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(54) **ELECTRIC AIR HEATING DEVICE COMPRISING A TIGHTENING DEVICE WITH INTEGRATED FUSE, ENGINE AND VEHICLE COMPRISING THE SAME**

ELEKTRISCHE LUFTHEIZVORRICHTUNG MIT EINER ANZIEHVORRICHTUNG MIT INTEGRIERTER SICHERUNG, MOTOR UND FAHRZEUG DAMIT

DISPOSITIF DE CHAUFFAGE D'AIR ÉLECTRIQUE COMPRENANT UN DISPOSITIF DE SERRAGE À FUSIBLE INTÉGRÉ, MOTEUR ET VÉHICULE LE COMPRENANT

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Description

[0001] The invention relates to an electric air heating device for diesel engine, comprising a tightening device -notably a screw connection- with integrated protective fuse. The invention also relates to a diesel engine equipped of an electric air heating device comprising at least one tightening device with integrated protective fuse and to a vehicle comprising the same.

[0002] In the text, the expressions "fuse" and "thermal fuse" mean and design an element of an electrical circuit destined to be able to interrupt an electric current in the electrical circuit comprising said "fuse" element under overheating conditions of said "fuse" element, said "fuse" element comprising a piece in a thermofusible solid material, closing the electrical circuit in a first solid conductive form -wherein the electric current flows in the electrical circuit- and opening the electrical circuit in a second solid non-conductive form -wherein no electric current flows in the electrical circuit- resulting from the overheating of the first solid conductive form.

[0003] To make it easier a diesel engine to start, it is advisable to warm the air flow entering the diesel engine. For this aim, an electric air heating device is sometimes accommodated in the inlet manifold of the diesel engine. Generally such an electric air heating device comprises a housing adapted to guide a flow of air to be heated through the internal volume of the housing and also comprises at least one resistive ribbon disposed in the internal volume of the housing so as to be able to heat the flow of air to be heated through the internal volume of the housing accommodating the resistive ribbon(s). When an electric current flows through the resistive ribbon(s), the temperature of the resistive ribbon(s) increases by Joule effect, and heat is transferred from the resistive ribbon(s) to the air of the flow of air contacting the resistive ribbons, providing with a flow of hot air to the engine. However, in the case when the resistive ribbon(s) is(are) heated and no air flows through the internal volume of the housing, the temperature of the resistive ribbon(s) increases and the corresponding heat is transferred to the housing and to the air heating device. As a consequence, the housing of the electric air heating device gets overheated due to the electric current operating the electric air heating device fastened to the inlet manifold of the diesel engine. A risk exists that some components of the engine extending in the vicinity of the housing of the electric air heating device would melt or ignite due to heating of the housing. This would be the case when the engine is not operable, when no air flows through the internal volume of the housing of the electric heater, and when there is an improper functioning of the control system of the air heating device, the air heating device being still in operating mode. Due to the control system, the heater functions normally even before the functioning of the engine and due to irregularities in the control system, the air heating device may function even after the engine stopped operating. As the air heating device has a deficient heat discharge from the heating elements in that time, the component parts of the air heating device, including the housing, get heated. When the housing reaches an excessive temperature due to improper operation of any kind, component parts of the air heating device, including the housing, start burning or melting. The component parts in the vicinity of the air heating device, the vehicle or the machine get ignited and/or melted. This problem becomes even more important when the vehicle or the machine is in a closed space of a garage or on ships.

[0004] A solution for preventing from overheating -notably against overheating over 200°C- of the air heating device and of the housing of the air heating device is necessary.

[0005] US2014/159855 discloses an air heating device comprising a housing accommodating two resistive ribbons fastened to the housing by means of fastening screws, one of the fastening screws being a fastening screw integrating a fuse therein. The shaft of the fastening screw integrating a fuse presents a longitudinal portion cooperating with a bore formed in the envelop of the housing, said longitudinal portion being electrically insulated from the envelop of the housing. The fuse comprises a coaxial tube with the same longitudinal axis than the shaft of the fastening screw and extending longitudinally with one end in electric connection with the housing and one end in in electric connection with an electric conductive washer in contact with the shaft. The fastening screw integrating a fuse also comprises a tube of electric insulating material -forming an insulating spacer- interposed radially between the shaft of the fastening screw and the fuse, said tube of electric insulating material being able to freely move in axial direction of the shaft of the screw. Thus, the fuse is radially electrically insulated from the shaft of the fastening screw and a closed electric circuit establishes between the resistive ribbon and the housing, said electric circuit comprising the shaft of the fastening screw, the electric conductive washer and the fuse serially electrically connected.

[0006] However, the fastening screw integrating a fuse of US2014/159855 presents some drawbacks. When the temperature of the housing increases and when the temperature of the fuse fastened to the housing reaches a value higher than the fusing temperature of the material of the fuse, the fuse melts. Consequently, the pretention force applied between the housing and the nut of the fastening screw drops to zero and the air heating device might fall apart. Parts of the air heating device could end-up in the combustion chamber of the engine, seriously damaging the engine.

[0007] The invention aims to overcome these drawbacks.

[0008] The invention aims to provide with a robust solution to overcome these drawbacks.

[0009] The invention aims to provide with an electric air heating device secured comprising a tightening device with integrated fuse.

[0010] The invention aims to provide with an electric air heating device comprising a tightening device with integrated fuse preserving sensibly the tightening strength after fusing of the material of the fuse.

[0011] The invention aims to provide with a secured electric air heating device comprising a tightening device with integrated fuse which is simple to manufacture, said tightening device with integrated fuse being easy to be mounted in an electric air heater.

[0012] The invention aims to provide with an electric air heating device which can be assembled from a low number of components, and is then simple to manufacture.

[0013] The invention aims to provide with a secured electric air heating device comprising a tightening device with an with integrated fuse presenting a reduced cost of manufacture.

[0014] The invention aims to provide with a secured screw connection with integrated fuse that allows limiting the time for assembly the electric air heating device.

[0015] The invention aims to provide with a secured electric air heating device comprising a tightening device with integrated fuse which enables to maintain the assembly of the electric air heating device even after the fuse of the secured tightening device fuses.

[0016] The invention aims to provide with a secured tightening device with integrated fuse that can be fabricated accurately.

[0017] The invention aims to provide with an electric air heating device comprising a secured tightening device with integrated fuse to be placed in an engine compartment of a diesel machine, and to a machine -notably a diesel machine- which is cheap and robust and withstanding harsh vibration profile.

[0018] The invention aims to provide with such an electric air heating device that solves the problem of the decrease of the tightening strength after fusing of the fuse of US2014/159855.

[0019] The invention aims to provide with such an electric air heating device that solves the problem of the dissociation of solid elements of the electric air heating device after fusing of the fuse of US2014/159855.

[0020] The invention aims to provide with such an electric air heating device preserving the tightening strength after the fuse melts.

[0021] The invention aims to provide with such an electric air heating device limiting if not avoiding the risks of dispersion of elements of the electric air heating device in the engine of the vehicle.

[0022] The invention aims to provide with such an electric air heating device limiting if not avoiding the risks of damaging the engine of the vehicle.

[0023] The invention aims to provide with such an electric air heating device enabling to manage the temperature of the electric air heating device and protect the electric air heating device and the environment of the electric air heating device against overheating and risks of ignition.

[0024] The invention relates to an electric air heating device of the type comprising:

- a housing delimited by a wall with an inner face and an outer face;
- at least one resistive ribbon disposed in an inner space of the housing adapted to heat air of a debit of air flowing through the housing and to form a debit of heated air;
- a tightening device cooperating with the inner face and with the outer face of said wall to fasten the resistive ribbon to said wall, said tightening device comprising at least:
    - o a tightening shaft extending across said wall, and;
    - o a tightening washer of the tightening device, facing the outer face of said wall and in electrically conductive contact with the tightening shaft;
- a cut-off for opening an electric circuit supplying said at least one resistive ribbon with electric current and interrupting the heating of said at least one resistive ribbons in a state of the electric air heating device, named overheating state, wherein the temperature of the wall exceeds a predetermined temperature;

said cut-off comprising a fuse disposed in electricity conductive contact with the tightening washer and with said wall;
characterized in that the tightening device comprises at least one tightening spacer;

- tightened longitudinally between the tightening washer and said wall,
- tightening of the resistive ribbon and said wall on each other at least in said overheating state, and
- providing with no electric conducting contact between the tightening washer and said wall.

[0025] The invention concerns an electric air heating device comprising at least one electric resistive ribbon to heat air of a flow of air, the electric air heating device being protected against overheating, notably in the case when the flow of air is interrupted and when the temperature of the wall of the housing increases dangerously. In that case, the electric supply of the resistive ribbons is cut off due to the melting of the fuse. The resistive ribbons remains securely fastened to the wall of the housing in the inner space of the housing. There is no risk that members of the electric air heating devices disassembles and fall into the compartment of the engine and/or in the combustion chamber of the engine and damage it. In addition, to repair the electric air heating device according to the invention, it is enough to replace the fuse and not the electric air heating device in its whole.

[0026] The electric air heating device according to the invention comprises a cut-off integrated in said tightening device, named first tightening device. Sais first tightening device fastens said at least one resistive ribbon to the wall of the housing and is disposed to electrically connects said at least one resistive ribbon to the negative (-) terminal of said storage battery. In preferred embodiments of an electric air heating device according to the invention, said first tightening device is connected to the negative (-) terminal of said storage battery through the wall of the housing.

[0027] The tightening spacer is so chosen and adapted to allow the tightening of said at least one resistive ribbon to the wall of the housing in both an operating state of the electric air heating device in which the fuse is in electrical contact with both the tightening washer and the wall of the housing and in said overheating state of the electric air heating device and where the material forming the fuse melts and interrupts the electric circuit between the tightening washer and the housing.

[0028] The cut-off of the electric air heating device is adapted to open the electric circuit in said overheating state and to maintain opened the electric circuit when the temperature of the wall of the housing decreases to a temperature lower than the predetermined temperature.

[0029] The fuse of the electric air heating device extends outside the housing and is mounted serially in the electric circuit.

