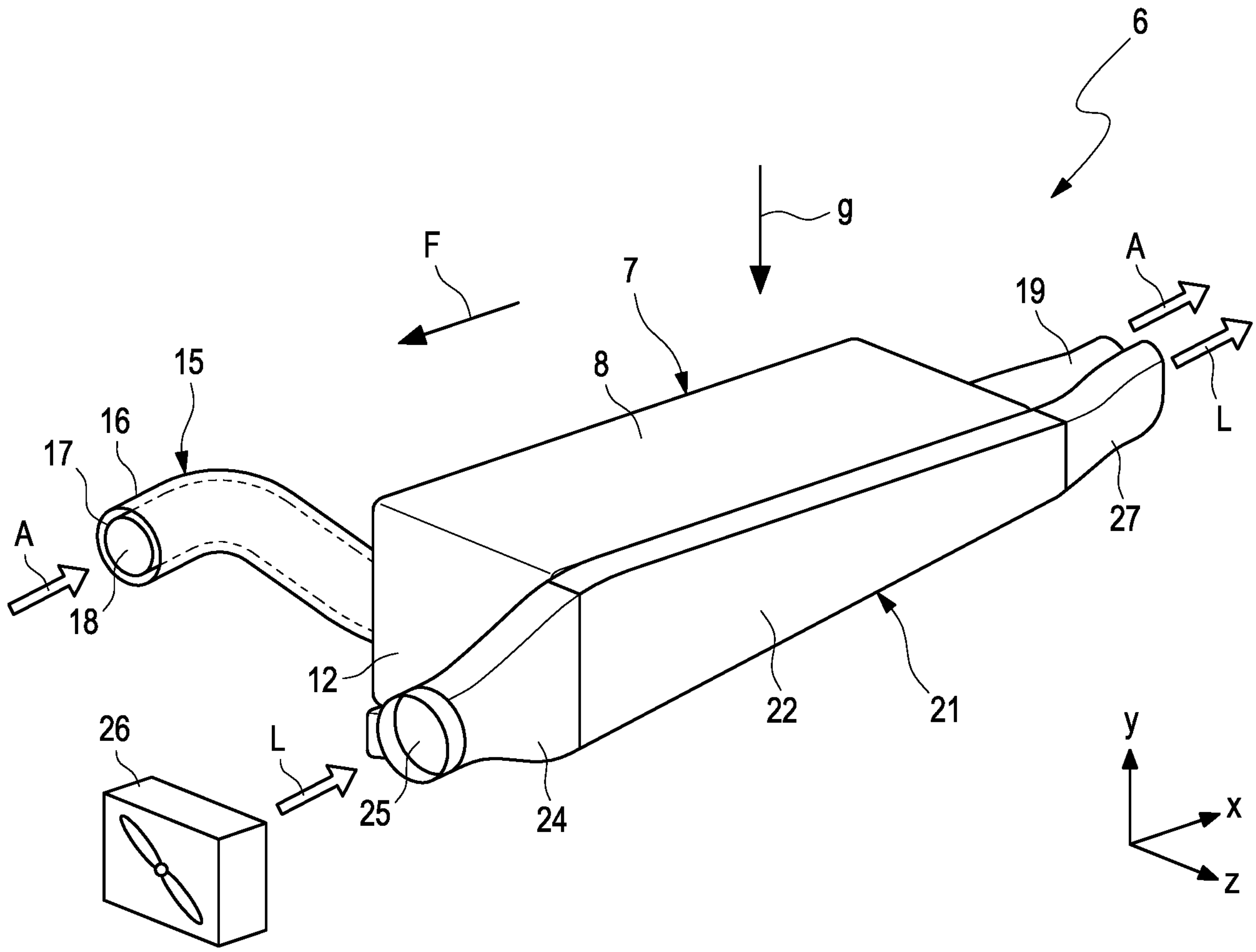

Fig. 2

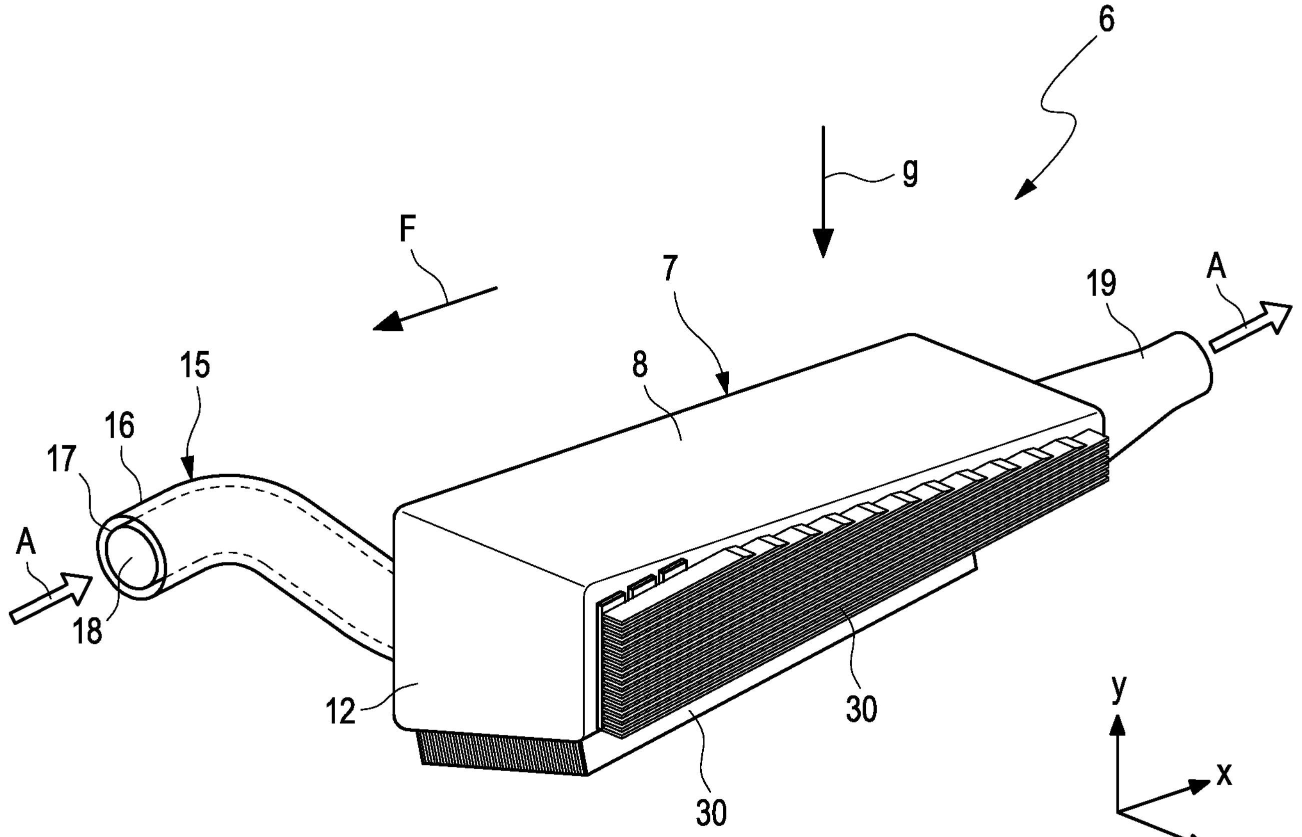

