(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 611 261 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
**03.07.2013 Bulletin 2013/27**

(51) Int Cl.:
***H05B 3/46*** *(2006.01)*

(21) Application number: **12198394.4**

(22) Date of filing: **20.12.2012**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**
Designated Extension States:
**BA ME**

(30) Priority: **26.12.2011 JP 2011284127**

(71) Applicant: **Valeo Japan Co., Ltd.**
**Saitama 360-0193 (JP)**

(72) Inventors:
- **Nagano, Hideki**
  **Kumagaya-shi,**
  **Saitama 360-0193 (JP)**
- **Ida, Hiroyuki**
  **Kumagaya-shi,**
  **Saitama 360-0193 (JP)**
- **Iwasa, Akio**
  **Kumagaya-shi,**
  **Saitama 360-0193 (JP)**
- **Tanda, Kiyoshi**
  **Kumagaya-shi,**
  **Saitama 360-0193 (JP)**
- **Hayashi, Naoto**
  **Kumagaya-shi,**
  **Saitama 360-0193 (JP)**

(74) Representative: **Fauré, Marion-Laurie**
**VALEO SYSTEMES THERMIQUES**
**Propriété Industrielle**
**THS - Service Propriété Industrielle TCC**
**8 Rue Louis Lormand**
**BP 517 La Verrière**
**78320 Le Mesnil Saint Denis (FR)**

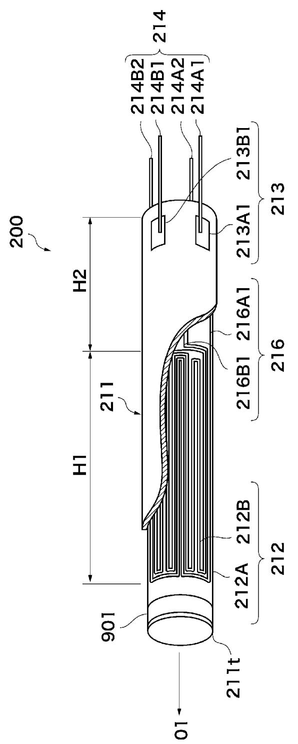
# (54) Ceramic heater and electric heating type hot water heating apparatus using the same

(57) An object of the invention is to provide a ceramic heater capable of easily switching a calorific value.

SOLUTION

In the ceramic heater 200 according to the invention comprising; a rod shaped support member 211 composed of ceramic; line shaped heating elements 212 which are buried in a side surface of the support member 211, generating heat by being energized and forming a heat generation region H1; and terminal sections 213 which are connected to the heating elements 212 and disposed on one end side of the support member 211; the number of the heating elements 212 is two or more pieces; and any of the heating elements 212 is disposed entirely of the heat generation region HI.

[FIG.1]




EP 2 611 261 A1

## Description

### TECHNICAL FIELD

**[0001]** The invention relates to a ceramic heater and, in particular, to a ceramic heater capable of easily switching a calorific value.

### BACKGROUND ART

**[0002]** A hybrid electrical vehicle (hereinafter, may be called also an HV vehicle) or an electrical vehicle (hereinafter, may be called also an EV vehicle) has a problem in that since a calorific value of an internal combustion engine (hereinafter, may be called also an engine) is small or an internal combustion engine itself does not exist, a sufficient amount of heat cannot be obtained by a heating system which employs a hot water type heater core which makes use of engine exhaust heat supplied from engine cooling water as in a conventional gasoline vehicle.

**[0003]** To solve the problem, there is proposed a technology for mounting a heating device on a vehicle as an auxiliary heat source for making up for the deficiency of exhaust heat of an engine in an HV vehicle and as an alternate heat source in place of an engine in an EV vehicle, wherein the heating device is including a heat transfer block (first housing) which accommodates an electrically heated wire as a heating element and an outside case (second housing) which accommodates the heat transfer block and forming a flow path through which a heat transfer medium flows between the heat transfer block and the outside case (refer to, for example, Patent Literature 1).

**[0004]** Incidentally, a ceramic heater is used to directly heat a liquid. As the ceramic heater, a ceramic heater for preventing an occurrence of damage due to a heat shock is disclosed (refer to, for example, Patent Literature 2).

### CITATION LIST

### PATENT LITERATURE

**[0005]**

Patent Literature 1: JP 2011-143781 A
Patent Literature 2: JP 2006-236617 A

### SUMMARY OF THE INVENTION

### PROBLEMS TO BE SOLVED BY THE INVENTION

**[0006]** The heating device described in Patent Literature 1 has a problem in that since the heat transfer block being used is composed of a cast product, it is difficult to reduce a size and weight of the heating device. Further, since the heat transfer medium is heated via the heat transfer block, a problem arises in that a prompt heating request cannot be coped with. Incidentally, although Patent Literature 1 discloses to use a sheathed heater including a coil-like heating wire such as a nichrome wire and the like inserted into a metal pipe as the electrically heated wire, Patent Literature 1 does not disclose to use a ceramic heater having a higher watt density. Although Patent Literature 2 discloses a ceramic heater, Patent Literature 2 does not disclose a ceramic heater suitable for a vehicle air-conditioning apparatus. Further, Patent Literature 2 does not disclose to easily switch a calorific value of a ceramic heater.

**[0007]** An object of the invention is to provide a ceramic heater capable of easily switching a calorific value. Further, an object of the invention is to provide an electric heating type hot water heating apparatus capable of efficiently performing heating and having a reduced size and weight.

### MEANS FOR SOLVING THE PROBLEMS

**[0008]** A ceramic heater according to the invention comprises: a rod shaped support member composed of ceramics; a line shaped heating element buried in a side surface of the support member, generating heat by being energized, and forming a heat generation region; and a terminal section connected to the heating element and disposed on one end side of the support member; wherein the number of the heating elements is two or more pieces; and any of the heating elements is disposed entirely of the heat generation region.

**[0009]** In the ceramic heater according to the invention, it is preferable that the heating elements have first heating element and second heating element, two pieces of which are configured as one set; the first heating element and the second heating element form a heater pattern including a basic wiring pattern; and the basic wiring pattern includes a wiring pattern for forming a partition region, having an opening section, by disposing the first heating element and a wiring pattern having the second heating element disposed in the partition region. Even if any of the first heating element or the second heating element is energized, heat can be generated at a heat generation region.

**[0010]** In the ceramic heater according to the invention, it is preferable that the partition region is a region formed by making one round trip by the first heating element passing one end of the opening section and detouring and returning to the other end of the opening section; the second heating element form a wiring pattern making two or more round trips, and a part or all of the wiring pattern of the second heating element is disposed in the partition region. A calorific value can be easily switched stepwise.