[0030] In some preferred embodiments of an electric air heating device according to the invention, the fuse is a tube-shaped fuse extending coaxially to the tightening shaft.

[0031] The electric air heating device according to the invention comprises a second tightening device, distinct of the first tightening device, fastening said at least one resistive ribbon to the housing and connecting electrically said at least one resistive ribbon to the positive (+) terminal of a storage battery so that a closed electric circuit is formed, wherein an electric current flows from the storage battery, through said second tightening device, then through said at least one resistive ribbon, then through said first tightening device and then through the housing back to the storage battery.

[0032] Advantageously and according to the invention, the electric current flows through the tightening shaft of said tightening device, from an inner end of the tightening shaft where the tightening device fasten the resistive ribbon, to an outer end of the tightening shaft, said outer end cooperating with the cut-off and a tightening nut.

[0033] In some preferred embodiments of an electric air heating device according to the invention, the resistive ribbons are serially connected in the electric circuit.

[0034] The tightening spacer of the electric air heating device according to the invention is so chosen and disposed that the electric current flows in said first tightening device from the resistive ribbon fastened to said first tightening device, through the tightening shaft of said first tightening device, then through the tightening washer, then through the fuse and back to the wall of the housing. The tightening spacer of the electric air heating device according to the invention is so chosen and disposed to avoid direct electric contact between the tightening shaft and the wall of the housing from one to the other. The tightening spacer of the electric air heating device is so chosen and disposed to keep tightened the resistive ribbon to the wall of the housing on each other, even in said overheating state. Advantageously, the tightening spacer is a tube extending coaxially as regards to the tightening shaft.

[0035] In some preferred embodiments of an electric air heating device according to the invention, the tightening spacer is made of at least one non-fuse material. The fusion temperature of the material of the tightening spacer is greater than the fusion temperature of the material of the fuse. Advantageously, the tightening spacer can be made of at least one metal chosen in the group formed of copper, aluminium, titanium, iron, zinc, beryllium, magnesium, silver, gold, lead. Advantageously, the tightening spacer can be made of at least one material chosen in the group formed of metallic alloys, silicon bronze, Inconel, brass, amalgams and aluminium alloys. There is nothing to prevent the tightening spacer from being made in a ceramic material or made of rigid rubber material or other plastic. There is nothing to prevent the tightening spacer from being made of a metallic material wrapped of an outer surface layer of at least one insulating material. The tightening spacer of the electric air heating device according to the invention is so chosen and disposed to be mechanically resistant to the longitudinal compression strength provided by said first tightening device.

[0036] In some embodiments of an electric air heating device according to the invention, the tightening spacer is a tube-shaped tightening spacer extending coaxially to the tightening shaft and in close contact with said tightening shaft.

[0037] In some embodiments of an electric air heating device according to the invention, said at least one tightening spacer comprises -notably is formed of-:

- at least one tube made of non-fuse metallic material adapted to tighten said at least one resistive ribbon on the wall in said overheating state of the electric air heating device;
- at least one insulator, named L-shaped or U-shaped insulator (in longitudinal section), so shaped to extend radially between the fuse and the tightening shaft and longitudinally between the tube made of non-fuse metallic material and at least one of the tightening washer and of the wall of the housing, and insulating said at least one tube made of non-fuse metallic material radially from the wall of the housing.

[0038] In some embodiments of an electric air heating device according to the invention, said at least one tube made of non-fuse metallic material and said at least one

tubular insulator extend coaxially to the tightening shaft.

[0039] In some preferred embodiments of an electric air heating device according to the invention, the tightening spacer comprises -notably is formed of-:

- at least one metal tube made of non-fuse material adapted to tighten said at least one resistive ribbon on the wall in said overheating state of the electric air heating device;
- at least one tubular insulator, electrically insulating said at least one metal tube made of non-fuse material radially from the fuse;
- a ring extending longitudinally between the wall and said at least one metal tube made of non-fuse material, and electrically insulating said at least one metal tube made of non-fuse material longitudinally from the wall.

[0040] The fusion temperature of the material forming the fuse is lower than the fusion temperature of the materials forming the tightening spacer. The fusion temperature of the material forming the fuse is lower than the fusion temperature of the non-fuse material of the metal tube.

[0041] The material forming the fuse can be chosen in the group formed of metallic alloys, brass, aluminium/zinc alloys, magnesium/zinc alloys, magnesium/aluminium alloys, silicon/magnesium alloys, tin/zinc alloys and lead/zinc alloys. Other materials are possible. The material forming the fuse is so chosen to match the desired predetermined temperature.

[0042] The material forming the metal tube can be chosen in the group formed of metals and metallic alloys. The material forming the metal tube is chosen in the group formed of copper, aluminium, titanium, iron, zinc, beryllium, magnesium, silver, gold, lead and their alloys in admissible proportions, as, for example, silicon bronze, Inconel, brass and amalgams. It is thus possible to adapt the melting temperature of the fuse to different air heating devices.

[0043] In some preferred embodiments of an electric air heating device according to the invention, the tightening washer, the fuse, said at least one metal tube made of non-fuse material and said at least one tubular insulator extend coaxially to the tightening shaft.

[0044] In some preferred embodiments of an electric air heating device according to the invention, the cut-off comprises a ring made of an electrical insulating material with high compressive strength and extending longitudinally between the wall of the housing and the tightening spacer -notably between the wall of the housing and at least one of said at least one the metal tube made of non-fuse material and of said at least one tubular insulator.

[0045] In some preferred embodiments of an electric air heating device according to the invention, the ring is made of a material with sufficient compressibility, high temperature resistance and low electric conductivity. In some preferred embodiments of an electric air heating device according to the invention, the ring is made of at least one material chosen in the group of ceramics, polymer material with high compressibility strength, high temperature resistance and low electric conductivity and micas.

[0046] In some preferred embodiments and according to the invention, the electric air heating device comprises a cover wrapping the external part of the tightening device so as to collect melted material of the fuse so that melted material of the fuse is caught within the protection cover, whatever the position of the tightening device.

[0047] In some preferred embodiments of an electric air heating device according to the invention, the tightening washer is chosen in the group formed of a plain washers and spring washers. However, nothing prevents the tightening device to comprise at least one additional washer chosen in the group formed of plain washers, fender washer, Belleville washers, curved washers and spring washers.

[0048] In some preferred embodiments of an electric air heating device according to the invention, the tightening washer can be a washer made of steel or a washer made of stainless steel.

[0049] In some preferred embodiments of an electric air heating device according to the invention, the tightening device comprises a screw and at least one nut cooperating with a threaded portion of the conductive shaft of the screw to fasten the resistive ribbon to the wall of the housing. The threaded shaft of the screw and at least one nut are so arranged for applying a tightening force to a headed end of the screw extending of the inner face of the wall of the housing.

[0050] In some other embodiments of an electric air heating device according to the invention, the tightening device comprises a rivet fastening the resistive ribbon to the wall of the housing.

[0051] In some preferred embodiments of an electric air heating device according to the invention, the tightening shaft of the tightening device is so disposed to extend across a bore formed in wall of the housing. The tightening shaft is so disposed coaxially to the bore and to be electrically isolated from an internal wall of the bore. The tightening device is so disposed to electrically insulate the resistive ribbon from the inner face of the wall of the housing and to connect the resistive ribbon to the positive pole of a remote external storage battery. The tightening shaft is fastened traversing the wall of the housing and electrically insulated as regards to the bore and without contact with the bore and with the wall of the housing, one longitudinal (internal) end of the tightening shaft being in electrical connection with one of the resistive ribbons, the other longitudinal (external) end of the tightening shaft comprising the cut-off.

[0052] The invention also extends to an engine -notably a diesel engine-comprising at least one electric air heating device according to the invention. The invention also extends to an engine wherein at least one electric air heating device according to the invention interposed

in an air intake manifold of an engine -notably a diesel engine-.

[0053] The invention also extends to a machine -notably a vehicle-comprising an engine -notably a diesel engine- according to the invention. The invention also extends to a machine -notably a vehicle- comprising an engine with an electric air heating device fastened in the engine compartment of a said machine. The invention also extends to a machine -notably to a vehicle- comprising an electric air heating device fastened in the engine compartment of a said machine -notably of said vehicle-.

[0054] Further aims, features and advantages of the invention will become apparent upon reading the following description, which is provided by way of a non-limiting example of some of its possible embodiments, and with reference to the accompanying drawings, in which:

- figure 1 is a sectional view of a tightening device with integrated thermal cut-off of an air heating device according to a particular first embodiment of the invention;
- figure 2 is a sectional view of a tightening device with integrated thermal cut-off of an air heating device according to a particular second embodiment of the invention;
- figure 3 is a sectional view of a tightening device with integrated thermal cut-off of an air heating device according to the embodiment represented figure 2 and wherein an overheating of the air heating device occurred;
- figure 4 is a perspective view of a detail of a tightening device fastened to the housing of an air heating device according to the invention;
- figure 5 is an exploded sectional view of a detail of an electric air heating device comprising a tightening device with integrated thermal cut-off according to the particular first embodiment of the invention;
- figure 6 is a general perspective view of an air heating device according to one embodiment of the invention, and;
- figure 7 is a perspective view of a detail of an air heating device according to one embodiment of the invention.

[0055] The aim of the invention is to provide with a simple, cheap and robust solution to prevent an air heating device of over-heating.