Fig. 3

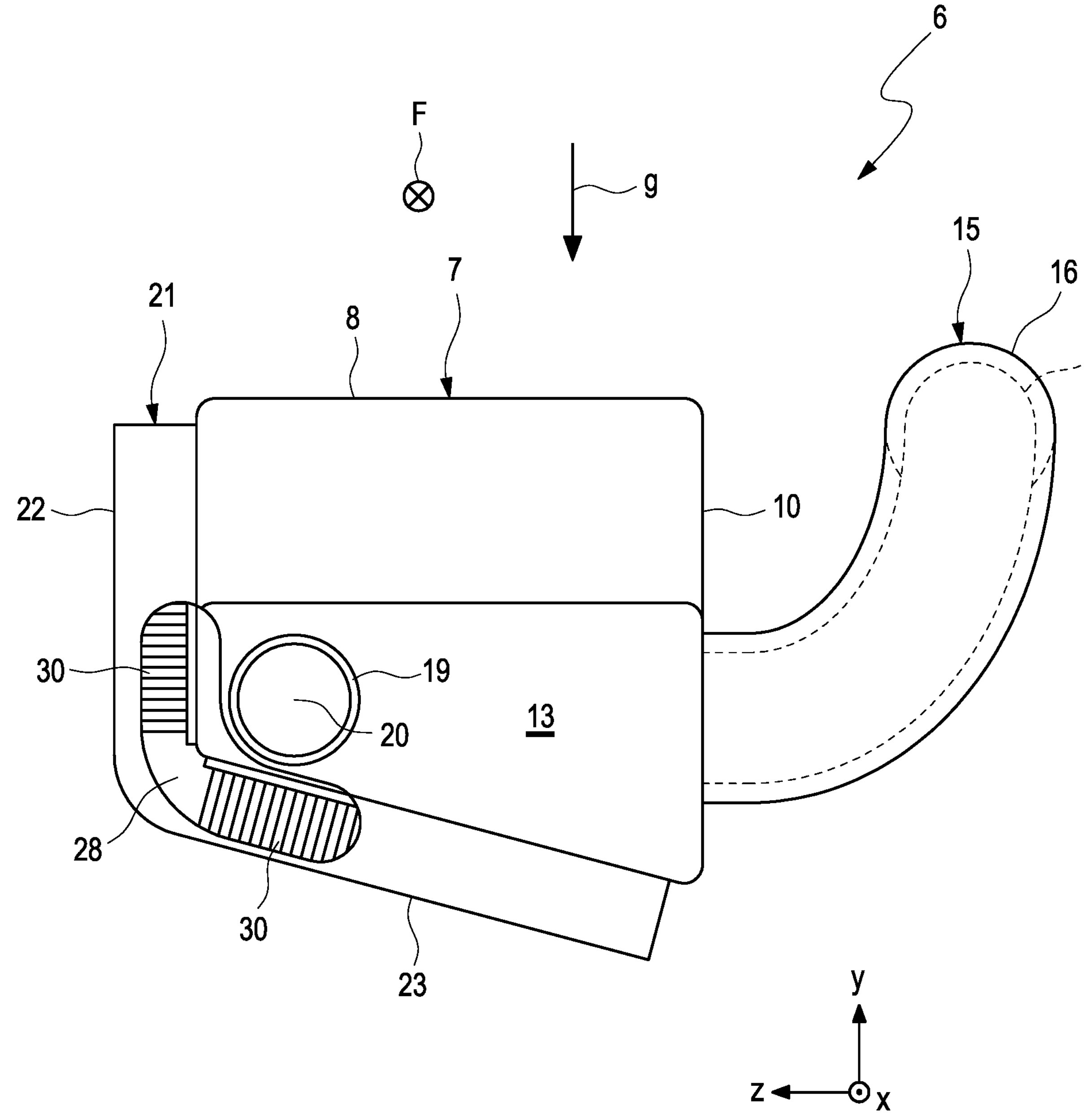

Fig. 4