**[0011]** In the ceramic heater according to the invention, it is preferable that the partition region is a region formed by making one round trip by the first heating element passing one end of the opening section and detouring and returning to the other end of the opening section; the second heating element forms a wiring pattern making one round trip; and the wiring pattern of the second heating element is disposed in the partition region. A magnitude of the calorific value can be easily switched.

**[0012]** In the ceramic heater according to the invention, it is preferable that the support member includes a hollow section extending in an axis direction of the support member, an extreme end hole disposed on an extreme end on a side opposite to a side where the terminal sections of the support member are disposed, and a side surface hole disposed on the side surface of the support member. A heat transfer medium can be efficiently heated.

**[0013]** In the ceramic heater according to the invention, it is preferable that the support member sequentially disposes the heat generation region, a sparse region having a wiring density lower than the heat generation region, and the terminal sections along the axis direction; and the side surface hole is disposed in the sparse region. Since the heat transfer medium flowing inside of the support member can be heated in entirely of the heat generation region, efficiency of heating can be further improved. Further, since the sparse region generates no heat or has a small calorific value, even if the side surface hole is disposed, a temperature does not become uneven in a circumferential direction of the support member, and thereby the heat transfer medium can be more uniformly heated.

**[0014]** In the ceramic heater according to the invention, it is preferable that a part or all of the heating element is formed in a spiral shape. The heat transfer medium can be more uniformly heated in a circumferential direction of the support member.

**[0015]** In the ceramic heater according to the invention, it is preferable to comprise a vibration-proof member disposed on the side surface of the support member. A damage of the ceramic heater due to a vibration can be prevented.

**[0016]** In the ceramic heater according to the invention, it is preferable that a part or all of a surface of the ceramic heater in contact with a liquid as a heating object is subjected to a hydrophilic process. A damage of the ceramic heater due to a heat shock can be prevented by suppressing a generation of bubbles of the heat transfer medium.

**[0017]** An electric heating type hot water heating apparatus according to the invention includes the ceramic heater according to the invention.

## EFFECTS OF THE INVENTION

**[0018]** The invention can provide a ceramic heater capable of easily switching a calorific value. Further, the invention can provide an electric heating type hot water heating apparatus capable of efficiently performing heating and having a reduced size and weight.

## BRIEF DESCRIPTION OF DRAWINGS

**[0019]**

FIG. 1 is a partially cutaway perspective view of a ceramic heater according to a first embodiment.
FIG. 2 is a development view illustrating a heater pattern of the ceramic heater illustrated in FIG. 1 as a first example of the heater pattern.
FIG. 3 is a development view illustrating a second example of the heater pattern.
FIG. 4 is a development view illustrating an example of a modification of the heater pattern.
FIG. 5 is a perspective view illustrating a side surface of a support member of a ceramic heater according to a second embodiment when the side surface is seen therethrough.
FIG. 6 is a longitudinal broken sectional view illustrating an example of an electric heating type hot water heating apparatus according to the embodiment.

## DESCRIPTION OF EMBODIMENTS

**[0020]** An aspect of the invention will be explained below referring to accompanying drawings. The embodiments explained below are examples of the invention, and the invention is not restricted by the embodiments. Note that, in the description and the drawings, it is assumed that components denoted by the same reference numerals show the same components each other. The invention may be variously modified as long as the modifications achieve an effect of the invention.

**[0021]** FIG. 1 is a partially cutaway perspective view of a ceramic heater according to a first embodiment. In the ceramic heater 200 according to the first embodiment comprising: a rod shaped support member 211 composed of ceramics; line shaped heating elements 212 which are buried in a side surface of the support member 211, generating heat by being energized, and forming a heat generation region H1; and terminal sections 213 which are connected to the heating elements 212 and disposed on one end side of the support member 211; the number of the heating elements 212 is two or more pieces; and any of the heating elements 212 is disposed entirely of the heat generation region H1.

**[0022]** The support member 211 is a rod shaped sintered body composed of ceramics. The ceramics is, for example, alumina, silicon nitride, aluminum nitride, and silicon carbide. The rod shape means a shape which has a width narrow and slender to a length and is, for example, a columnar shape, a strip shape, and a cylindrical shape. The support member 211 has a lateral cross section of, for example, a circular shape, an elliptical shape, a rectangular shape, a square shape, a triangular shape, and a polygonal shape. FIG. 1 shows a mode in which the support member 211 is of the columnar shape.

**[0023]** A vibration-proof member 901 is preferably disposed on a side surface of the support member 211. The vibration-proof member 901 is more preferably disposed on a side surface on an extreme end 211t side opposite to the side where the terminal sections 213 are disposed. When a vibration is transmitted to the ceramic heater 200, the extreme end 211t side opposite to the side where the terminal sections 213 are disposed vibrates with a large amplitude using the terminal sections 213 side as a fulcrum. Although it is intended to suppress the amplitude by holding a periphery of the extreme end 211t side, since ceramics is fragile, there is a possibility that a surface of the support member 211 is damaged by collision between an amplitude suppressing holding member and the surface. Thus, the provision of the vibration-proof member 901 can improve vibration resistant property of the ceramic heater 200 without the collision between the amplitude suppressing holding member and the surface of the support member 211. A material of the vibration-proof member 901 is preferably a material having a relatively high melting point and is, for example, metal such as iron, copper, titanium, and the like and an alloy such as stainless steel, and the like. The vibration-proof member 901 may be formed integrally with the ceramic heater 200 by baking with fitting, for example, a ring shaped metal or alloy around an outer circumferential surface of the ceramic heater 200 or may be formed independently of the ceramic heater 200.

**[0024]** The heating elements 212 and drain wires 216 connected to the heating elements 212 are buried in the side surface (circumferential surface) of the support member 211. FIG. 1 illustrates an example of a mode in which two heating elements, i.e., a first heating element 212A and a second heating element 212B are provided as each of the heating elements 212. Each of the drain wires 216 has an anode side drain wires 216A1 and a cathode side drain wire (not illustrated) connected to the first heating element 212A and an anode side drain wires 216B1 and a cathode side drain wire (not illustrated) connected to the second heating element 212B. Any of the heating elements 212 and the drain wires 216 is a resistive element mainly composed of a high melting point metal, for example, tungsten, molybdenum, rhenium, and the like and is formed by a method of printing and the like. The heating elements 212 substantially generate heat by being energized and form the heat generation region H1. That is, the heat generation region H1 is a region where a heater pattern is formed. The heat generation region H1 is preferably a region which covers an entire circumference of the support member 211. In contrast, the drain wires 216 are used to energize the heating elements 212. The drain wires 216 are a resistive element having a resistance value set lower than the heating elements 212 and form a sparse region H2 which does not substantially generate heat even if energized. Here, substantially generating heat means that an element itself generates heat and makes a heat generation amount in a degree in which the element functions as a heater.