[0056] A sectional view of a detail of a tightening device 5 with integrated cut-off 6 comprising a fuse 10 of particular first and second embodiments of an electric air heating device 1 according to the invention are represented figure 1 and figure 2 respectively. In figure 1 and 2, fuse 10 has never been exposed to a temperature greater than the fusion temperature of the material forming said fuse 10, the electric circuit is a closed circuit and the electric air heating device is in an operating state. The tightening device 5 with integrated electric cut-off 6 is fastened to the housing 2 and comprises a shaft 9 extending longitudinally through a bore 21 made in the housing 2 and traversing the housing 2. The tightening device 5 fastened to the housing 2 comprises a screw 22 with a threaded shaft 23 cooperating with a nut 24 for fastening the heating ribbon 3 to the housing 2. The headed longitudinal end of the screw 22 forms an electrically conductive contact with a longitudinal end of a heating ribbon 3 extending in the inner space 4 of the housing 2, said longitudinal end of the heating ribbon 3 forming a washer with a central hole cooperating with the head of the screw 22. An electrically conductive washer 18 is interposed between the washer-shaped longitudinal end of the heating ribbon 3 and a washer 19 made of an electrical insulating material, for example, made of mica, said mica washer 19 being in contact with the housing 2 and electrically insulating the heating ribbon 3, the electrically conductive washer 18 and the screw 22 from the housing 2. The thickness of the electrically conductive washer 18 is so chosen to improve the electric conductivity between the heating ribbon 3 and the shaft 9. The tightening device 5 comprises a O-ring seal 20 disposed in a countersink 43 formed at the internal end of the bore 21 and adapted to prevent a leakage of air through the bore 21. The O-ring seal 20 is also adapted to maintain the screw 22 in a position wherein the shaft 9,23 is axially centred within the bore 21 and to prevent electrically conducting contact to occur with the wall of the bore 21. The tightening device 5 is arranged in such a manner that the electrical circuit necessarily establishes through the cut-off 6.

[0057] However, according to the invention, nothing prevents the tightening device 5 from being a rivet fastening the heater ribbons 3 to the housing 2.

[0058] The cut-off 6 integrated in the tightening device 5 is a cut-off opening the electric circuit when the temperature of the electric air heating device and/or of the housing 2 exceeds the fusion temperature of the material constitutive of the fuse 10.

[0059] In the particular first and second embodiments represented figure 1 and 2, the fuse 10 is a tube-shaped fuse. However, nothing prevents the fuse 10 to be differently shaped. The fuse 10 can be made of various materials. Advantageously, the material of the fuse 10 is so chosen to adjust the melting temperature so that the thermal cut-off is adaptable to different electric air heating devices 1. The fuse 10 is made in an alloy material with a fusion temperature adapted to the use conditions of the electric air heating device 1.

[0060] In the particular first and second embodiments represented figures 1 and 2, the tightening device 5 also comprise a cover 15 fastened to the shaft 23 of the screw 22. The cover 15 can be made in a plastic material. The cover 15 is intended to cooperate with the external face 7 of the housing 2 to protect the tightening device 5 against dirt from the engine and also to catch the fuse material in the cover 15 so that it does not disperse in the engine compartment. The cover 15 comprises means for fastening said cover 15 to the shaft 23 of the tightening device 5 and to the air heating device 1:

- a first wedging washer 26 interposed between the nut 24 and the cover, and dimensioned to adapt the position of the cover 15 with respect to the housing 2;
- a second washer 27 cooperating with a spring washer 28 and a nut 42 to secure the cover 15 to the air heating device 1.

[0061] The cut-off 6 of the particular first embodiment of an electric air heating device 1 according to the invention represented figure 1 comprises as tightening elements:

- the screw 22 cooperating with the nut 24 to fasten the heating ribbon 3 on the internal face 13 of the housing 2;
- a tightening spacer 46 forming a tube extending coaxially to the shaft 9,23 and disposed in abutment with the bottom 25 of a counterbore 17 formed in the bore 21. The tightening spacer 46 is made of a material with high compressive strength and high electric insulating properties and is advantageously made of a ceramic material. The tightening spacer 46 is so chosen to withstand high tighten torque. The tightening spacer 46 extends radially inwardly next to the shaft 9,23, outwardly next to the fuse 10 and is longitudinally dimensioned to be able to transmit the compressive strength provided by the nut 24 cooperating with the threaded shaft 23 of the screw 22 to the heating ribbon 3 and to fasten the heating ribbon 3 to the external face 13 of the housing 2.
- a tightening washer 8 adapted to transfer the compressive strength provided by the nut 24 cooperating with the threaded shaft 23 to the tightening spacer 46, and
- a spring washer 16 disposed to push elastically the tightening washer 8 against the tightening tube 11 and to prevent from self-unwinding of the nut 24.

[0062] The fuse 10 and the tightening spacer 46 are so chosen and dimensioned that upon tightening of the tightening device 5 to the housing 2, the fuse 10 is first compressed between the tightening washer 8 and the housing 2 to as to form the electric contact for electric current, and then the tightening spacer 46 is secondly compressed between the tightening washer 8 and the bottom 25 of the counterbore 17 formed in the bore 21 of the housing 2.

[0063] The cut-off 6 comprises as electric conductive/insulating elements:

- the electric conductive shaft 9,23 of the screw 22;
- the electric conductive tightening washer 8 dimensioned to be in electric contact with the shaft 9,23 of the tightening device 5;
- the fuse 10 extending longitudinally between the tightening washer 8 and the external face 7 of the housing 2 and radially facing the external face of the tightening spacer 46, and;
- the tightening spacer 46 radially interposed between electric conductive shaft 9,23 of the screw 22 and the conductive fuse 10.

[0064] The tightening spacer 46 is so chosen, dimensioned and disposed to prevent any direct electrically conductive contact between the shaft 9,23 of the screw 22 and the housing 2. The tightening spacer 46 is so chosen and disposed that the electric current flowing through the heating ribbons 3, flows necessarily through the fuse 10 to reach the grounded housing 2.

[0065] However, according to the invention, nothing prevents the one-piece tightening spacer 46 from being formed of a plurality of elements. A sectional view of a detail of a tightening device 5 with integrated cut-off 6 comprising a fuse 10 of a particular second embodiment of an electric air heating device 1 according to the invention is represented figure 2.

[0066] The cut-off 6 of the particular second embodiment of an electric air heating device 1 according to the invention represented figure 2 comprises as tightening elements:

- the screw 22 cooperating with the nut 24 to fasten the heating ribbon 3 on the internal face 13 of the housing 2;
- a ring 14 forming a thick washer extending coaxially to the shaft 9,23 and disposed in abutment with the bottom 25 of a counterbore 17 formed in the bore 21. The ring 14 is made of a material with high compressive strength and high electric insulating properties and is advantageously made of a ceramic material. The ring 14 made of a material with high compressive strength is adapted to withstand high tighten torque;
- a tightening tube 11 extending coaxially to the shaft 9,23 and radially next to the shaft 9,23. The tightening tube 11 is dimensioned to be able to transmit the compressive strength provided by the nut 24 cooperating with the threaded shaft 23 of the screw 22 to the heating ribbon 3 and to fasten the heating ribbon 3 to the external face 13 of the housing 2. In a preferred embodiment, the tightening tube 11 is made of metallic material. Nothing prevents the tightening tube 11 from being made of a metal, or of an metallic alloy;
- a tubular insulator 12 extending longitudinally between the ring 14 and the tightening washer 8, and susceptible to cooperate with the tightening tube 11 in transmission of the compressive strength. In a preferred embodiment, the tubular insulator 12 is made of at least one polymer insulating material;
- a tightening washer 8 adapted to transfer the compressive strength provided by the nut 24 cooperating with the threaded shaft 23 to the tightening tube 11, and
- a spring washer 16 disposed to push elastically the tightening washer 8 against the tightening tube 11

and to prevent from self-unwinding of the nut 24.

[0067] The fuse 10 and the tightening tube 11 are so chosen and dimensioned that when tighten the tightening device 5 to the housing 2, the fuse 10 is first compressed between the tightening washer 8 and the housing 2 to as to form the electric contact for electric current, and then further tightening compresses the tightening tube 11.

[0068] The cut-off 6 comprises as electric conductive/insulating elements:

- the electric conductive shaft 9,23 of the screw 22;
- the electric conductive tightening washer 8 dimensioned to be in electric contact with the shaft 9,23 of the tightening device 5;
- the fuse 10 extending longitudinally between the tightening washer 8 and the external face 7 of the housing 2 and radially facing the external face of the tubular insulator 12;
- the electrical insulation ring 14, and
- the tubular insulator 12 extending radially interposed between the tightening tube 11 and the conductive fuse 10.

[0069] However, nothing prevents the tubular insulator 12 and the electrical insulation ring 14 from being formed of the same material. Nothing also prevents the tubular insulator 12 and the electrical insulation ring 14 from being formed of one piece in one material.

[0070] The electrical insulation ring 14 and the tubular insulator 12 are so chosen and disposed to prevent any direct electrically conductive contact between the shaft 9,23 of the screw 22 and the housing 2. The electrical insulation ring 14 and the tubular insulator 12 are chosen and disposed so that the electric current flowing through the heating ribbons 3, flows necessarily through the fuse 10 to reach the grounded housing 2.

[0071] A sectional view of a detail of a tightening device 5 with integrated cut-off 6 of a particular embodiment of an electric air heating device 1 according to the invention is represented figure 3. In figure 3, due to overheating of the electric air heating device and of the housing 2, the fuse 10 has been exposed to a temperature greater than the fusion temperature of the material forming the fuse so that the fuse 10 has melted. When melting, the hot melted material constitutive of the fuse flows out, breaks the contact between the tightening washer 8 and the housing 2, and then solidifies. Most part of the material -notably most of the alloy- forming the fuse stays trapped in the cover 15.

[0072] The electric circuit comprising the heating ribbons 3 has opened and the electric air heating device has been switched in a non-operating state, as the material constitutive of the fuse 10 does not form an electrical contact between the tightening washer 8 and the external face 7 of the housing 2. However, even in the non-operating state of the electric air heating device 1, the compression strength provided by screw 22 in cooperation with spring washer 16 is preserved after fuse melts down, due to the tightening tube 11 extending longitudinally between tightening washer 8 and ring 14. The tightening device 5 is kept resistant to vibrations provided by the engine in operation and no part of the electric air heating device disassembles and falls apart in the engine compartment. Additionally, the fuse material remains confined in the cover 15 whatever the orientation of the electric air heating device 1. The replacement of the fuse 10 is possible by removing the cover 15, loosening of the nut 15, extracting the spring washer 16, the tightening washer 8 and the deformed fuse material and replacing a new fuse. This replacement avoids the change of the entire electric air heating device.

