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Description

[0001] The invention relates to a holding body for heating elements having the features of the preamble of Claim 1. The invention further relates to a heating apparatus and a method for mounting the holding body.

[0002] A holding body of the type mentioned at the beginning is known for example from WO 2013/060645 A1.

[0003] The constant change-over from daytime to nighttime temperatures as well as permanently extreme climate conditions can be problematic for the electronics in equipment and switch cabinets. They cause the appearance of condensation or frost which can lead to corrosion. Corrosion increases the risk of functional breakdowns and operating failures through leakage currents or flashovers. Constant climate conditions are absolutely essential in order to prevent the formation of condensation and frost, guarantee a satisfactory functioning and increase the service life of the electronics. Heating apparatuses or fan heaters are used for this purpose.

[0004] Heating apparatuses of this kind are generally fitted with electric heating elements based on PTC semiconductor technology. The holders of such heating elements must guarantee good heat transmission on the one hand and a secure fixing on the other hand. Frequent temperature changes can lead to material fatigue and thus to a reduction of the holding force for the heating elements. If the holder completely breaks down it can lead to a total failure of the apparatus.

[0005] One example of such a heating apparatus with a PTC heating element is described in DE 10 2006 018 151 A1. Here the heating element is arranged in a centrally arranged recess of a heat exchanger. The heating element lies flat against the inner surfaces of the recess. The heating element is held in position whereby the ends of the side walls of the heat exchanger are bent inwards during assembly by using pressing tools. The inner surfaces thereby closely adjoin the heating element so that the heating element is firmly clamped over its surface area.

[0006] Bending in the side walls however means plastically deforming the material which, combined with frequent temperature changes, impairs the holding function. Replacing the heating element is not possible due to the type of assembly in which the side walls are permanently plastically deformed.

[0007] WO 2013/060645 A1 describes a holding body which comprises an outer part and an inner part which is arranged in the outer part. The outer part and the inner part are designed as polygon profiles with polygon corners and polygon sides which are connected to the polygon corners. Several receiving regions are formed in the circumferential direction between the inner part and the outer part and the heating elements are arranged in these receiving regions. The receiving regions are arranged in the corners of the polygon profiles. The sides of the polygon profile are elastically deformed in the fitted state and are under mechanical stress. The resulting contact pressing force acts on the heating elements and holds these in position. The holding function is possible without any additional tensioning elements.

[0008] When mounting the holding body described above the diameter of the outer part is initially enlarged. The enlargement of the outer part diameter is undertaken by heating and/or by applying a force which acts radially outwards or radially inwards. The inner part is then introduced so that the heating elements are arranged in the receiving regions. If the inner part is in position, then the outer part is cooled down again and/or relaxes so that the outer part shrink-fits onto the inner part. The polygon sides are thereby elastically deformed and build up a mechanical tension which charges the heating elements with a contact pressing force and fixes them.

[0009] The mounting step of changing the diameter of the outer part which is necessary in order to fix the inner part and the heating elements inside the outer part is time-consuming and cost-intensive.

[0010] The object of the invention is to improve a holding body of the type mentioned at the beginning so that a secure holding of the heating elements in the

holding body is possible despite frequent temperature changes, and cooling of the heating apparatus is possible, wherein the holding body is configured in such a manner that simple mounting, in particular easier joining of the polygon profiles, is possible. The object of the invention is further to provide a heating apparatus with a holding body of this kind, as well as a method for mounting a holding body of this kind.

[0011] This is achieved according to the invention with regard to
- the holding body, by the object of Claim 1;
- the heating apparatus, by the object of Claim 15;
- and the method, by the object of Claim 16.

[0012] The object is achieved basically by a holding body for heating elements, in particular oval and circular heating elements, having an outer part assembly and an inner part assembly, which is arranged within the outer part assembly and forms an elastic connection, being under mechanical tension. The outer part assembly and/or the inner part assembly include/s a plurality of receiving means being arranged distributed in the circumferential direction, in each of which a heating element is arranged. The outer part assembly and the inner part assembly each comprises a polygon profile having polygon corners and polygon sides which connect the polygon corners to one another. The inner part assembly and the outer part assembly are twistable relative to one another and are dimensioned such that by a relative rotation between the inner part assembly and the outer part assembly the polygon profiles elastically deform such that, in the mounted state, a press fit is formed in the area of the heating elements by the induced mechanical tension, in particular by a spring force.