**[0025]** The terminal sections 213 and lead wires 214 joined to the terminal sections 213 are disposed on an outer surface of the support member 211. Each of the terminal sections 213 has an anode side terminal section 213A1 and a cathode side terminal section (not illustrated) for the first heating element 212A and an anode side terminal sections 213B1 and a cathode side terminal section (not illustrated) for the second heating element 212B. Each of the lead wires 214 has an anode side lead wires 214A1 and a cathode side lead wire 214A2 for the first heating element 212A and an anode side lead wire 214B1 and a cathode side lead wires 214B2 for the second heating element 212B. The heating elements 212 and the terminal sections 213 are electrically connected via the drain wires 216, respectively, and when the lead wires 214A1 and 214A2 are energized, the first heating element 212A generate heat, whereas when the lead wires 214B1 and 214B2 are energized, the second heating element 212B generate heat. As described above, since the respective heating elements 212A and 212B can be independently subjected the energization control, a calorific value can be easily switched. Further, the support member 211 is preferably disposed with a detection electrode (not illustrated) for preventing energization without the heat transfer medium.

**[0026]** FIG. 2 is a development view illustrating a heater pattern of the ceramic heater illustrated in FIG. 1 as a first example of the heater pattern. The heating elements preferably have the first heating element 212A and the second heating element 212B, two pieces of which are configured as one set. The first heating element 212A and the second heating element 212B do not three-dimensionally intersect each other and any of the first heating element 212A and the second heating element 212B are disposed entirely of the heat generation region H1. When the heat generation region H1 is partitioned by an optional width in an axis direction O1 and a circumferential direction P1, it is preferable that there is no region in which the first heating element 212A or the second heating element 212B is eccentrically located. Since a heater temperature becomes uniform in the heat generation region H1 and a temperature of a heat transfer medium can be prevented from being locally increased, a damage of the ceramic heater 200 due to a heat shock can be prevented by suppressing a generation of bubbles.

**[0027]** It is preferable that the first heating element 212A and the second heating element 212B form a heater pattern 250 including a basic wiring pattern U1; and that the basic wiring pattern U1 includes a wiring pattern for forming a partition region F1, having an opening section 217, by disposing the first heating element 212A and a wiring pattern having the second heating element 212B disposed in the partition region F1. The second heating element 212B is disposed in the partition region F1 passing through the opening section 217. Since a heat generation region, which is formed when the first heating element 212A generates heat, and a heat generation region, which is formed when the second heating element 212B generates heat, can be repeatedly formed by providing the basic wiring pattern U1, even if any ones of the first heating element 212A or the second heating element 212B is energized, heat can be generated at the heat generation region H1.

**[0028]** It is preferable that the partition region F1 is a region formed by making one round trip by the first heating element 212A passing one end 217A of the opening section 217 and detouring and returning to the other end 217B of the opening section; the second heating element 212B form a wiring pattern making two or more round trips; and a part or all of the wiring pattern of the second heating element 212B is disposed in the partition region F1. The term "detouring" means to exclude that the one end 217A of the opening section 217 is connected to the other end 217B thereof in a shortest distance because a region acting as the partition region F1 cannot be formed by such a connection manner. The wiring pattern of the first heating element 212A in the partition region F1 has, for example, a U-shape, a V-shape, or an arc shape. The number of times at which the second heating element 212B makes the round trip is preferably 2 to 5 times and more preferably 2 to 3 times. FIG. 2 illustrates a mode in which the number of times at which the second heating element 212B makes the round trip is 2 times as an example. Further, FIG. 2 illustrates a mode in which a part of the wiring pattern of the second heating element 212B is disposed in the partition region F1. Although not illustrated, a mode in which the wiring pattern of the second heating element 212B is entirely disposed in the partition region F1 is a mode in which the wiring pattern is disposed so that a meander section r is accommodated in the partition region F1.

**[0029]** The number of the basic wiring patterns U1 in the heater pattern 250 is one piece or plural pieces. When the number of the basic wiring patterns U1 is the one piece (not illustrated), the heater pattern is the basic wiring pattern U1. Further, the heater pattern 250 preferably includes plural pieces of the basic wiring patterns U1. As illustrated in, for example, FIG. 2, the mode which includes the plural pieces of the basic wiring patterns U1 is a mode in which a wiring pattern of a portion, in which the first heating elements 212A are coupled with each other and the second heating elements 212B are coupled with each other between a basic wiring pattern U1 and a basic wiring pattern U1 adjacent thereto, is formed in a meander shape. In the mode, one set of the anode side drain wire 216A1 and a cathode side drain wire 216A2 which are connected to the first heating element 212A and the anode side drain wires 216B1 and a cathode side drain wires 216B2 which are connected to the second heating element 212B is disposed on a heater pattern as the drain wires. Otherwise, a mode in which plural pieces of the basic wiring patterns U1 are disposed in parallel (not illustrated) may be employed. In the mode, the anode side the drain wires 216A1 and the cathode side drain wires 216A2 connected to the first heating element 212A and the anode side drain wires 216B1 and the cathode side drain wires 216B2 connected to the second heating element 212B are disposed as the drain wires, respectively in each basic wiring pattern U1. Although FIG. 2 illustrates a mode in which the basic wiring pattern U1 is repeated 4 times, the number of repetitions is not limited thereto.

**[0030]** The ceramic heater having the heater pattern 250 can realize an extensive heater output width at low cost by easily switching the calorific value to three steps of (1) a step 1 at which only the first heating element 212A is energized, (2) a step 2 at which only the second heating element 212B is energized, and (3) a step 3 at which both the first heating element 212A and the second heating element 212B are energized. A switching means (not illustrated) of energization to the first heating element 212A and the second heating element 212B is preferably, for example, control by a relay.

**[0031]** FIG. 3 is a development view illustrating a second example of the heater pattern. In each of basic wiring patterns U2, it is preferable that a partition region F2 is a region formed by making one round trip by the first heating element 212A passing one end 217A of the opening section 217 and detouring and returning to the other end 217B of the opening section 217; the second heating element 212B form a wiring pattern making one round trip; and the wiring pattern of the second heating element 212B is disposed in the partition region F2. The second heating element 212B is disposed in the partition region F2 passing through the opening section 217. The basic wiring pattern U2 is a wiring pattern in which the first heating element 212A and the second heating element 212B are disposed in parallel at a ratio of 1 : 1.