[0073] In the detail of an electric air heating device according to the invention represented figure 4, wherein cover is not represented, the housing 2 presents a bore 21 traversing the housing 2 and adapted to accommodate a tightening device 5, named tightening device (+), connected to the positive (+) terminal of a storage battery (not shown). The electric air heating device represented figure 4 comprises a tightening device 5 with an integrated cut-off 6. In the electric air heating device represented figure 4, the cover 15 is removed. The tightening device 5 comprises a screw with a threaded shaft 23 traversing the bore formed in the housing 2. A heating ribbon 3 is fastened in the inner space 4 of the housing 2 in such a way that the heating ribbon 3 is electrically connected to the shaft 9 of the screw and electrically insulated of the housing 2. For this aim the tightening device 5 comprise an electrically conductive washer 18 interposed between a washer-shaped longitudinal end of the heating ribbon 3 (increasing the surface of electrical contact between the heating ribbon 3 and the shaft of the screw and improving the electric conductivity between the heating ribbon 3 and the shaft) and a washer 19 made of an electrically insulating material, for example, made of mica, said mica washer 19 being in contact with the housing 2 and electrically insulating the heating ribbon 3 from the internal face 13 of the housing 2.

[0074] The tightening device 5 represented figure 4 presents a fuse 10 of an electrically conductive material extending between and in contact on one of its longitudinal ends with the housing 2 and on its opposite longitudinal end, with a tightening washer 8 and maintained longitudinally in compression by the screw in cooperation with the nut 24 and the spring washer 16.

[0075] The electric air heating device represented figure 5 in longitudinal section presents a tightening device 5 with an integrated cut-off 6 comprising a fuse 10. The tightening device 5 is fastened to the housing 2 and cooperates with a bore 21 formed in the housing 2. The bore 21 comprises a counterbore 17 at an external end of the bore 21 and a countersink 43 at an internal end of the bore 21. The counterbore 17 forms an abutment receiving the ring 14 extending coaxially with the shaft 9 of the screw 22, with the fuse 10, with the tightening washer 8, with the tightening tube 11 and with the tubular insu-

lator 12. In the tightening device 5, the tightening tube 11 and the shaft 9 of the screw 22 are radially electrically insulated by the insulator 12 and longitudinally electrically insulated by the ring 14 so that the electric current travels necessarily from the heating ribbon 3 through the shaft 9, the tightening washer 8, the fuse 10 to reach the external face 7 of housing 2.

[0076] An electric air heating device 1 comprising a tightening device 5 according to a particular embodiment of the invention with an integrated thermal cut-off 6 comprising a fuse tube 10 is represented figure 6.

[0077] Generally, an electric air heating device 1 is interposed in an air intake manifold fastened in the engine compartment of a diesel machine. As a consequence, there is a need of stopping electrical supply to the electric air heating device 1 in the case of overheating of the electric air heating device -notably overheating of the housing of the electric air heating device- and before the electric air heating device or components surrounding the electric air heating device (for example air filter, hoses, ...) start to derogate.

[0078] Thus, the invention concerns an electric air heating device wherein supply of electric power to the heating ribbons is interrupted in case of overheating of the housing and limiting the risks that constitutive elements of the air heating device disassemble due to vibrations provided by the operating engine and falls into the combustion chamber of the engine and damage it.

[0079] One of the main advantages is that the longitudinal tightening force exerted by the tightening device 5 is maintained, including after melting of the constituent material of the fuse tube 10, following overheating of the housing 2 causing said melting. In this case, the operation of the electric air heating device 1 is interrupted due to the opening of the electrical supply circuit of the heating ribbons 3 of the electric air heating device 1. However, the constituent elements of the tightening device 5 and the electric air heating device 1 are held by the tightening force applied by the tightening device 5 and, despite the vibrations provided by the motor in operation and possibly by the air flow, do not risks to damage the motor.

[0080] In the embodiment represented figure 6, the electric air heating device 1 comprises four tightening devices 5 traversing the housing 2 through bores 21 made in the housing and fastening the heating ribbons 3 to the housing 2. One of the tightening device 5, named tightening device (+) 30 is connected to the positive (+) terminal of a storage battery (not shown) forming the source of electric power of the vehicle. The tightening device (+) 30 with integrated cut-off 6 is mounted on the top of the electric air heating device 1. The tightening device (+) 30 traverse the housing 2 through a traversing bore made in the housing 2 of the electric air heating device 1. The tightening device (+) 30 is electrically insulated from the internal wall of the bore traversing the housing 2 and connected to one longitudinal end of a first heating ribbon 31 extending in the inner space 4 of the housing 2 so that the electric current flows through the first heating ribbon 31 to a second longitudinal end 32 of the first heating ribbon 31. The second longitudinal end 32 of the first heating ribbon 31 is fastened to the housing 2 by means of a second tightening device 33 traversing the housing 2 and electrically insulated from the housing 2. The electric air heating device 1 represented figure 6 comprises a second heating ribbon 34 with a first longitudinal end 36 fastened to the housing 2 by a third tightening device 35. The second tightening device 33 and the third tightening device 35 include a plate 37 of electrical insulating material, insulating from the housing 2 the second tightening device 33, the second longitudinal end 32 of the first heating ribbon 31, the first longitudinal end 36 of the second heating ribbon 34 and the third tightening device 35. The second tightening device 33 and the third tightening device 35 also comprise a bridge 38 made of an electrical conductive material 36 and connecting electrically the first heating ribbon 31 and the second heating ribbon 34. The second longitudinal end 39 of the second heating ribbon 34 is fastened to the housing 2 by means of a fourth tightening device 5 with integrated thermal cut-off 6 comprising a tube 10 made of a electrically conducting fuse material. The fourth tightening device 5 traverses the housing 2 through a bore made in the housing 2 and is electrically insulated from the bore of the housing 2, in such a way that the electric current supplied by the source of electric power (storage battery, not shown) connected to the tightening device (+) 30 circulates in the heating ribbons 31,34 up to the fourth tightening device 5 according to the invention, necessarily flows along the shaft of the fourth tightening device 5 and reaches housing 2 by an electric conductive connection necessarily comprising fuse tube 10, and so that the electric current necessarily flows through the fuse tube 10 extending in contact with the housing 2. The housing 2 is grounded (negative terminal) by means of a connection engaging a hole 29(-) formed in the housing 2.

[0081] The embodiment of the electric air heating device 1 according to the invention represented figure 6 comprises a housing 2 delimiting an inner space 4 for the passage of a debit of air to be heated. Two serpentine shaped heating ribbons 31,34 extend in the inner space 4 transversally in the flow of air to be heated. Said serpentine shaped heating ribbons 31,34 present a plurality of linear segments 40 separated longitudinally from each other with a bent party 41 (or turns, or folds). The electric air heating device 1 comprises two holders 44 for insulator secured to opposite inner faces of the housing 2. Each one of the holders 44 accommodate a solid piece 45 of an insulating material. Said at least two insulators 45 present aligned recesses, each of the aligned recesses being adapted to receive and accommodate a bent party 41 of one serpentine shaped heating ribbon 31,34.

[0082] The detail of an electric air heating device 1 represented figure 7 shows the tightening device 5, named tightening device (+) 30, adapted to be connected to the positive (+) terminal of a storage battery (not shown).

Said tightening device (+) 30 traverses a bore of the housing 2 and presents an internal end electrically connected to a heating ribbon 31 fastened in the inner space 4 of the electric air heating device 1. The electric air heating device also comprises a heating ribbon 34 fastened in the inner space 4 of the electric air heating device 1 and electrically connected to the tightening device 5(-) placed in electrical contact with the housing 2 through the fuse 10 only. The tightening device (+) 30, the heating ribbons 31,34, the tightening device 5(-), the housing 2 and the hole 29(-) adapted to be connected to the negative (-) terminal of a storage battery (not shown) form a part of the electric circuit enabling the heating of the heating ribbons 3 by Joule effect.

Claims

1. - Electric air heating device (1) of the type comprising:

- a housing delimited by a wall (2) with an inner face (13) and an outer face (7);
- at least one resistive ribbon (3) disposed in an inner space (4) of the housing adapted to heat air of a debit of air flowing through the housing and to form a debit of heated air;
- a tightening device (5) cooperating with the inner face (13) and with the outer face (7) of said wall (2) to fasten the resistive ribbon (3) to said wall (2), said tightening device (5) comprising at least:
  - ◦ a tightening shaft (9) extending across said wall (2), and
  - ◦ a tightening washer (8) of the tightening device (5), facing the outer face (7) of said wall (2) and in electrically conductive contact with the tightening shaft (9);
- a cut-off (6) for opening an electric circuit supplying said at least one resistive ribbon (3) with electric current and interrupting the heating of said at least one resistive ribbons (3) in a state of the electric air heating device (1), named overheating state, wherein the temperature of the wall (2) exceeds a predetermined temperature; said cut-off (6) comprising a fuse (10) disposed in electricity conductive contact with the tightening washer (8) and with said wall (2);

characterized in that the tightening device (5) comprises at least one tightening spacer

- ▪ tightened longitudinally between the tightening washer (8) and said wall (2),
- ▪ tightening of the resistive ribbon (3) and said wall (2) on each other at least in said overheating state, and
- ▪ providing with no electric conducting contact between the tightening washer (8) and said wall (2).

2. - Electric air heating device (1) according to claim 1, **characterized in that** the tightening spacer comprises:

- at least one metal tube (11) made of non-fuse material adapted to tighten said at least one resistive ribbon (3) on the wall (2) in said overheating state of the electric air heating device (1);
- at least one tubular insulator (12), electrically insulating said at least one metal tube (11) made of non-fuse material radially from the fuse 10);
- a ring (14) extending longitudinally between the wall (2) and said at least one metal tube (11) made of non-fuse material, and electrically insulating said at least one metal tube (11) made of non-fuse material longitudinally from the wall (2).

3. - Electric air heating device (1) according to claim 2, **characterized in that** the tightening washer (8), the fuse (10), said at least one metal tube (11) made of non-fuse material and said at least one tubular insulator (12) extend coaxially to the tightening shaft (9).

