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(54) HEATING DEVICE

(57) A heating device (1) is provided suitable to heat a component (10) of an engine of vehicles, comprising an actuator (3) comprising: a conductive wire (30) in metal alloy, suitable to heat up by the Joule effect, consisting of material with resistivity between 0.5 and 100 Ω / m, a coating (31) of the conductive wire (30) of the electrically insulating type having a thickness comprised between 1 μm and 100 μm, the conductive wire (30) and the coating (31) having a single dimension of main extension, a first layer (32), consisting of a thermally conductive, metal lamina, placed in adherence with the component (10), and having a membrane conformation, i.e. with two main dimensions with respect to the third, and a second layer (33) arranged more externally with respect to the first layer (32) the conductive wire (30) and the coating (31) made from polymeric, heat-insulating material and also having a membrane conformation and totally covering the first layer (32).

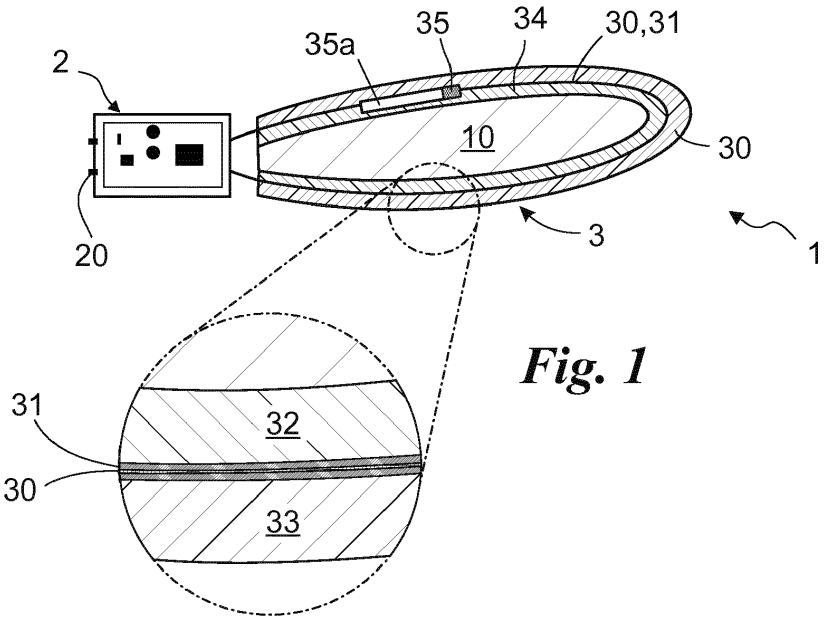

Fig. 1

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Description

[0001] The present invention relates to a heating device for engine of the type as recited in the preamble of the first claim.

[0002] In particular the invention relates to a heating device for an engine suitable to heat elements exposed to harsh environmental conditions which, due to their freezing, may make it impossible or difficult to start the vehicle.

[0003] Some systems suitable for heating engine parts are known in the current state of the art.

[0004] They use, for example, in the automotive field, electrified catalysts and active heating systems applied to the engine exhaust to achieve high temperatures from the earliest stages of starting the car.

[0005] Such systems may be constituted by actuators electrically individually controlled and arranged suitably in the vicinity of critical engine components or they may be electric blankets, conceptually similar to those in use for example in the automotive field for heating tyres.

[0006] Other systems use heated injectors to introduce Urea in the after-treatment apparatus; other injectors are heated by the injection of Ethanol.

[0007] Most of the systems briefly mentioned respond to a "point to point" logic.

[0008] This term refers to the types of connections which connect by direct communication to one network terminal or another, consequently they have a structure which generally requires a large number of electrical connections for each single system.

[0009] In fact, among the conventional technologies two different types of heaters for engines may be noted: a control system with independent actuators and a control system with feedback actuators.

[0010] The control system with independent actuators comprises, briefly, a source of electricity, one or more activation signals, a relay box required to provide power to the heaters and a series of heaters.