**[0032]** The number of the basic wiring patterns U2 in a heater pattern 251 is one piece or plural pieces. When the number of the basic wiring patterns U2 is one piece (not illustrated), the heater pattern is the basic wiring pattern U2. Further, the heater pattern 251 preferably includes plural pieces of the basic wiring patterns U2. As illustrated in, for example, FIG. 3, the mode which includes the plural pieces of the basic wiring patterns U2 is a mode in which a wiring pattern of a portion, in which the first heating elements 212A are coupled with each other and the second heating elements 212B are coupled with each other between a basic wiring pattern U2 and a basic wiring pattern U2 adjacent thereto, is formed in a meander shape. In the mode, one set of the anode side drain wires 216A1 and the cathode side drain wires 216A2 which are connected to the first heating element 212A and the anode side drain wires 216B1 and the cathode side drain wires 216B2 which are connected to the second heating element 212B is disposed on a heater pattern as the drain wires. Otherwise, a mode in which the plural pieces of the basic wiring patterns U2 are disposed in parallel (not illustrated) may be employed. In the mode, the anode side the drain wires 216A1 and the cathode side drain wires 216A2 connected to the first heating element 212A and the anode side drain wires 216B1 and the cathode side drain wires 216B2 connected to the second heating element 212B are disposed as the drain wires, respectively in each basic wiring pattern U2. Although FIG. 3 illustrates a mode in which the basic wiring pattern U2 is repeated 4 times, the number of repetitions is not limited thereto.

**[0033]** The ceramic heater having the heater pattern 251 can easily switch the calorific value to two steps of (1) a step 1 at which only the first heating element 212A is energized, and (2) a step 2 at which both the first heating element 212A and the second heating element 212B are energized. A switching means (not illustrated) of energization to the first heating element 212A and the second heating element 212B is preferably, for example, control by a relay.

**[0034]** Up to now, although the mode in which the heating elements 212 are disposed in parallel with an axis direction of the support member 211 is shown, the embodiment is not limited thereto. FIG. 4 is a development view illustrating an example of a modification of the heater pattern. The example of the modification of the heater pattern will be explained referring to FIG. 4. Note that since a ceramic heater 201 illustrated in FIG. 4 has the same basic structure as the ceramic heater 200 according to the first embodiment illustrated in FIG. 1, common sections are denoted by the same reference numerals.

**[0035]** As the example of the modification of the heater pattern, a part or all of the heating elements 212 is preferably formed in a spiral shape. With the configuration, the heat transfer medium can be more uniformly heated in the circumferential direction of the support member.

**[0036]** Although not illustrated, as another example of the modification of the heater pattern, the first heating element 212A and the second heating element 212B may form the heater pattern 251 composed of a combination of the basic wiring patterns U1 and the basic wiring patterns U2. A specific example is a heater pattern in which the basic wiring patterns U1 and the basic wiring patterns U2 are alternately disposed in parallel.

**[0037]** FIG. 5 is a perspective view illustrating a side surface of a support member of a ceramic heater according to a second embodiment when the side surface is seen therethrough. In the ceramic heater 300 according to the second embodiment, the support member 311 preferably includes a hollow section 317 extending in an axis direction O1 of the support member 311, an extreme end hole 318 disposed on an extreme end 311t on a side opposite to a side where a terminal section 314 of the support member 311 is disposed, and a side surface hole 319 disposed on a side surface of the support member 311.

**[0038]** A basic configuration of the ceramic heater 300 is the same as the ceramic heater 200 except that the support member 311 has the hollow section 317, the extreme end hole 318, and the side surface hole 319 and is formed in a cylindrical shape. Further, as an example, a heater pattern is made to the same pattern as the heater pattern 251 illustrated in FIG. 3.

**[0039]** The support member 311 preferably has a bottomed cylindrical shape. As a method of forming the support member 311 in the bottomed cylindrical shape, there is a method of forming a bottom section 320 using a filling member composed of, for example, ceramics, a heat resistant resin, and the like.

**[0040]** The hollow section 317 acts as a flow path of a heat transfer medium. The hollow section 317 has a lateral cross section of, for example, a circular shape, an elliptical shape, a rectangular shape, a square shape, a triangular shape, or a polygonal shape. Among the shapes, the lateral cross section is more preferably of the circular shape. The extreme end hole 318 is a through hole disposed on the extreme end 311t of the support member 311 and communicating with the hollow section 317. The side surface hole 319 is a through hole disposed on the side surface of the support member 311 and communicating with the hollow section 317. The side surface hole 319 is, for example, formed by baking the support member 311 with a part of a side surface thereof scooped out.

**[0041]** In the ceramic heater 300 according to the second embodiment, a part of the heat transfer medium passes through the hollow section 317 from the side surface hole 319 and flows out from the extreme end hole 318, and the remaining part of the heat transfer medium passes outside of the ceramic heater 300. As described above, since the heat transfer medium is in contact with not only an outer circumferential surface of the support member 311 but also with an inner circumferential surface thereof, the heat transfer medium can be more efficiently heated.

**[0042]** In the ceramic heater 300 according to the second embodiment, it is preferable that the support member 311 sequentially disposes with a heat generation region H1, a sparse region H2 having a wiring density lower than the heat generation region H1, and the terminal sections 314 along the axis direction O1; and the side surface hole 319 is disposed in the sparse region H2. With the configuration, since the heat transfer medium which flows inside of the support member 311 can be heated in entirely of the heat generation region H1, heating efficiency is further improved. Here, the wiring density means the number of resistive elements passing through a virtual line when the virtual line is drawn along a circumferential direction P1 at an optional position of the support member 311. For example, in the heater pattern 251 illustrated in FIG. 3, the heat generation region H1 is a region in which the heating elements 212A and 212B are disposed as the resistive elements and the wiring density of the resistive elements is 16 pieces. On the other hand, the sparse region H2 is a region in which the drain wires 216A1, 216A2, 216B1, and 216B2 are disposed as the resistive elements, and the wiring density of the resistive elements is 4 pieces. As illustrated in FIG. 3, it is preferable to dispose a region S, in which no resistive element is formed, to the sparse region H2 and to dispose the side surface hole 319 in the region S. Since the sparse region H2 generates no heat or has a small calorific value, even if a flow of the heat transfer medium is made uneven in a periphery of the support member 311 by disposing the side surface hole 319, a temperature does not become uneven in a circumferential direction and thus the heat transfer medium can be heated uniformly.