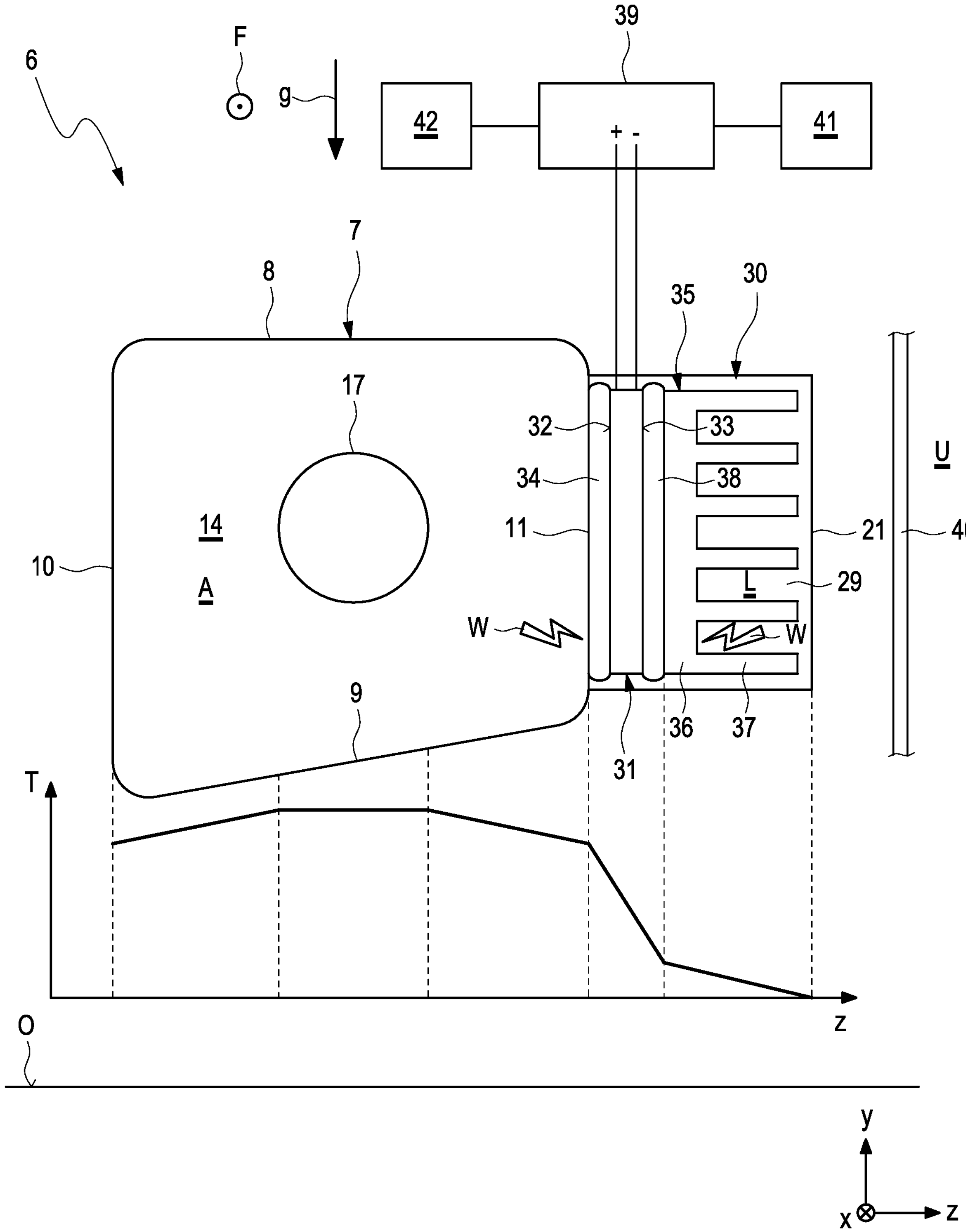
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Fig. 5

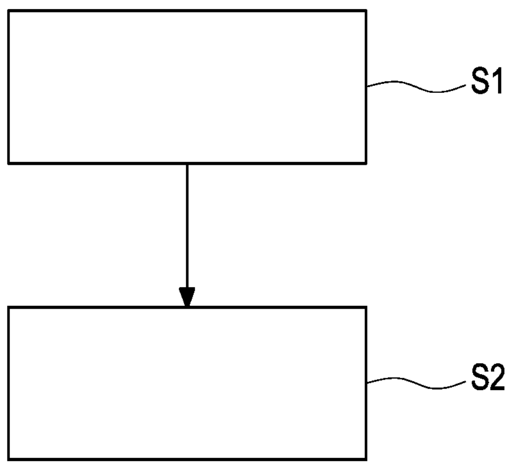

Fig. 6