[0011] Through the activation signal the relay box electrically pilots the actuators which begin to heat the parts they are applied to, until the deactivation of the relay box by means of the activation signal/s.

[0012] Therefore this type of system functions substantially by means of a switch, which is turned on or off in a manually controlled manner.

[0013] The control system with feedback actuators comprises, instead, in short, a source of electricity, an activation signal of the entire control system, a control unit, one or more decouplers, one or more actuators and one or more sensors.

[0014] The entire system can be activated by means of the activation signal, while the control unit, automatically decides whether or not to activate the actuators based on feedback received from the sensors, placed on the elements to be heated, and the temperature objective provided for. Upon achieving the target temperature, the control unit manages the definitive cut-out of the actuator, its putting into stand-by or a modulation of the same. The decouplers, possibly integrated into the control unit, are intended to supply the necessary power to the single actuator in the correct form: they receive an activation signal from the control unit and amplify such a signal upon a request for power of the single actuator They can also, if required, modulate the power according to the logic implemented on the control box.

[0015] Consequently this type of system is an evolution of the independent actuators system which allows monitoring of the characteristic parameters relative to the elements to be heated in such a way that the switching on or off of the actuators is controlled on the basis of said parameters.

[0016] The prior art described has several significant drawbacks.

[0017] In particular, the previously described systems make it possible primarily to heat the elements of interest according to a switch logic, and therefore provide an energy outlay which, in certain conditions, may be vain.

[0018] Particularly with regard to the independent actuation systems, the manual switching on or off of the heaters leads, or may easily lead, to a waste of energy in the moment in which the components to be heated reach the desired temperature. It is also not possible to vary the temperature in output of the heaters, or, when possible, the improved performance leads to an increase in the number of electrical connections needed to connect the heaters, decouplers, sensors and control unit.

[0019] The increase in the number of connections may result in turn in problems from the point of view of space.

[0020] Therefore another major drawback is the versatility of the systems described. They are not suitable for every type of system for performance reasons, for example if the system with independent actuators is implemented in an apparatus that requires great sensitivity, or space, if the feedback system is placed in small volumes.

[0021] Another drawback is the lifetime of the components, as well as costs. Non-optimized systems such as that described have shorter life cycles, for example of the actuators, and therefore greater costs.

[0022] Another drawback of no lesser importance is the low efficiency of many known heaters.

[0023] In this situation the technical purpose of the present invention is to devise a heating device for engines able to substantially overcome at least in part the drawbacks mentioned above.

[0024] Within the sphere of said technical purpose one important aim of the invention is to obtain a heating device for engines which has a high energy efficiency.

[0025] Within the sphere of said technical purpose one important aim of the invention is to obtain a heating device for engines which comprises a smaller number of electrical connections than those of the prior art.

[0026] Another important aim of the invention is to provide a heating device able to carry out its functions in an optimised manner, i.e. control a plurality of parameters

useful to the heating of elements, for example of an engine.

[0027] Moreover, a further aim of the invention is to increase the useful life of the elements included in the system and, also as a consequence of what has just been said, to reduce the costs needed for the maintenance of the heating device.

[0028] The technical purpose and specified aims are achieved by a heating device as claimed in the appended claim 1. Preferred embodiment examples are described in the dependent claims.

[0029] The characteristics and advantages of the invention are clearly evident from the following, detailed description of preferred embodiments thereof, with reference to the accompanying drawings, in which:

Fig. 1 shows a diagram of the heating device for engines according to the invention with a magnification;

Fig. 2 illustrates the switch inside the heating device according to the invention; and

Fig. 3 is an application example of the pressure heating device on a "blow-by" circuit.

[0030] Herein, the measures, values, shapes and geometric references (such as perpendicularity and parallelism), when used with words like "about" or other similar terms such as "approximately" or "substantially", are to be understood as except for measurement errors or inaccuracies due to production and/or manufacturing errors and, above all, except for a slight divergence from the value, measure, shape or geometric reference which it is associated with. For example, said terms, if associated with a value, preferably indicate a divergence of not more than 10% of said value.