**[0043]** In the ceramic heaters 200 and 300, a part or all of a surface thereof which is contact with a liquid as a heating object is preferably subjected to a hydrophilic process. When the ceramic heater 200 is formed in a columnar shape, the surface in contact with the liquid is, for example, an outer surface of the support member 211. Further, when the ceramic heater 300 is formed in a cylindrical shape, the surface in contact with the liquid is, for example, the outer surface and/or an inner surface of the support member 311. When bubbles are deposited on the surface of the ceramic heaters 200 and 300, there is a possibility that the ceramic heaters 200 and 300 are damaged because a heat shock is generated when the bubbles are removed after they have been grown largely. However, since the bubbles are removed by the application of the hydrophilic process before they have been deposited and grown, the ceramic heaters 200 and 300 can be prevented from being damaged by the heat shock.

**[0044]** FIG. 6 is a longitudinal broken sectional view illustrating an example of an electric heating type hot water heating apparatus according to the embodiment. As an example of the electric heating type hot water heating apparatus according to the embodiment, a mode in which the ceramic heater 200 according to the first embodiment is applied to the electric heating type hot water heating apparatus 100 will be explained. The electric heating type hot water heating apparatus 100 according to the embodiment includes the ceramic heater 200 according to the embodiment. The electric heating type hot water heating apparatus 100 is used to make up for the deficiency of engine exhaust heat or to supply a heat source of a heating system which substitutes for engine exhaust heat in, for example, an HV vehicle or an EV vehicle. Note that an up/down direction in the drawing shows an up/down direction of a vehicle.

**[0045]** The electric heating type hot water heating apparatus 100 according to the embodiment includes a case 30 having an inlet port 31, a flow path 40, and an outlet port 32 of a heat transfer medium and the ceramic heater 200 disposed in the flow path 40. The heat of the ceramic heater 200 can be efficiently transmitted to the heat transfer medium and heating can be performed promptly by directly heating the heat transfer medium by the ceramic heater 200. Since a structure is simple, a reduction in size and weight is possible. Further, since the ceramic heater 200 has a high watt density, a high calorific value can be obtained even by a small number of ceramic heaters, and thereby the number of parts can be reduced and a size can be further reduced.

**[0046]** The ceramic heater 200 can be attached to the case 30 by, for example, attaching a flange 215 to an outer circumference of the ceramic heater 200 on the terminal sections 213 side, inserting the ceramic heater 200 into the flow path 40 from the inserting port 33 disposed in the case 30, abutting the flange 215 against an inner circumferential surface of the inserting port 33 via a seal member such as an O ring and the like (not illustrated) interposed therebetween, and fixing the ceramic heater 200 by a fixing member such as a screw, a clamp, and the like (not illustrated).

EXPLANATION OF REFERENCE SIGNS

**[0047]**

| | |
|---|---|
| 30 | case |
| 31 | inlet port |
| 32 | outlet port |
| 33 | inserting port |
| 40 | flow path |
| 100 | electric heating type hot water heating apparatus |

| | |
|---|---|
| 200, 201, 300 | ceramic heater |
| 211 | support member |
| 211t | extreme end |
| 212 | heating element |
| 212A | first heating element |
| 212B | second heating element |
| 213 (213A1, 213A2, 213B1, 213B2) | terminal section |
| 214 (214A1, 214A2, 214B1, 214B2) | lead wire |
| 215 | flange |
| 216 (216A1, 216A2, 216B1, 216B2) | drain wire |
| 217 | opening section |
| 250, 251 | heater pattern |
| 311 | support member |
| 311t | extreme end |
| 314 (314A1, 314A2, 314B1, 314B2) | lead wire |
| 317 | hollow section |
| 318 | extreme end hole |
| 319 | side surface hole |
| 320 | bottom section |
| 901 | vibration-proof member |
| H1 | heat generation region |
| H2 | sparse region |
| U1, U2 | basic wiring pattern |
| F1, F2 | partition region |
| r | meander section |
| O1 | axis direction |
| P1 | circumferential direction |

## Claims

**1.** A ceramic heater, comprising:

a rod shaped support member composed of ceramics;
a line shaped heating element buried in a side surface of the support member, generating heat by being energized, and forming a heat generation region; and
a terminal section connected to the heating element and disposed on one end side of the support member; wherein:

the number of the heating elements is two or more pieces; and
any of the heating elements is disposed entirely of the heat generation region.

**2.** The ceramic heater according to claim 1, wherein:

the heating elements have a first heating element and a second heating element, two pieces of which are configured as one set;
the first heating element and the second heating element form a heater pattern including a basic wiring pattern; and
the basic wiring pattern includes a wiring pattern for forming a partition region, having an opening section, by disposing the first heating element and a wiring pattern having the second heating element disposed in the partition region.

**3.** The ceramic heater according to claim 2, wherein:

the partition region is a region formed by making one round trip by the first heating element passing one end of the opening section and detouring and returning to the other end of the opening section;
the second heating element forms a wiring pattern making two or more round trips; and
a part or all of the wiring pattern of the second heating element is disposed in the partition region.

**4.** The ceramic heater according to claim 2, wherein:

the partition region is a region formed by making one round trip by the first heating element passing one end of the opening section and detouring and returning to the other end of the opening section;
the second heating element forms a wiring pattern making one round trip; and
the wiring pattern of the second heating element is disposed in the partition region.

**5.** The ceramic heater according to any one of claims 1 to 4, wherein: the support member includes a hollow section extending in an axis direction of the support member, an extreme end hole disposed on an extreme end on a side opposite to a side where the terminal sections of the support member are disposed, and a side surface hole disposed on the side surface of the support member.

**6.** The ceramic heater according to claim 5, wherein:

the support member sequentially disposes the heat generation region, a sparse region having a wiring density lower than the heat generation region, and the terminal section along the axis direction; and
the side surface hole is disposed in the sparse region.

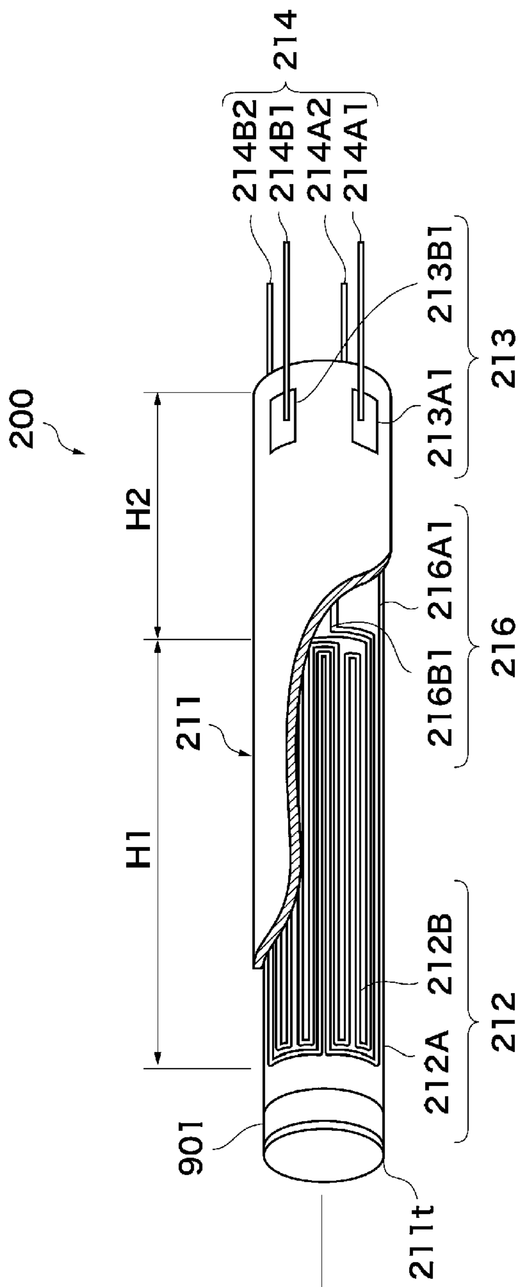
**7.** The ceramic heater according to any one of claims 1 to 6, wherein a part or all of the heating element is formed in a spiral shape.