4. - Electric air heating device (1) according to one of claims 1 or 3, **characterized in that** the cut-off (6) comprises a ring (14) made of an electrical insulating material with high compressive strength and extending longitudinally between the wall (2) and the tightening spacer.

5. - Electric air heating device (1) according to claims 2 to 4, **characterized in that** the ring (14) is made of at least one ceramic material.

6. - Electric air heating device (1) according to one of claims 1 to 5, **characterized in that** it comprises a cover (15) wrapping the external part of the tightening device (5) so as to collect melted material of the fuse (10) so that melted material of the fuse (10) is caught within the protection cover (15), whatever the position of the tightening device (5).

7. - Electric air heating device (1) according to one of claims 1 to 6, **characterized in that** the tightening washer (8) is chosen in the group formed of plain washers and spring washers.

8. - Electric air heating device (1) according to one of claims 1 to 7, **characterized in that** the tightening device (5) comprises a screw (22) and at least one nut (24) cooperating with a threaded portion (23) of the conductive shaft (9) of the screw (22) to fasten the resistive ribbon (3) to the wall (2) of the housing.

9. - Electric air heating device (1) according to one of claims 1 to 7, **characterized in that** the tightening device (5) comprises a rivet.

10. - Electric air heating device (1) according to one of claims 1 to 9, **characterized in that** the tightening shaft (9) of the tightening device is so disposed to extend across a bore (21) formed in wall (2) of the housing.

11. - Engine comprising at least one electric air heating device (1) according to one of the claims 1 to 10.

12. - Vehicle **characterized in that** it comprises an engine according to claim 11.

13. - Vehicle according to claim 12, **characterized in that** it comprises at least one electric air heating device (1) according to one of the claims 1 to 10.

Patentansprüche

1. Elektrische Luftheizvorrichtung (1) des Typs umfassend:

- ein Gehäuse, das durch eine Wand (2) mit einer Innenfläche (13) und einer Außenfläche (7) begrenzt ist;
- mindestens ein Widerstandsband (3), das in einem Innenraum (4) des Gehäuses angeordnet ist und dazu angepasst ist, die Luft eines durch das Gehäuse strömenden Luftstroms zu erhitzen und einen Vorrat an erhitzter Luft zu bilden;
- eine Spannvorrichtung (5), die mit der Innenseite (13) und mit der Außenseite (7) der Wand (2) zusammenwirkt, um das Widerstandsband (3) an der Wand (2) zu befestigen, wobei die Spannvorrichtung (5) mindestens umfasst:
  - ◦ einen Spannschaft (9), der sich quer über die Wand (2) erstreckt, und
  - ◦ eine Spannscheibe (8) der Spannvorrichtung (5), die der Außenfläche (7) der Wand (2) gegenüberliegt und in elektrisch leitendem Kontakt mit dem Spannschaft (9) steht;
- eine Abschaltvorrichtung (6) zum Öffnen eines Stromkreises, der das mindestens eine Widerstandsband (3) mit elektrischem Strom versorgt, und zum Unterbrechen des Erhitzens des mindestens einen Widerstandsbandes (3) in einem Zustand der elektrischen Luftheizvorrichtung (1), der als Überhitzungszustand bezeichnet wird, in dem die Temperatur der Wand (2) eine vorbestimmte Temperatur überschreitet;

wobei die Abschaltvorrichtung (6) eine Schmelzsicherung (10) umfasst, die in elektrisch leitendem Kontakt mit der Spannscheibe (8) und mit der Wand (2) angeordnet ist; **dadurch gekennzeichnet, dass** die Spannvorrichtung (5) mindestens einen Spannabstandshalter umfasst,

- • der in Längsrichtung zwischen der Spannscheibe (8) und der Wand (2) festgezogen wird,
- • der das Widerstandsband (3) und die Wand (2) zumindest im Überhitzungszustand gegenseitig festzieht und
- • keinen elektrisch leitenden Kontakt zwischen der Spannscheibe (8) und der Wand (2) herstellt.

2. Elektrische Luftheizvorrichtung (1) gemäß Anspruch 1, **dadurch gekennzeichnet, dass** der Spannabstandshalter umfasst:

- mindestens ein Metallrohr (11) aus nicht schmelzendem Material, das dazu angepasst ist, im Überhitzungszustand der elektrischen Luftheizvorrichtung (1) mindestens ein Widerstandsband (3) an der Wand (2) festzuziehen;
- mindestens einen rohrförmigen Isolator (12), der das mindestens eine Metallrohr (11) aus nicht schmelzendem Material radial von der Schmelzsicherung (10) elektrisch isoliert;
- einen Ring (14), der sich in Längsrichtung zwischen der Wand (2) und dem mindestens einen Metallrohr (11) aus nicht schmelzendem Material erstreckt und das mindestens eine Metallrohr (11) aus nicht schmelzendem Material in Längsrichtung von der Wand (2) elektrisch isoliert.

3. Elektrische Luftheizvorrichtung (1) gemäß Anspruch 2, **dadurch gekennzeichnet, dass** die Spannscheibe (8), die Schmelzsicherung (10), das mindestens eine Metallrohr (11) aus nicht schmelzbarem Material und der mindestens eine rohrförmige Isolator (12) koaxial zum Spannschaft (9) verlaufen.

4. Elektrische Luftheizvorrichtung (1) gemäß einem der Ansprüche 1 oder 3, **dadurch gekennzeichnet, dass** die Abschaltvorrichtung (6) einen Ring (14) aus einem elektrisch isolierenden Material mit hoher Druckfestigkeit umfasst, der sich in Längsrichtung zwischen der Wand (2) und dem Spannabstandshalter erstreckt.

5. Elektrische Luftheizvorrichtung (1) gemäß einem der Ansprüche 2 bis 4, **dadurch gekennzeichnet, dass** der Ring (14) aus mindestens einem keramischen Material besteht.

6. Elektrische Luftheizvorrichtung (1) gemäß einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, dass**

sie eine Abdeckung (15) umfasst, die den äußeren Teil der Spannvorrichtung (5) umhüllt, um geschmolzenes Material der Schmelzsicherung (10) aufzufangen, sodass geschmolzenes Material der Schmelzsicherung (10) unabhängig von der Position der Spannvorrichtung (5) im Innern der Schutzabdeckung (15) aufgefangen wird.

7. Elektrische Luftheizvorrichtung (1) gemäß einem der Ansprüche 1 bis 6, **dadurch gekennzeichnet, dass** die Spannscheibe (8) aus der aus Unterlegscheiben und Federscheiben gebildeten Gruppe ausgewählt ist.

8. Elektrische Luftheizvorrichtung (1) gemäß einem der Ansprüche 1 bis 7, **dadurch gekennzeichnet, dass** die Spannvorrichtung (5) eine Schraube (22) und mindestens eine Mutter (24) umfasst, die mit einem Gewindeabschnitt (23) des leitenden Schafts (9) der Schraube (22) zusammenwirkt, um das Widerstandsband (3) an der Wand (2) des Gehäuses zu befestigen.

9. Elektrische Luftheizvorrichtung (1) gemäß einem der Ansprüche 1 bis 7, **dadurch gekennzeichnet, dass** die Spannvorrichtung (5) einen Niet umfasst.

10. Elektrische Luftheizvorrichtung (1) gemäß einem der Ansprüche 1 bis 9, **dadurch gekennzeichnet, dass** der Spannschaft (9) der Spannvorrichtung so angeordnet ist, dass er sich durch eine in der Gehäusewand (2) ausgebildete Bohrung (21) erstreckt.

11. Motor, umfassend mindestens eine elektrische Luftheizvorrichtung (1) gemäß einem der Ansprüche 1 bis 10.

12. Fahrzeug, **dadurch gekennzeichnet, dass** es einen Motor gemäß Anspruch 11 umfasst.

13. Fahrzeug gemäß Anspruch 12, **dadurch gekennzeichnet, dass** es mindestens eine elektrische Luftheizvorrichtung (1) gemäß einem der Ansprüche 1 bis 10 umfasst.

Revendications

1. Dispositif électrique de chauffage d'air (1) du type comprenant :

- un logement délimité par une paroi (2) avec une face intérieure (13) et une face extérieure (7) ;
- au moins un ruban résistif (3) disposé dans un espace intérieur (4) du logement adapté pour chauffer de l'air d'un débit d'air s'écoulant à travers le logement et pour former un débit d'air chauffé ;
- un dispositif de serrage (5) coopérant avec la face intérieure (13) et avec la face extérieure (7) de ladite paroi (2) pour fixer le ruban résistif (3) à ladite paroi (2), ledit dispositif de serrage (5) comprenant au moins :

  ◦ une tige de serrage (9) s'étendant à travers ladite paroi (2), et ;
  ◦ une rondelle de serrage (8) du dispositif de serrage (5), faisant face à la face extérieure (7) de ladite paroi (2) et en contact électriquement conducteur avec la tige de serrage (9) ;

- un coupe-circuit (6) pour ouvrir un circuit électrique fournissant, audit au moins un ruban résistif (3), un courant électrique et interrompant le chauffage dudit au moins un ruban résistif (3) dans un état du dispositif électrique de chauffage d'air (1), appelé état de surchauffage, dans lequel la température de la paroi (2) dépasse une température prédéterminée ;

ledit coupe-circuit (6) comprenant un fusible (10) disposé en contact conducteur d'électricité avec la rondelle de serrage (8) et avec ladite paroi (2) ; **caractérisé en ce que** le dispositif de serrage (5) comprend au moins une entretoise de serrage,

- serrée longitudinalement entre la rondelle de serrage (8) et ladite paroi (2),
- effectuant le serrage du ruban résistif (3) et de ladite paroi (2) l'un sur l'autre au moins dans ledit état de surchauffage, et
- ne fournissant aucun contact conducteur électrique entre la rondelle de serrage (8) et ladite paroi (2).