[0013] The press fit according to the invention occurs when the largest part of the inner radial expansion of the outer part assembly is less than the smallest part of the outer radial expansion of the inner part assembly. The radial expansion relates here to all components which are assigned to the respective assembly. In the case of press fits, a mounting force is required to produce a form-fitting connection. The mounting force is introduced by the relative rotation.

[0014] The radial expansions of the inner part assembly and outer part assembly of the holding body according to the invention are consequently dimensioned so that they overlap in the region of the receiving means of the heating elements. The inner part assembly can thereby be inserted into the outer part assembly so that a relative rotation is possible between the two assemblies. Contact between the two assemblies is produced by the relative rotation and the geometry of the polygon profiles. The inner part assembly presses in the regions of the receiving means for the heating elements the outer part assembly, in particular the polygon profile of the outer part assembly, radially outwards whereby the polygon profiles elastically deform. Analogously, the inner part assembly in the regions of the receiving means is pressed inwards and is thereby elastically deformed. Rotation is continued whereby the polygon profiles are further elastically deformed until the heating elements are situated in the receiving regions provided. The elastic deformation remains. The mechanical tension or spring force induced by the elastic deformation in the polygon profiles, thus in the polygon profiles of the outer part assembly and the inner part assembly, applies a contact pressing force on the heating elements and fixes them in their relevant receiving means. The continuous pressure is also maintained in the heating phase and ensures optimum heat transfer and fixing. In particular the joining of the heating elements and the polygon profiles by the rotation and the close connection thereby formed improves the heat transport of the heating apparatus.

[0015] The heating elements are preferably each arranged in an edge region inside the holding body. This is advantageous since the air stream which flows through the holding body during operation is more concentrated in the edge regions. It is thus particularly advantageous to arrange the heating elements in this region in order to improve the heat transport.

[0016] A holding body according to the invention allows a mounting process without having to change the diameter of the outer part in an addition mounting step. The mounting of the holding body can take place almost without tools and is connected with a reduced working and time expense.

[0017] The holding body according to the invention for heating elements is not restricted only to use in a switch cabinet. Use in other regions is not excluded.

[0018] Preferred embodiments of the invention are provided in the dependent claims.

[0019] In one embodiment the heating elements are arranged in the mounted state between the polygon sides and/or the polygon corners. This allows various different variations of the holding body. For example, a holding body is conceivable in which the heating elements are arranged solely in the polygon corners. Configurations in which the heating elements are arranged between the polygon sides of the inner part assembly and the polygon corners of the outer part assembly, or vice versa, are likewise possible.

[0020] In a preferred embodiment the receiving means each include wall portions which are adapted to the heating elements and enclose them at least in part in the circumferential direction. The greater and closer the contact is between the polygon profiles or receiving means and the heating elements, so the better is the heat transmission between the said components.

[0021] In a particularly preferred embodiment the wall portions of a receiving means each are in part formed by the outer part assembly and the inner part assembly. A first wall portion has an angle of curvature of $K>180^\circ$ and a second wall portion has an angle of curvature of $K<180^\circ$. This has the advantage that the heating elements are enclosed practically completely by the wall portions, which results in a better transmission of the heat and contact pressing force.

[0022] In a further preferred embodiment the outer part assembly forms the receiving means, and the inner part assembly forms the abutments for the heating elements, or vice versa. The heating elements in the installed state are pressed against the abutments. This produces a better transmission of the contact pressing force and the heat. The holding function of the receiving means is sufficient to

hold the heating elements for the mounting process. In the mounted state the receiving means interact with the heating elements and the abutments and form a press fit which fixes the heating elements in a force-fitting and form-fitting manner between the inner part assembly and the outer part assembly. More advantageously the receiving means for the heating elements are arranged so that the polygon sides have maximum elasticity and hold the heating elements continuously under tension.

[0023] In order to bring the heating elements into a suitable position prior to the mounting process a contact surface is arranged in front of the abutments in the direction of the relative rotation. This makes it easier to mount the inner part assembly and preserves the heating elements during the mounting process. During the relative rotation the heating elements remain in contact with the polygon profile of the outer part assembly. The heating elements rub here on the polygon profile. Since the contact surfaces are arranged directly in front of the abutments the relative rotation is restricted and the stress on the heating elements through friction is minimized.

[0024] In order to hold the heating elements in the suitable position prior to the mounting process, the contact surfaces can be formed to be oblique or concave. The contact surfaces can be configured so that during the relative rotation they assist in guiding the heating elements into the receiving means, i.e., less resistance through friction occurs. Alternatively, the contact surfaces can have other forms which are advantageous for the mounting process.