[0031] In addition, where used terms such as "first", "second", "upper", "lower", "main" and "secondary" do not necessarily refer to an order, a priority relationship or relative position, but may simply be used to more clearly distinguish different components from each other.

[0032] With reference to the Drawings, reference numeral **1** globally denotes the heating device for engines according to the invention.

[0033] The engine which the heating device 1 can be connected to may be of the automotive, aeronautical, nautical or other type. It is, however, preferably for a car engine.

[0034] The engine consists of a plurality of components **10** including some which may be subject to the freezing of their surfaces, or of the liquid comprised therein in the case of very low temperatures impairing the functionality of the entire engine.

[0035] In particular, when in the presence of "blow-by" engines, the water vapour normally present in the circuit may block the said circuit. This obstruction can result in more severe cases in a failure to expel the gases present in the oil sump with consequent raising of the pressure and risk of damage to the oil seals on the crankshaft bearings. Damage of this type can be harmful and make the vehicle unable to operate.

[0036] Even the urea tanks in modern, low environmental impact engines may be subject to freezing.

[0037] The heating device for engines 1 is an apparatus also preferably connectable to an electric circuit board **2** known per se.

[0038] Such electric circuit board 2 is preferably interfaced with a control box for example of the type conventionally present on motorised vehicles in the automotive sector. It comprises at least one connector **20**. Such connector is for example a socket suitable to connect the device 1 to the control unit. The connector 20 and the board 2 are also preferably integrated in a single piece.

[0039] The heating device 1 comprises at least one actuator **3**.

[0040] Such actuator 3 may be present in the heating device 1 in a single number, or may be flanked by other actuators 3 having the same structure.

[0041] In any case, all the actuators 3 are powered by the electric circuit board 2, the electric circuit board 2 is thus suitable to deliver electric power to at least one actuator.

[0042] The actuator 3 has preferably a flexible sandwich structure and is suitable to surround at least partially at least one component 10 of the engine.

[0043] The sandwich structure of the actuator 3 preferably comprises a conductive wire **30**, a coating **31** of said conductive wire 30, a first layer **32** and a second layer **33**. The conductive wire 30 is suitable to heat up by the joule effect. It consists of an element having only one dimension of a main extension, in detail it may be made of a resistive wire or tape. It is preferably of the electrically resistive type and placed in electrical connection with the electric circuit board 2. In particular, it is placed in connection with the electric circuit board 2 by means of the connectors 20.

[0044] The resistive wire 30, when shaped as a tape preferably has dimensions of the perpendicular cross-section respectively comprised between 10 and 300 μm, on the short side, and between 100 μM and 5 mm on the long side.

[0045] The resistive wire 30, when not a tape but with a cross-section of dimensions similar to each other, has for example a circular cross-section, but may also have a square cross-section or otherwise, with a diameter comprised between 50 μm and 1 mm.

[0046] The conductive wire 30 is for example made from material with resistivity between 0.5 and 100 Ω / m. Such material is preferably an austenitic alloy of nickel and chromium (Ni-Cr), commercially named Nikrothal, more in detail a preferred alloy is composed of C 0.1%, Si 1%, Mn 1%, 2% Fe 2%, Cr 20%, Ni Bal. Alternatively, the conductive wire 30 is in an alloy of Iron, Chromium and Aluminium (Fe-Cr-Al), commercially known as Khantal, more in detail an example of such alloy is composed of C 0.1 %, Si 0.7%, Mn 0.5%, Al 4.8%, Cr 21 %, Fe Bal.

[0047] In general all the alloys have the common denominator of having a quantity equal to at least 10% of Chromium in them.