2. Dispositif électrique de chauffage d'air (1) selon la revendication 1, **caractérisé en ce que** l'entretoise de serrage comprend :

- au moins un tube de métal (11) fait de matériau non fusible adapté pour serrer ledit au moins un ruban résistif (3) sur la paroi (2) dans ledit état de surchauffage du dispositif électrique de chauffage d'air (1) ;
- au moins un isolant tubulaire (12), isolant électriquement ledit au moins un tube de métal (11), fait de matériau non fusible, radialement par rapport au fusible (10) ;
- une bague (14) s'étendant longitudinalement entre la paroi (2) et ledit au moins un tube de métal (11) fait de matériau non fusible, et isolant électriquement ledit au moins un tube de métal (11), fait de matériau non fusible, longitudinalement par rapport à la paroi (2).

3. Dispositif électrique de chauffage d'air (1) selon la revendication 2, **caractérisé en ce que** la rondelle de serrage (8), le fusible (10), ledit au moins un tube de métal (11), fait de matériau non fusible, et ledit au moins un isolant tubulaire (12) s'étendent de façon coaxiale par rapport à la tige de serrage (9).

4. Dispositif électrique de chauffage d'air (1) selon l'une des revendications 1 ou 3, **caractérisé en ce que** le coupe-circuit (6) comprend une bague (14) faite d'un matériau isolant électrique avec une haute résistance à la compression et s'étendant longitudinalement entre la paroi (2) et l'entretoise de serrage.

5. Dispositif électrique de chauffage d'air (1) selon les revendications 2 à 4, **caractérisé en ce que** la bague (14) est faite d'au moins un matériau en céramique.

6. Dispositif électrique de chauffage d'air (1) selon l'une des revendications 1 à 5, **caractérisé en ce qu'**il comprend un couvercle (15) entourant la partie externe du dispositif de serrage (5) afin de collecter un matériau fondu du fusible (10) pour que le matériau fondu du fusible (10) soit recueilli à l'intérieur du couvercle de protection (15), quelle que soit la position du dispositif de serrage (5).

7. Dispositif électrique de chauffage d'air (1) selon l'une des revendications 1 à 6, **caractérisé en ce que** la rondelle de serrage (8) est choisie parmi le groupe formé de rondelles plates et de rondelles élastiques.

8. Dispositif électrique de chauffage d'air (1) selon l'une des revendications 1 à 7, **caractérisé en ce que** le dispositif de serrage (5) comprend une vis (22) et au moins un écrou (24) coopérant avec une portion filetée (23) de la tige conductrice (9) de la vis (22) pour fixer le ruban résistif (3) à la paroi (2) du logement.

9. Dispositif électrique de chauffage d'air (1) selon l'une des revendications 1 à 7, **caractérisé en ce que** le dispositif de serrage (5) comprend un rivet.

10. Dispositif électrique de chauffage d'air (1) selon l'une des revendications 1 à 9, **caractérisé en ce que** la tige de serrage (9) du dispositif de serrage est disposée afin de s'étendre à travers un alésage (21) formé dans la paroi (2) du logement.

11. Moteur, comprenant au moins un dispositif électrique de chauffage d'air (1) selon l'un des revendications 1 à 10.

12. Véhicule, **caractérisé en ce qu'**il comprend un moteur selon la revendication 11.

13. Véhicule selon la revendication 12, **caractérisé en ce qu'**il comprend au moins un dispositif électrique de chauffage d'air (1) selon l'un des revendications 1 à 10.

Fig 1

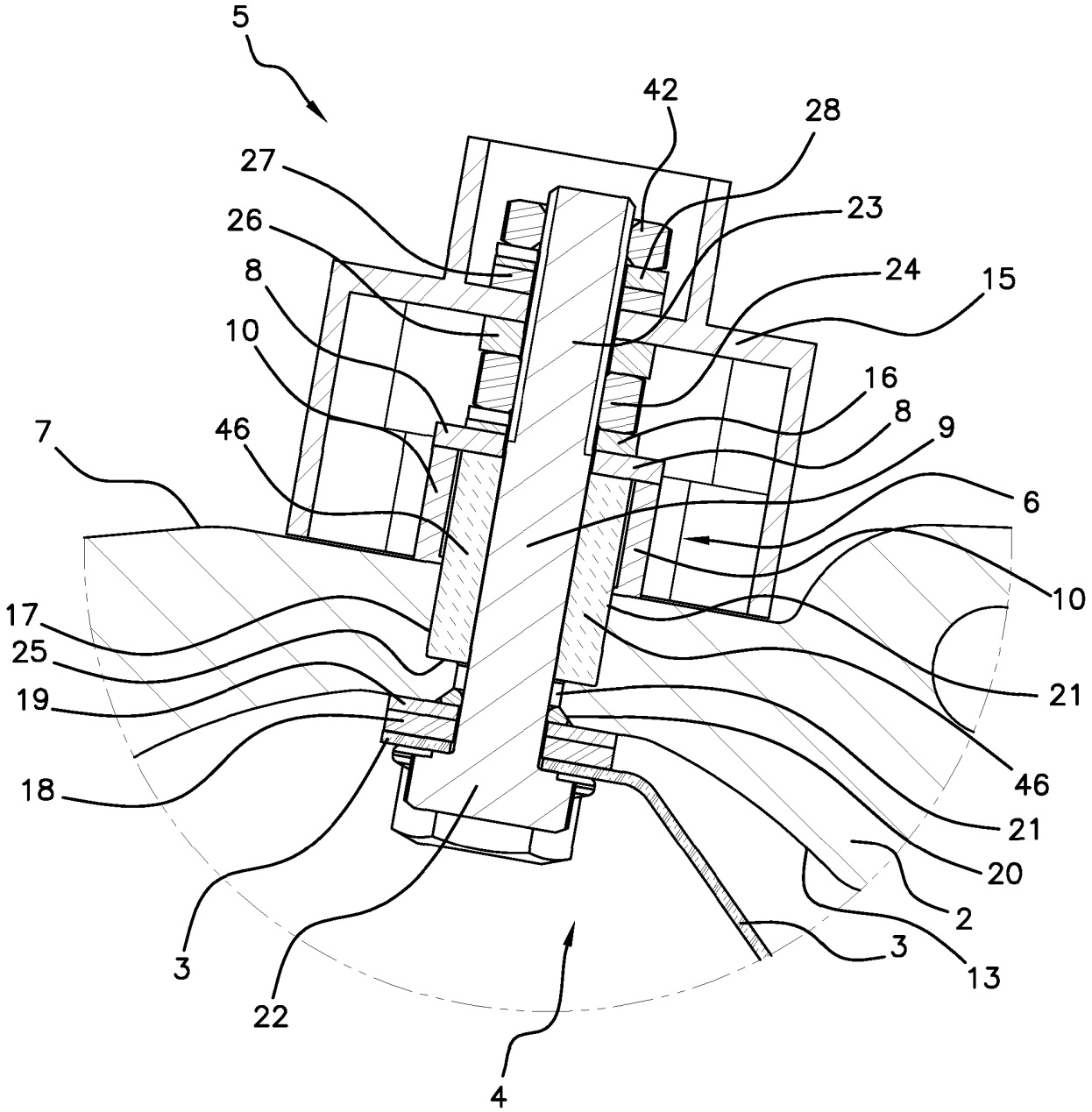
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Fig 2

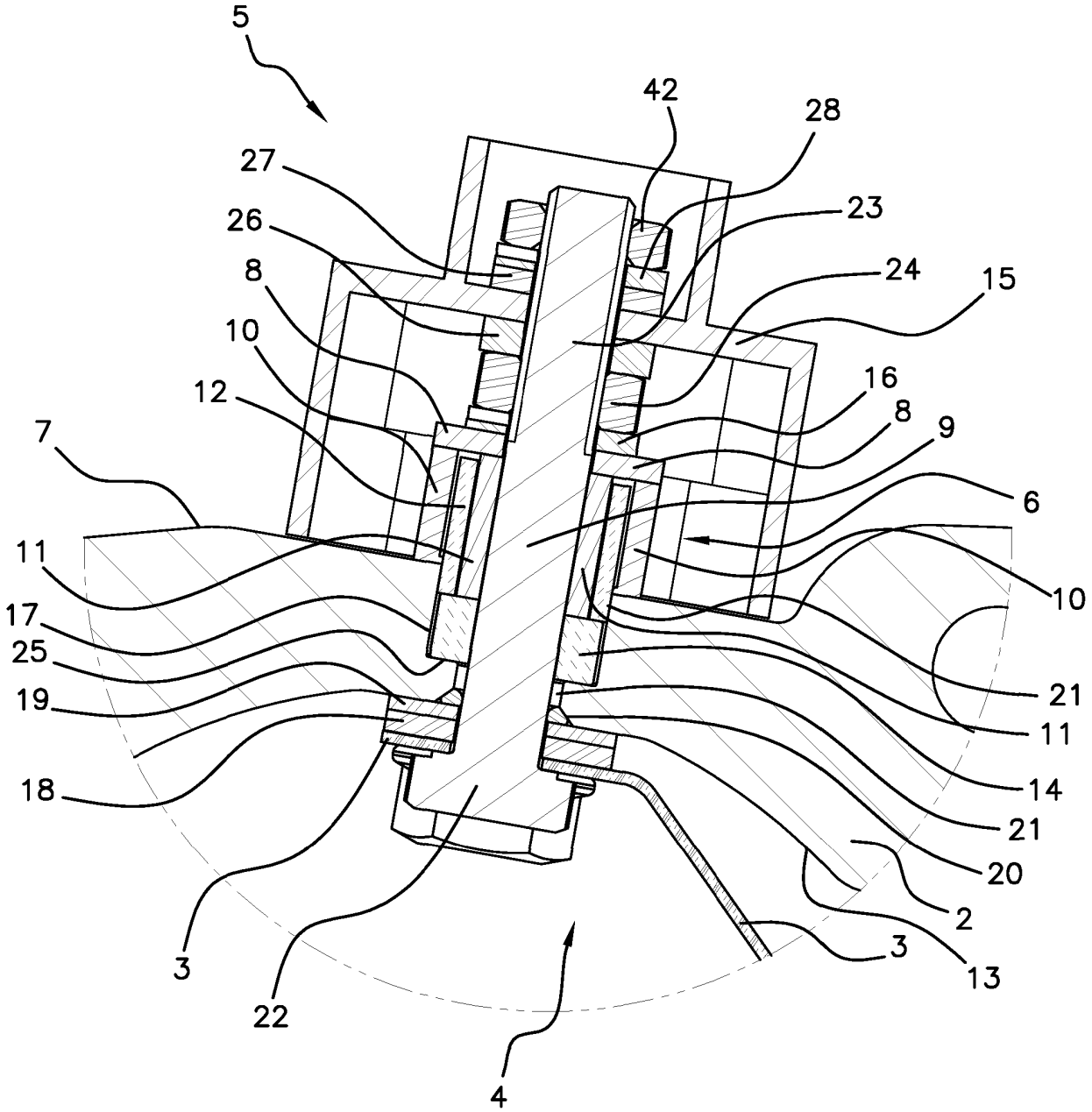
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Fig 3