[0025] In a preferred embodiment a core is arranged concentrically within the inner part assembly and is connected to the inner part assembly by webs. The webs are preferably spaced as far apart as possible from the receiving means of the heating elements. This has an advantageous effect on the elastic deformability of the polygon profiles and the mechanical tension or spring force resulting therefrom which holds the heating elements in position. The core has an advantageous effect on the dissipation of heat and the stability (honeycomb) of the holding body. If the receiving means are formed on the polygon sides, then the webs are connected to the inner sides of the polygon corners. If the receiving means are formed on the

polygon corners, then the webs are connected to the polygon sides of the polygon profile of the inner part assembly. Thus a greater elastic deformation or a greater contact pressing force can be produced in the region of the receiving means. It is conceivable that the core is connected to the polygon profile in a different way.

[0026] In a further preferred embodiment the core forms an inner profile for receiving a tool. The relative rotation is introduced via the inner profile. Different tools can be used. The type of tool depends on the form of the inner profile, i.e., other tools are conceivable. Alternatively the holding body can be configured so that the relative rotation can be introduced without tools, in particular by hand.

[0027] In a particularly preferred embodiment the inner profile of the core is formed as an internal hexagon. This has the advantage that the relative rotation can be introduced with a hexagon key. The hexagon key is a standard tool which is made in different sizes. This makes it easier to use different sizes for the inner profile and the holding body since no special tool need be made. The hexagon form (honeycomb) further produces increased stability and a better force-fitting connection between the assemblies.

[0028] It is advantageous if at the core, in particular within the inner profile, a regulation unit is arranged, including a temperature monitor or temperature regulator and a thermal fuse which are electrically connected to the heating elements by a star connection. A simple installation of the electronic components is thus possible. Alternatively, further electronic components and possibilities for attaching the regulation unit are conceivable. For example, it is conceivable that two bimetal regulators or one bimetal regulator and one safety fuse are arranged on the heating apparatus and regulate the temperature of the heating apparatus or switch it off if overheating occurs.

[0029] The polygon profiles comprise at least three polygon corners and three polygon sides. Designs with more sides and corners which have correspondingly more receiving means and heating elements are thus possible.

[0030] More advantageously the adjacent polygon corners of the polygon profiles each have the same angle of spacing. The symmetrical cross section enables uniform cooling during the production process. The symmetry and the similar construction of the two polygon profiles allow the polygon profiles to be pushed inside one another without leading to overlapping of the radial expansions.

[0031] It is advantageous if in the mounted state the polygon corners of the polygon profiles are arranged offset relative to one another so that the polygon corners are oriented so as to be at least approximately centred relative to the oppositely arranged polygon sides. This arrangement improves a uniform tension distribution and thus a uniform distribution of the contact pressing force. The relative strengths are thereby determined and the system is not underdetermined nor overdetermined. In a further more advantageous way air channels are formed by the offset arrangement of the polygon corners and polygon sides and enable a more efficient cooling or heat transport.

[0032] The polygon corners of the polygon profiles can also be oriented in approximately the same way for the same purpose.

[0033] More advantageously the polygon profiles can have a concave, convex or straight form. This type of design of the polygon profiles causes a higher mechanical tension which improves the press fit between the inner part assembly and the outer part assembly. Other suitable geometric forms of the profiles are also conceivable which cause a higher mechanical tension of the polygon profiles and improve the holding function.

[0034] The polygon profiles can have a rib structure or a lamella structure. The enlargement of the surface area resulting from this improves the heat exchange with the atmosphere. Basically, practically all surface areas of the holding body are suitable for having a rib structure. The inner faces of the receiving means as well as the abutments are adapted to the heating elements. They lie flat against the heating elements and enclose these for the most part. This enables a good heat transfer between the heating elements and the polygon profiles. Basically other

structures for enlarging the surface areas are also conceivable. Alternatively, the surface structures can be made separately and joined to the surfaces of the holding body or connected in other ways. More complicated rib structures and better surfaces are thereby possible.

[0035] It is advantageous for the mounting process if the inner part assembly and the outer part assembly are arranged concentrically. A concentric arrangement of the assemblies causes a uniform tension distribution in the mounted state in the polygon profiles and centres the two assemblies.