[0048] The coating 31 is preferably of the electrically insulating type. In addition it may have a size of between 1 μm and 100 μm. Preferably the material used for the coating 31 is polymeric, more preferably Ethylene Tetrafluoroethylene (ETFE). It covers the wire 30 and is thus shaped like the latter. It provides, most advantageously, an electrically insulating and not thermally insulating coating. The first layer 32 is preferably placed in adherence with a component 10, on the one side, and a coating 31 on the other. It may have a membrane or plate shape, i.e. may have two main dimensions with respect to the third. In this case, the conductive wire 30 and the coating 31 are arranged along the upper surface **32a** of the first layer 32, parallel to the same, so as not to leave large convex areas of said upper surface 32a devoid of contact of said wire 30 with the coating 31. The term large convex areas means in particular circular areas with a diameter of 5 cm, more preferably of 2 cm.

[0049] For example, Fig. 3 shows a first layer 32 having a tubular surface (with a diameter of the tube much larger than the diameter of the conductive wire 30) and a conductive wire wound substantially in a spiral along said tube. Alternatively, the first layer 32 extends mainly along a single dimension.

[0050] The first layer 32 is preferably made from a thermally conductive lamina. Said lamina is in fact preferably suitable to transfer the heat produced electrically to the components 10 which the actuator 3 adheres to.

[0051] Consequently, the first layer 32 is preferably made of metal and / or composed of material with a coefficient of thermal conductivity at least greater than 20 W / (m * K), more in particular such material is aluminium. The thickness is then preferably between 20 μm and 2 mm.

[0052] The second layer 33 is preferably a coating of thickness between 0.1 mm and 30 mm. It is arranged more externally than the others and is preferably composed of a thermally insulating material, suitably with a coefficient of thermal conductivity of less than 0.04 W / (m * K). In particular such material is polymeric, for example flexible elastomeric foam (FEF), more particularly polyethylene foam with closed cells.

[0053] The second layer 33, like the first layer 32, preferably has a membrane or plate conformation, that is to say, may have two main dimensions with respect to the third. It preferably totally covers the first layer 32 and the wire 30 with the coating 31. It also preferably has the same shape or form as the first layer 32.

[0054] The actuator 3 thus composed further comprises an automatic switch **35** in electrical connection with the conductive wire 30. Such switch 35 is preferably suitable to automatically open the circuit, so as to no longer have a heating by joule effect, in the case of too high a temperature. It is in electrical connection with the electric circuit board 2 and is suitable to vary the temperature of said actuator 3 keeping the electric power delivered by the electric circuit board 2 constant.

[0055] In a preferred embodiment the switch 35 is composed of two metal laminae, of different materials and different thermal expansion coefficients, in contact with each other and the ends of which are in contact with an electrical connection. The laminae are placed on the free side so as to maintain the position in contact with the electrical connection. When the temperature changes, due to the different change in length of the two laminae, said laminae place themselves in a position other than the rest position, interrupting the contact between the lamina and the electrical connection. The variation in length, cross-section and other geometric shapes of the laminae also varies the cut-in temperature.

[0056] Alternatively, the switch 35 comprises a temperature sensor and a switch. The temperature sensor **35a** is for example suitable to measure the temperature of the component 10 and may be of the type already known in the current state of the art, such as piezoelectric type sensors. The connector **35b** is instead a switch suitable to open or close an electrical connection as a function of the temperature.

[0057] As already said the connectors 20 are suitable to connect the third layer 32 to the electric circuit board 2. Therefore the electric power supplied by the electric circuit board 2 translates into the generation of a circuit and in current.

[0058] The current flows for example in the third resistive layer generating heat which is then governed through the switch 35b.

[0059] The latter is thus suitable to allow or prevent the passage of electric current inside the third layer 32.

[0060] The functioning of the heating device 1, described above in structural terms, is as follows.

[0061] The heating device 1 may be placed around the component 10 to be heated. In particular, the first layer is placed in contact with the outer surface of the component 10 so as to cover the same at least partially.

[0062] Once the device has been installed and once connected to the electric circuit board 2, for example of a vehicle, it is able, when it receives electrical power from the electric circuit board 2, to heat the component 10 it is placed on.