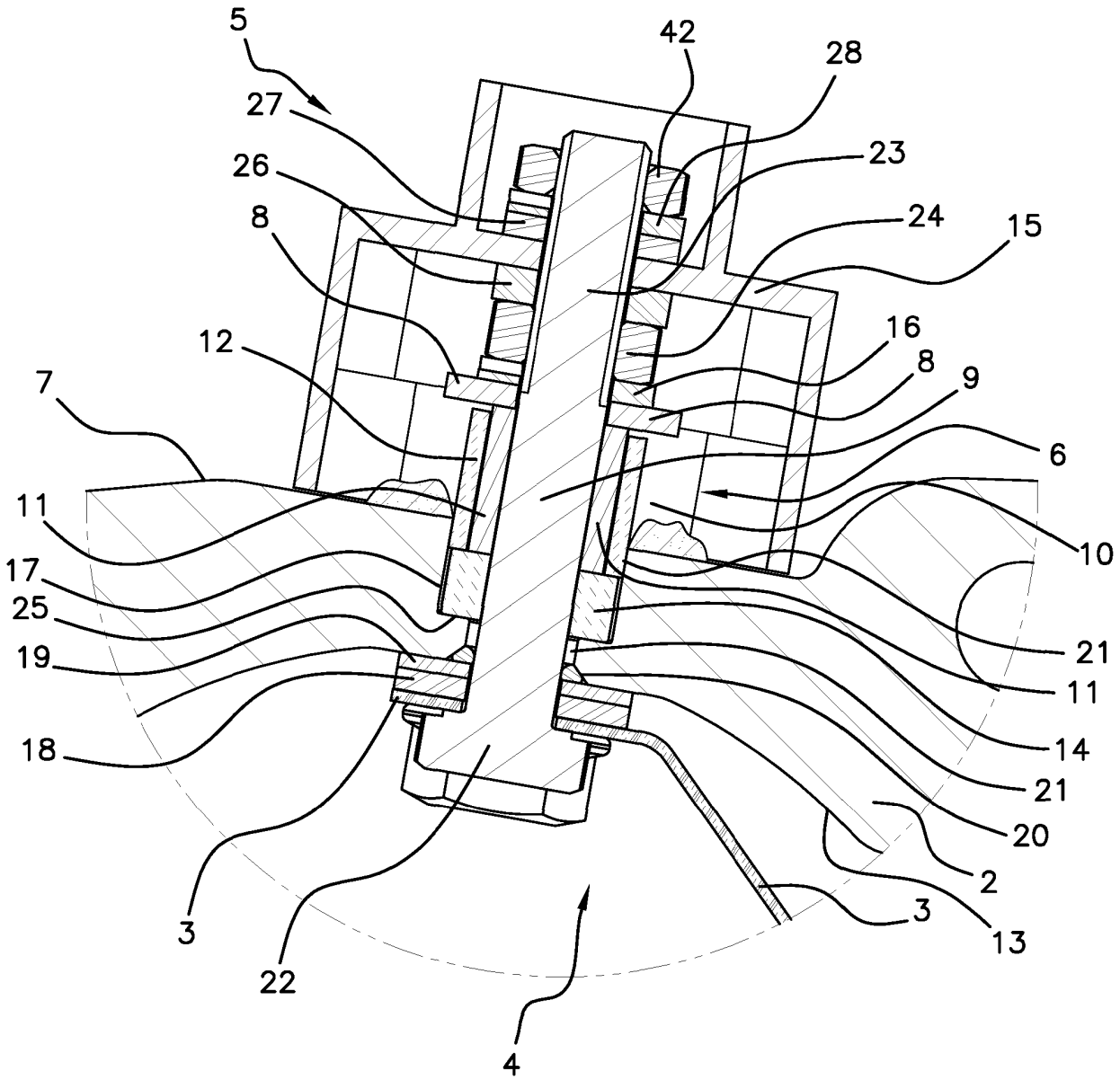
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Fig 4