**8.** The ceramic heater according to any one of claims 1 to 7, comprises a vibration-proof member disposed on the side surface of the support member.

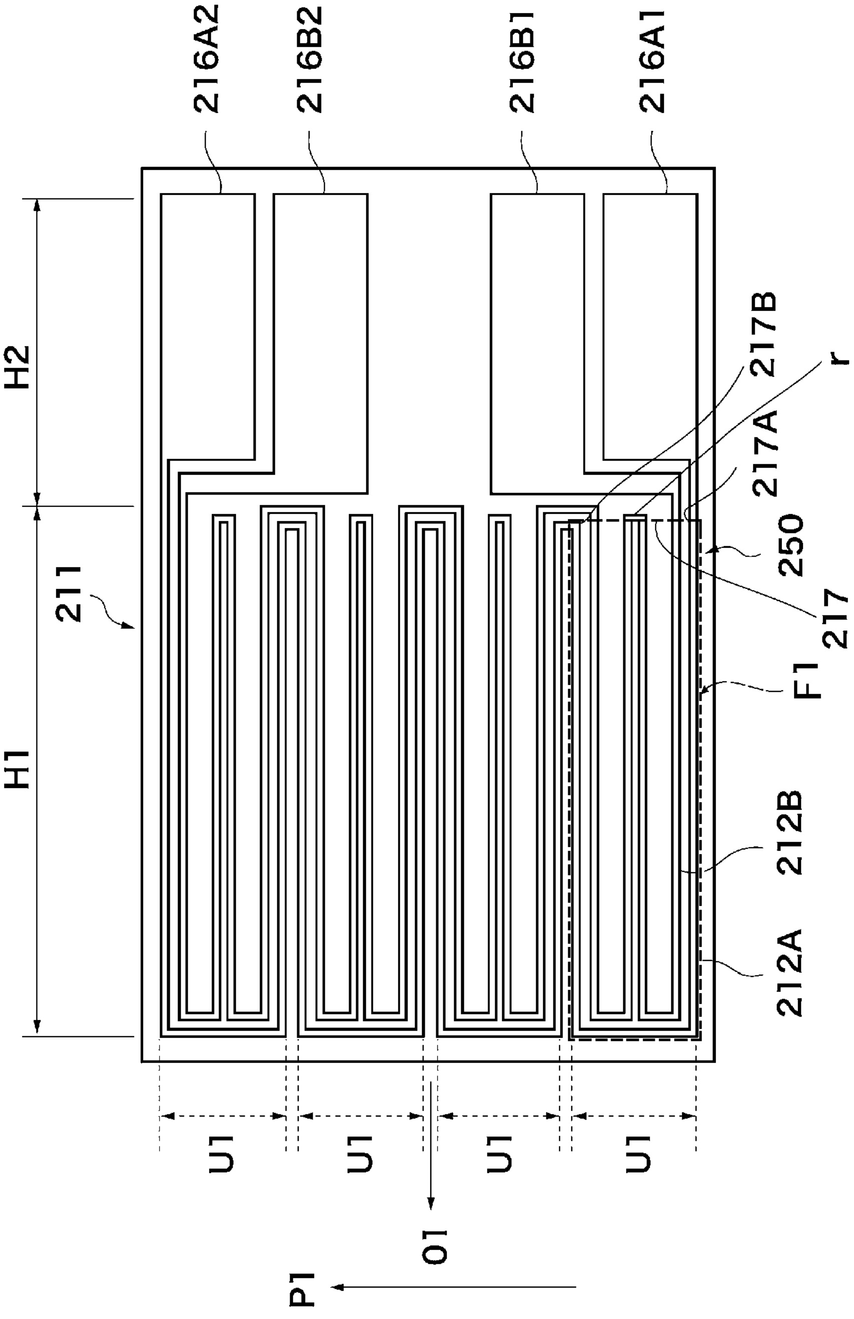
**9.** The ceramic heater according to any one of claims 1 to 8, wherein a part or all of a surface of the ceramic heater in contact with a liquid as a heating object is subjected to a hydrophilic process.

**10.** An electric heating type hot water heating apparatus comprising the ceramic heater according to any one of claims 1 to 9.