[0063] Heat is provided in particular by the conductive wire 30 and diffuses through the first conductive layer 32, while it is scarcely obstructed by the coating 31.

[0064] The temperature sensor 35a thus makes it possible to measure the temperature of the component 10 and consequently, when the desired temperature is reached, the switches 35b make it possible to close the electrical circuit of the third layer 32b, stopping the heat input.

[0065] The heating device 1 for an engine according to the invention achieves important advantages.

[0066] In fact, the heating device 1 is extremely efficient and has a very low thermal inertia, which results in high heat transfer rates, even higher than 90%, between

the actuator and component 10 and to fast heating of the sandwich structure. Moreover, the sandwich is extremely flexible and therefore adaptable to any geometric form, a characteristic that makes the actuator 3 universally applicable. As a result, the heating device 1 limits the energy expenditure needed to operate thanks to the intervention of the automatic switch 35 and to the particular configuration described, the actuator is able to limit itself to a given temperature, maintaining the invariance of the thermal power expressed, throughout the operating range.

[0067] In addition, the heating device 1 makes it possible in this sense to increase the life cycle of the components 10 it is placed on.

[0068] Another important advantage is the versatility of the heating device 1 which is easily attachable to an electric circuit board 2 without the need for special expedients. The latter, which can in turn be connected to engine or vehicle control units. Consequently, the heating device is able to interact with the outside world, self-diagnosing, communicating its state of operation and implementing the strategies imposed by control systems. These actions are manageable with a simple message received on a dedicated communication line by means of the electric circuit board 2, which makes the device belong to the category of "smart actuators".

[0069] From the new command functions, the reconstruction of an entire control unit, the new validation of applications and in general a series of extremely complex and costly activities would arise.

[0070] The heating device 1 avoids the aforementioned steps thus allowing a reduced outlay also from the point of view of costs.

[0071] Variations may be made to the invention without departing from the scope of the inventive concept defined in the claims.

[0072] In said sphere all the details may be replaced with equivalent elements and the materials, shapes and dimensions may be as desired.

Claims

1. Heating device (1) suitable to heat a component (10) of a vehicle engine

   - **characterised in that** it comprises an actuator (3) comprising:

     - a conductive wire (30) in metal alloy, suitable to heat up by the Joule effect, composed of material with resistivity between 0.5 and 100 Ω / m,
     - a coating (31) of said conductive wire (30) of the electrically insulating type having a thickness comprised between 1 μm and 100 μm,
     - said conductive wire (30) and said coating (31) having a single main extension dimension,
     - a first layer (32), consisting of a thermally conductive and metallic lamina placed in adherence with said component (10), and having a membrane conformation, i.e. with two main dimensions with respect to a third,
     - and a second layer (33) arranged more externally with respect to said first layer (32), said conductive wire (30) and said coating (31) made from polymeric, heat-insulating material and also having a membrane conformation and totally coating said first layer (32).

2. Heating device (1) according to the preceding claim, wherein said conductive wire (30) is an austenitic alloy of nickel and chromium (Ni-Cr).

3. Heating device (1) according to claim 1, wherein said conductive wire (30) is an alloy of Iron, Chromium and Aluminium (Fe-Cr-Al).

4. Heating device (1) according to one of the claims 1-3, wherein said conductive wire (30) and said coating (31) are arranged along the upper surface (32a) of said first layer (32), parallel thereto, so as not to leave large convex areas of said upper surface (32a) devoid of contact with said conductive wire (30) and said coating (31).

5. Heating device (1) according to the preceding claim, wherein said large convex areas are circular areas with a diameter of 5 cm.

6. Heating device (1) according to at least one preceding claim, wherein said resistive wire (30) has a circular cross-section with a diameter size comprised between 50 μm and 1 mm.

7. Heating device (1) according to at least one preceding claim, wherein said coating (31) is in Ethylene Tetrafluoroethylene (ETFE).