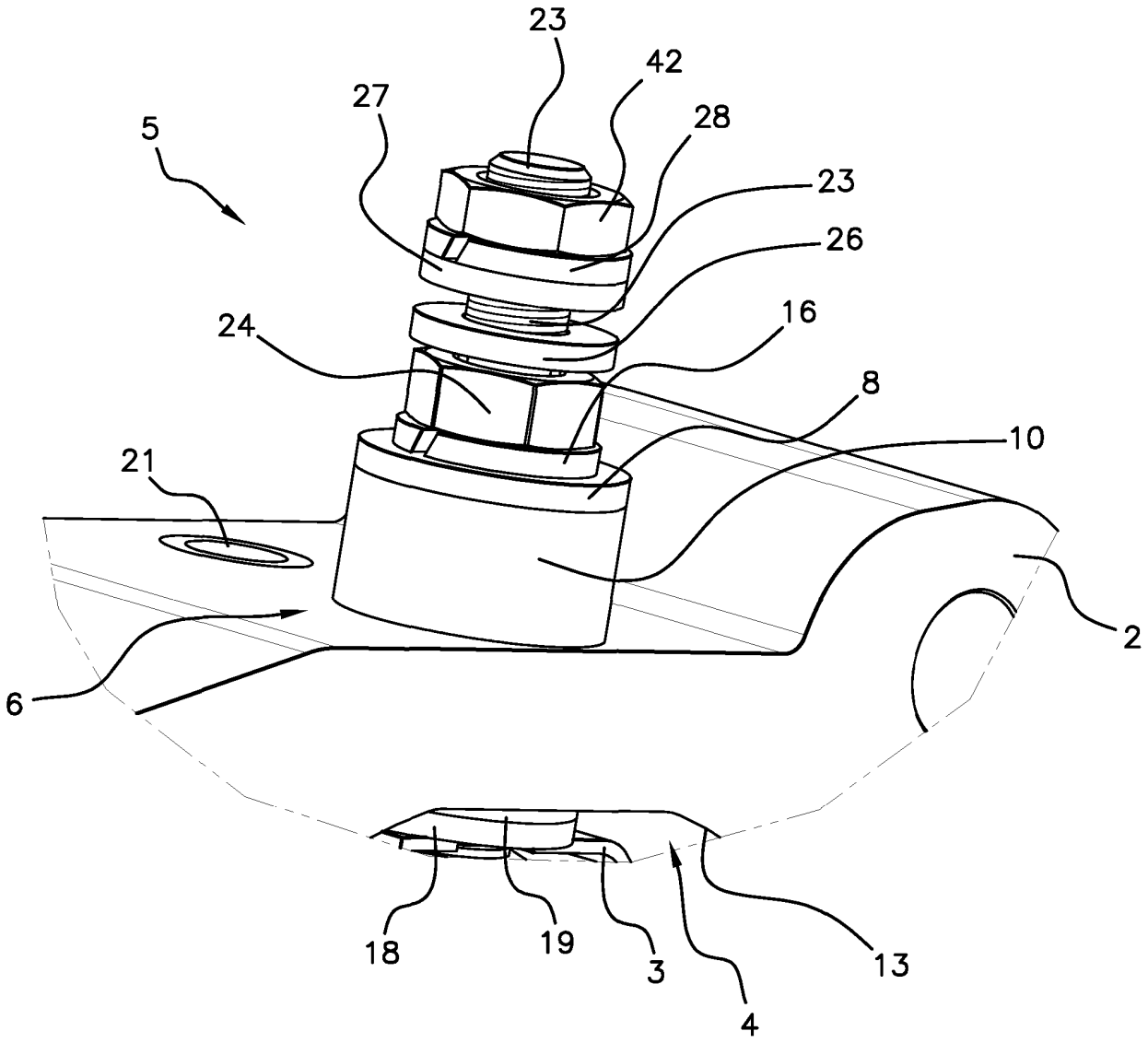

Fig 5

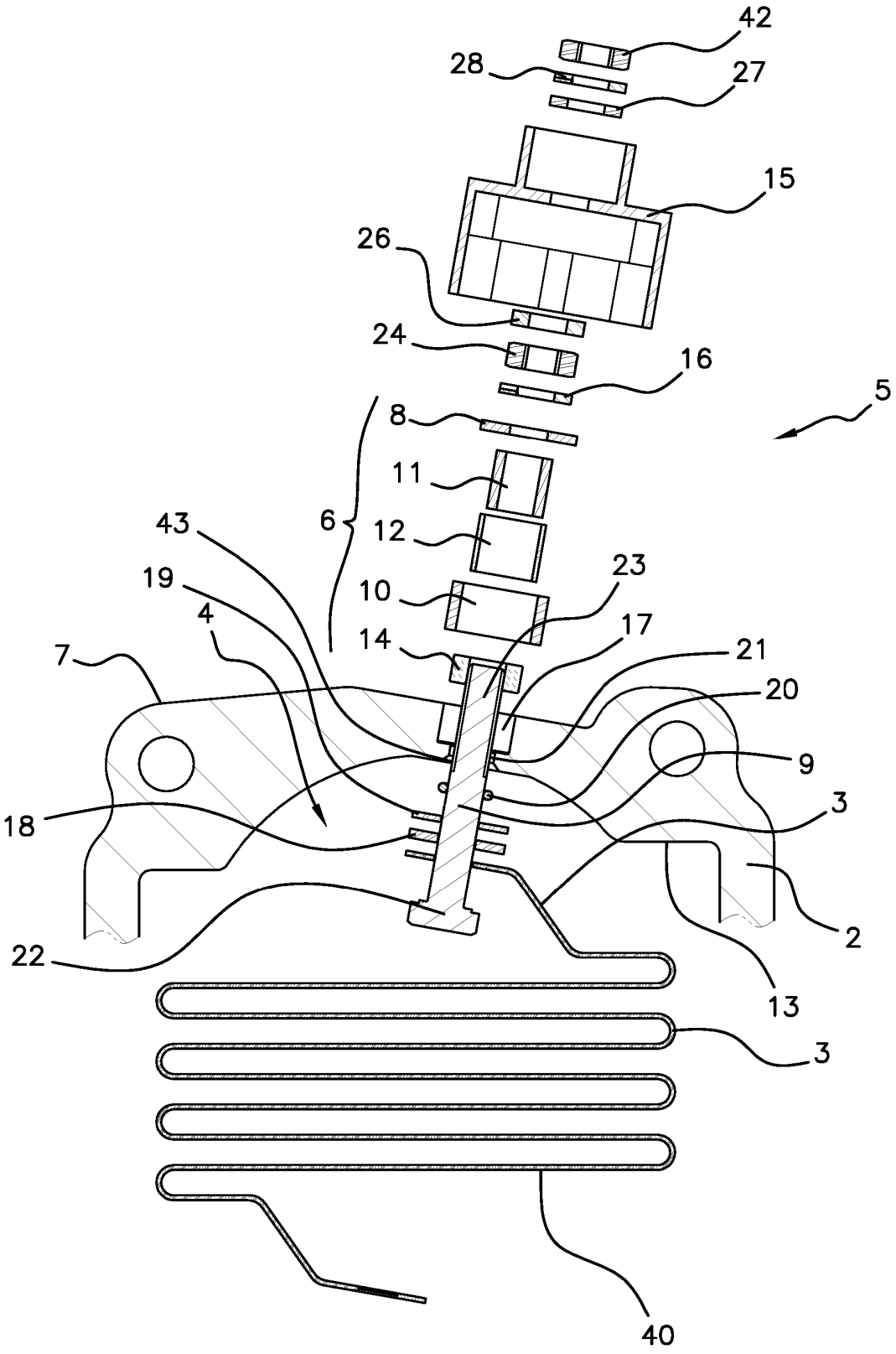
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Fig 6

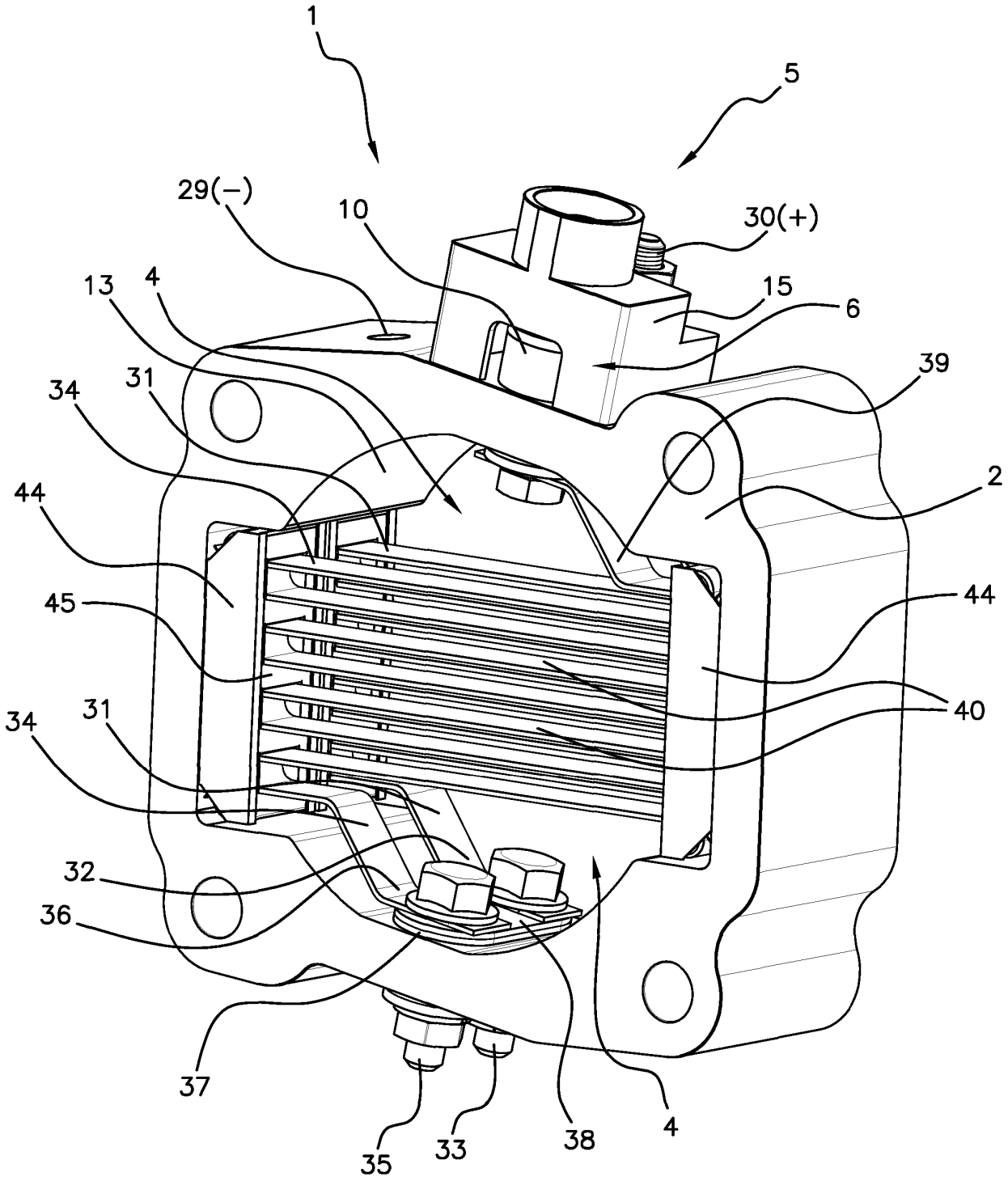
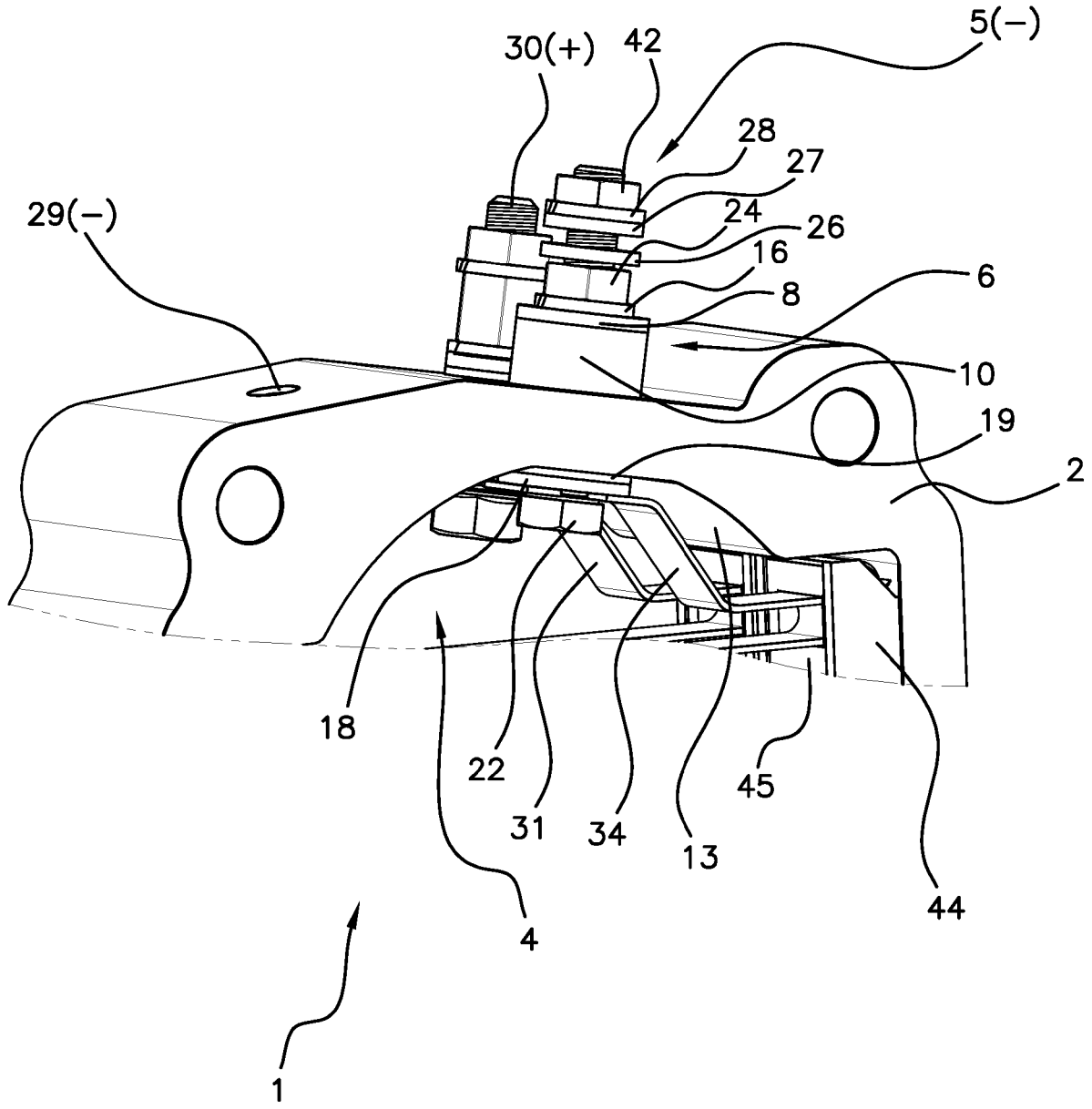


Fig 7



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Patent documents cited in the description

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