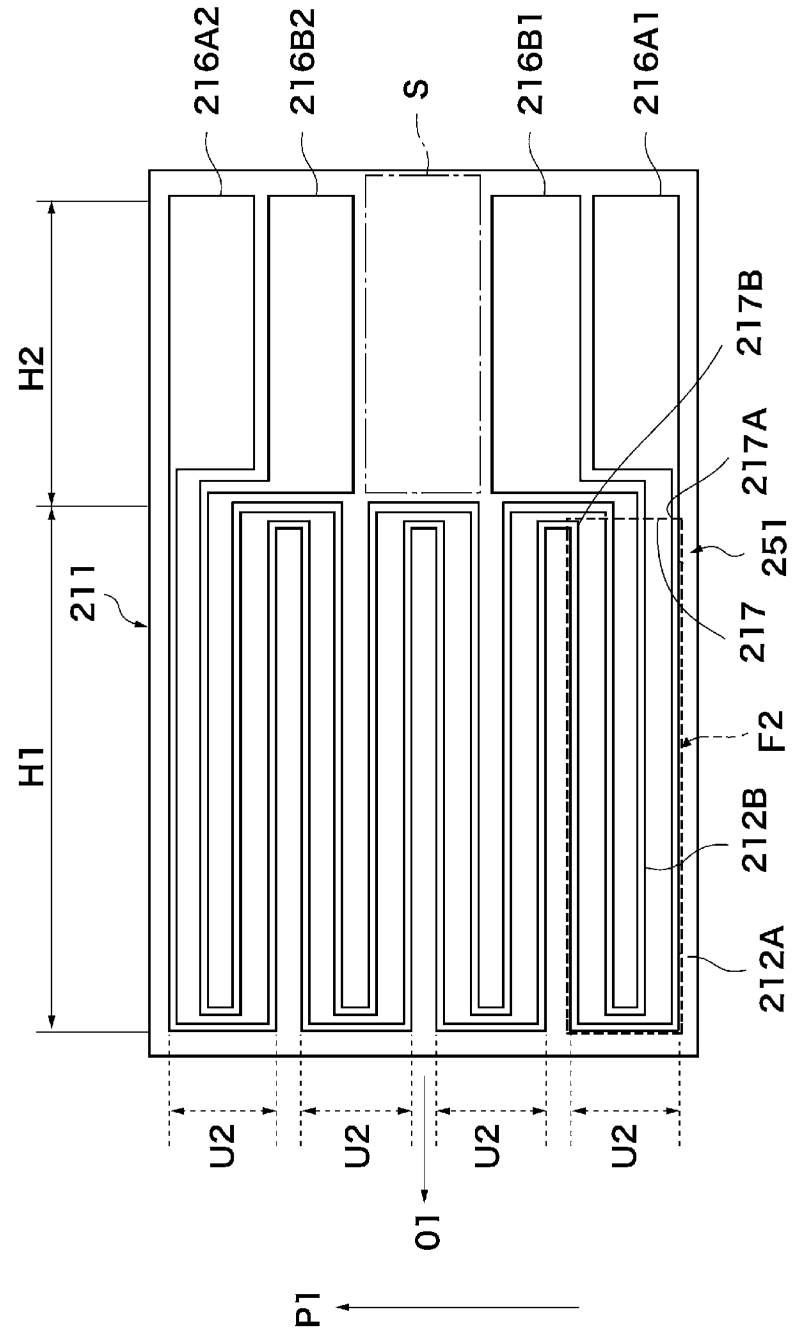
[FIG.1]


200
214
214B2
214B1
214A2
214A1
213B1
213A1
213
H2
216A1
216B1
216
211
H1
212B
212A
212
901
211t
O1

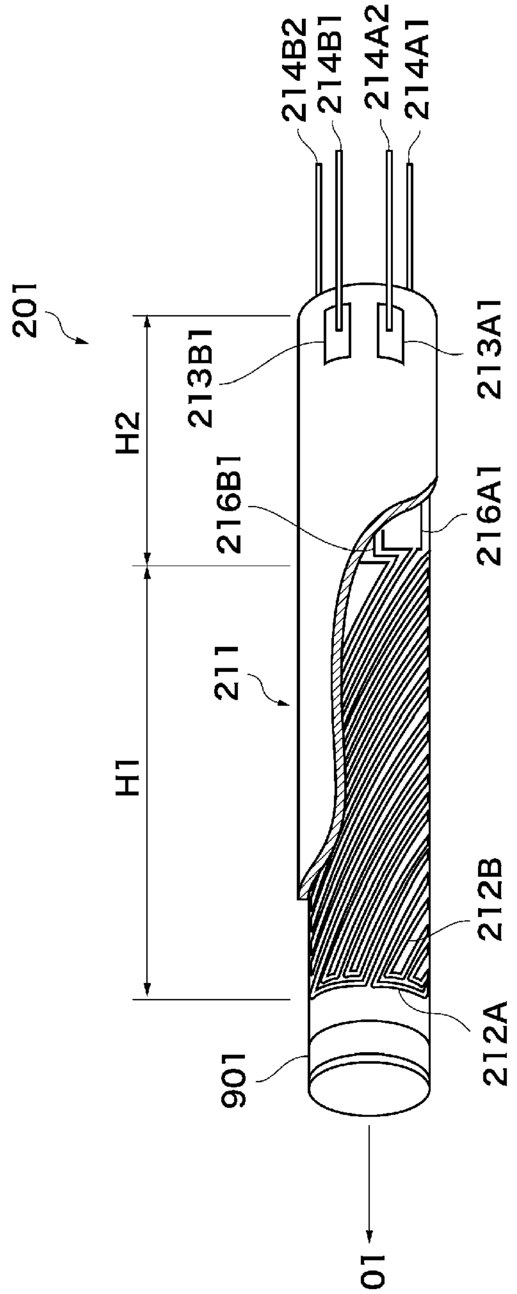
[FIG.2]


216A2
216B2
216B1
216A1
H2
H1
211
217B
r
217A
250
217
F1
212B
212A
U1
U1
U1
U1
O1
P1

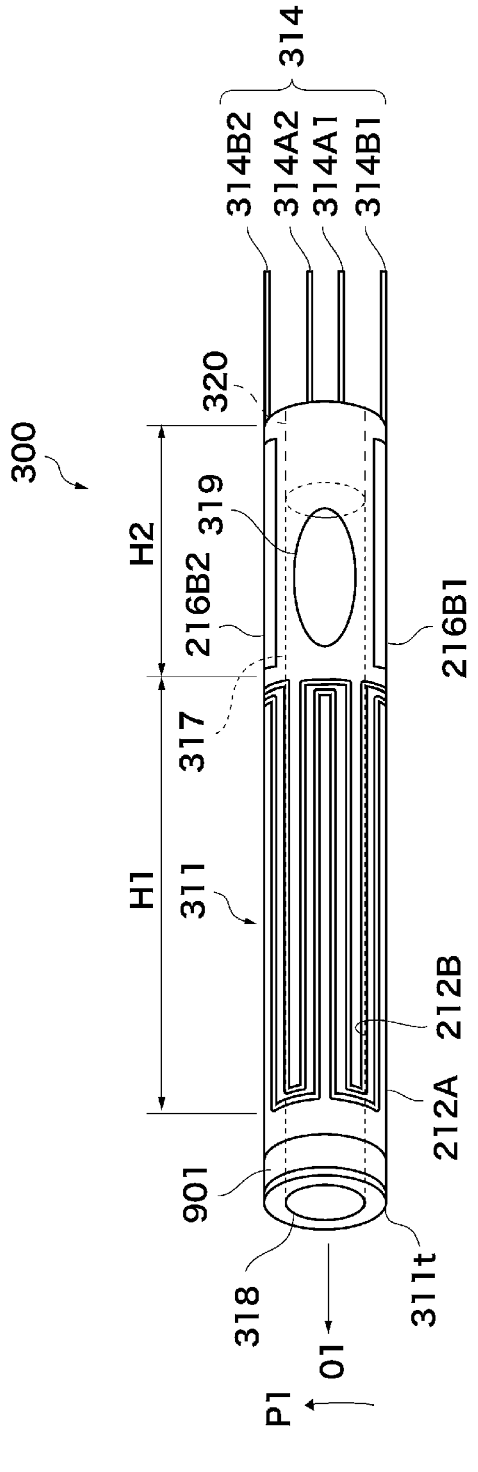
[FIG.3]