8. Heating device (1) according to at least one preceding claim, wherein said actuator (3) comprises an automatic switch (35) suitable to automatically open the circuit, so as to longer have the heating by joule effect, in case of too high temperature.

9. Heating device (1) according to at least one preceding claim, comprising an electric circuit board (2) interfaced with said control unit of said vehicle.

10. Heating device (1) according to the preceding claim, comprising at least one connector (20) suitable to connect said device (1) with said control unit of said vehicle, and wherein said connector (20) and said circuit board (2) are also preferably integrated in a

single piece.

Amended claims in accordance with Rule 137(2) EPC.

1. Heating device (1) suitable to heat a component (10) of a vehicle engine comprising:

   - a conductive wire (30) in metal alloy, suitable to heat up by the Joule effect, composed of material with resistivity between 0.5 and 100 Ω / m,
   - a coating (31) of said conductive wire (30) of the electrically insulating type having a thickness comprised between 1 μm and 100 μm,
   - said conductive wire (30) and said coating (31) having a single main extension dimension,
   - **characterised by** comprising:

     - a first layer (32), consisting of a thermally conductive and metallic lamina placed in adherence with said component (10), and having a membrane conformation, i.e. with two main dimensions with respect to a third,
     - and a second layer (33) arranged more externally with respect to said first layer (32), said conductive wire (30) and said coating (31),
     - said second layer (33) being made from polymeric, heat-insulating material and also having a membrane conformation and totally coating said first layer (32).

2. Heating device (1) according to the preceding claim, wherein said conductive wire (30) is an austenitic alloy of nickel and chromium (Ni-Cr).

3. Heating device (1) according to claim 1, wherein said conductive wire (30) is an alloy of Iron, Chromium and Aluminium (Fe-Cr-Al).

4. Heating device (1) according to one of the claims 1-3, wherein said conductive wire (30) and said coating (31) are arranged along the upper surface of said first layer (32), parallel thereto, so as not to leave large convex areas of said upper surface devoid of contact with said conductive wire (30) and said coating (31).

5. Heating device (1) according to the preceding claim, wherein said large convex areas are circular areas with a diameter of 5 cm.

6. Heating device (1) according to at least one preceding claim, wherein said resistive wire (30) has a circular cross-section with a diameter size comprised between 50 μm and 1 mm.

7. Heating device (1) according to at least one preceding claim, wherein said coating (31) is in Ethylene Tetrafluoroethylene (ETFE).

8. Heating device (1) according to at least one preceding claim, wherein said actuator (3) comprises an automatic switch (35) suitable to automatically open the circuit, so as to longer have the heating by joule effect, in case of too high temperature.

9. Heating device (1) according to at least one preceding claim, comprising an electric circuit board (2) interfaced with said control unit of said vehicle.

10. Heating device (1) according to the preceding claim, comprising at least one connector (20) suitable to connect said device (1) with said control unit of said vehicle, and wherein said connector (20) and said circuit board (2) are also preferably integrated in a single piece.

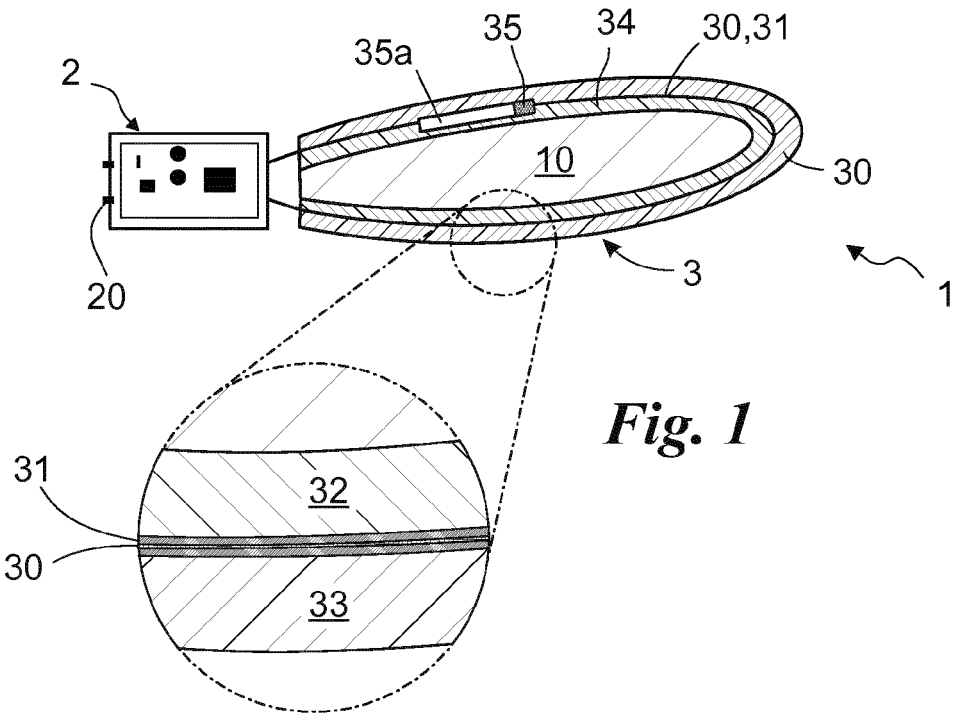

Fig. 1

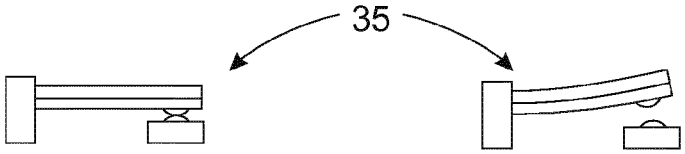

Fig. 2

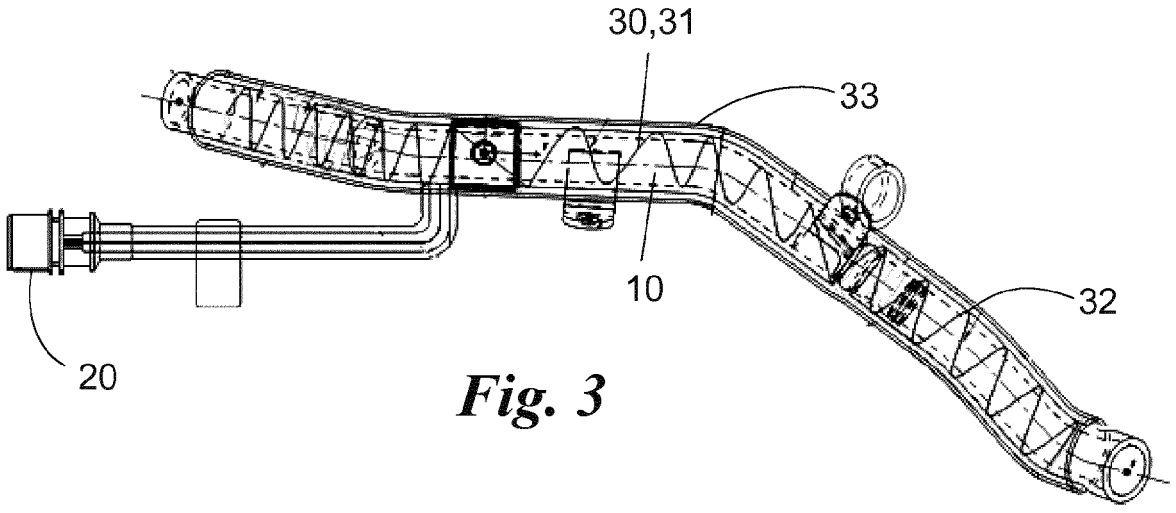

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 16 19 7604

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			TECHNICAL FIELDS SEARCHED (IPC) H05B F02N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	27 April 2017	von Mittelstaedt, A

CATEGORY OF CITED DOCUMENTS

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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