216A2
216B2
S
216B1
216A1
217B
217A
251
217
F2
212B
212A
H2
H1
211
U2
U2
U2
U2
O1
P1

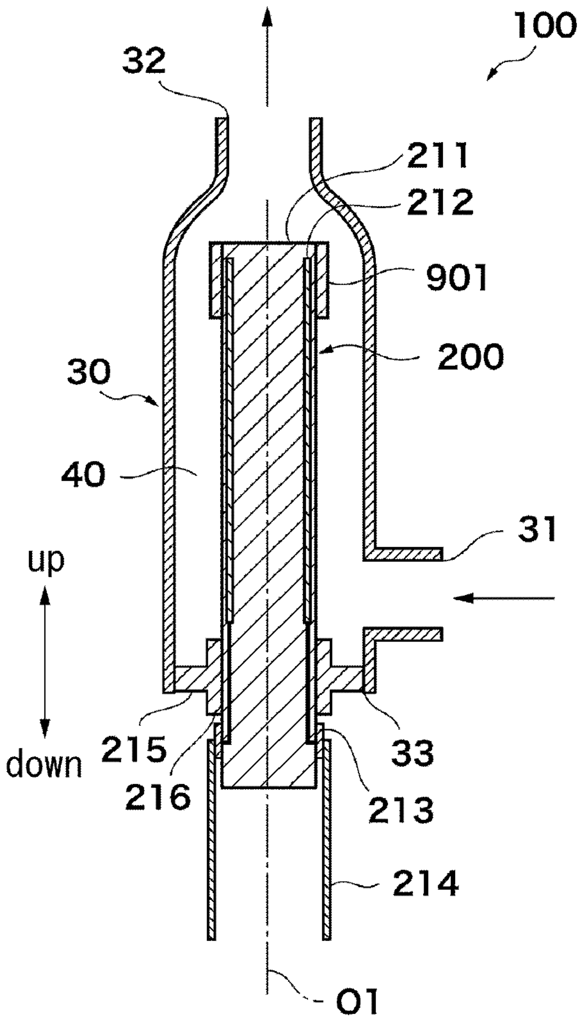
[FIG.4]


214B2
214B1
214A2
214A1
201
213B1
213A1
H2
216B1
216A1
211
H1
212B
212A
901
O1

[FIG.5]


314
314B2
314A2
314A1
314B1
320
300
H2
319
216B2
216B1
317
H1
311
212B
212A
901
318
311t
O1
P1

[FIG.6]



Europäisches Patentamt
European Patent Office
Office européen des brevets

# EUROPEAN SEARCH REPORT

Application Number
EP 12 19 8394

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (IPC) |
|---|---|---|---|
| A,D | JP 2006 236617 A (NGK SPARK PLUG CO) 7 September 2006 (2006-09-07) * the whole document * ----- | 1-10 | INV. H05B3/46 |
| A | EP 0 914 021 A2 (NGK SPARK PLUG CO [JP]) 6 May 1999 (1999-05-06) * the whole document * ----- | 1-10 | |
| A | DE 199 41 038 A1 (GUENTHER HEISKANALTECHNIK GMBH [DE]) 1 March 2001 (2001-03-01) * the whole document * ----- | 1-10 | |
| A | US 7 115 844 B2 (FERGUSON PATRICK [GB]) 3 October 2006 (2006-10-03) * abstract * * column 4, line 41 - line 43 * * figures 1,2 * ----- | 1-10 | |
| A | US 5 381 510 A (FORD DIXON [US] ET AL) 10 January 1995 (1995-01-10) * abstract * * figure 5 * ----- | 1-10 | TECHNICAL FIELDS SEARCHED (IPC) H05B |

The present search report has been drawn up for all claims

1

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 17 April 2013 | Chelbosu, Liviu |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
.......................................................................................................
& : member of the same patent family, corresponding document

## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 19 8394

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
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

17-04-2013

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| JP 2006236617 A | 07-09-2006 | NONE | |
| EP 0914021 A2 | 06-05-1999 | DE 69831844 T2 | 13-07-2006 |
| | | EP 0914021 A2 | 06-05-1999 |
| | | EP 1524882 A2 | 20-04-2005 |
| | | JP 3691649 B2 | 07-09-2005 |
| | | JP H11135239 A | 21-05-1999 |
| | | US 6084220 A | 04-07-2000 |
| DE 19941038 A1 | 01-03-2001 | AT 280483 T | 15-11-2004 |
| | | CA 2383481 A1 | 08-03-2001 |
| | | DE 19941038 A1 | 01-03-2001 |
| | | DK 1206900 T3 | 24-01-2005 |
| | | EP 1206900 A1 | 22-05-2002 |
| | | ES 2230147 T3 | 01-05-2005 |
| | | PT 1206900 E | 28-02-2005 |
| | | US 6797925 B1 | 28-09-2004 |
| | | WO 0117317 A1 | 08-03-2001 |
| US 7115844 B2 | 03-10-2006 | AT 405132 T | 15-08-2008 |
| | | AU 2002350943 A1 | 30-06-2003 |
| | | DK 1454508 T3 | 15-12-2008 |
| | | EP 1454508 A1 | 08-09-2004 |
| | | ES 2314113 T3 | 16-03-2009 |
| | | GB 2383197 A | 18-06-2003 |
| | | PT 1454508 E | 06-11-2008 |
| | | SI 1454508 T1 | 28-02-2009 |
| | | US 2005082280 A1 | 21-04-2005 |
| | | WO 03053101 A1 | 26-06-2003 |
| US 5381510 A | 10-01-1995 | AT 185462 T | 15-10-1999 |
| | | AU 7372294 A | 20-02-1995 |
| | | CA 2165990 A1 | 02-02-1995 |
| | | DE 69421097 D1 | 11-11-1999 |
| | | DE 69421097 T2 | 20-07-2000 |
| | | EP 0746961 A1 | 11-12-1996 |
| | | ES 2136738 T3 | 01-12-1999 |
| | | JP H09500481 A | 14-01-1997 |
| | | US 5381510 A | 10-01-1995 |
| | | WO 9503680 A1 | 02-02-1995 |

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

## REFERENCES CITED IN THE DESCRIPTION



### Patent documents cited in the description


- JP 2011143781 A **[0005]**
- JP 2006236617 A **[0005]**