[0036] It is preferred to form the heating elements cylindrical or oval-cylindrical. Heating elements with circular or at least partially circular outer surfaces do not cant during relative rotation. Alternatively heating elements with other forms are conceivable.

[0037] The outer part assembly can be joined from several parts and closed with plates in particular aluminium plates. This enables a higher surface structure to be achieved during manufacture.

[0038] A heating apparatus with a holding body is disclosed and claimed within the scope of the invention. An axial end of the holding body is connected to an aerator in such a way that air can flow through the holding body in the longitudinal direction.

[0039] A method for mounting a holding body according to the invention according to Claim 1 is disclosed and claimed within the scope of the invention. The heating elements are arranged in the associated receiving means. The inner part assembly is then introduced into the outer part assembly and rotated with a tool which interacts with the core, until the heating elements are fixed between the inner part assembly and the outer part assembly by the mechanical tension induced by the elastic deformation of the polygon profiles.

[0040] The invention will now be explained in further detail using several

exemplary embodiments and with reference to the accompanying diagrammatic drawings.

[0041] In the drawings

Fig. 1 shows a perspective view of an exemplary embodiment of a holding body according to the invention;

Fig. 2 shows a plan view of the holding body according to Fig. 1;

Fig. 3 shows a perspective view of a further exemplary embodiment of a holding body according to the invention;

Fig. 4 shows a plan view of the holding body according to Fig. 3;

Fig. 5 shows a perspective view of a further exemp0lary embodiment of a holding body according to the invention;

Fig. 6 shows a plan view of the holding body according to Fig. 5;

Fig. 7 shows a diagrammatic circuit diagram of an exemplary embodiment;

Fig. 8 shows a section of an exemplary embodiment of a heating apparatus according to the invention.

[0042] Fig. 1 and Fig. 2 show an exemplary embodiment of a holding body according to the invention. The holding body comprises an outer part assembly 11 and an inner part assembly 12, which is arranged concentrically in the outer part assembly, as well as heating elements 10 which are arranged between the inner part assembly 12 and the outer part assembly 11. The holding body is preferably made from aluminium and provides on the one hand a holding function and on the other hand a cooling function.

[0043] The outer part assembly 11 comprises a first or an outer polygon profile 14. The inner part assembly 12 comprises a second or an inner polygon profile 14'. The first and second polygon profiles 14, 14' each comprise three first and second polygon corners 14a, 14a' and each three first and second polygon sides 14b, 14b'. Variations and forms are also conceivable which have more than three first and second polygon corners 14a, 14a' each and polygon sides 14b, 14b' each. The number of first polygon corners corresponds to the number of second polygon corners 14a'. The first polygon corners 14a are flattened and have a concave curvature. The first and second polygon sides 14b, 14b' have a convex curvature. It is also conceivable that the first polygon corners 14a have a concave curvature and the first and second polygon sides 14b, 14b' have a convex curvature. The second polygon corners 14a' are rounded. It is possible that the first and second polygon corners 14a, 14a' and/or the first and second polygon sides 14b, 14b' are formed straight.

[0044] The outer part assembly 11 comprises a spacer frame 23 which surrounds the first polygon profile 14. The spacer frame 23 is formed as a square. Other forms are alternatively possible (e.g. round). The spacer frame 23 can also be configured as a housing. The corners of the spacer frame 23 are rounded and each have on their inner sides a geometrically defined fastening point 24. The fastening points 24 are configured as recesses over the entire axial length of the spacer frame 23. Other forms of fastening points 24 are conceivable, for example those which do not or only partly or in portions extend over the axial length of the spacer frame 23. The holding body can be fixed by the fastening points 24 in a switch cabinet, and/or an aerator or cover can be arranged on the holding body. It is conceivable to connect two or more holding bodies to one another by the fastening points 24. A web 19 is formed on each inner side of the spacer frame 23 and connects the spacer frame 23 to the first polygon profile 14. The spacer frame 23 can also be connected to the first polygon profile 14 in different ways. The spacer frame 23 and the first polygon profile 14 are preferably connected to webs 19 and are configured as one component. The webs 19 are more advantageously spaced as far as possible from the receiving means for the heating elements 10 in order to achieve a better spring action and to receive the most concentrated air stream possible in

the region of the heating elements 10. Alternatively, the space frame 23 can be made as a separate component.

[0045] The first polygon profile 14 has a lamella or rib structure on the outer and inner surfaces of the first polygon sides 14b and on the outer surfaces of the first polygon corners 14a. The rib structure enlarges the surface area of the first polygon profile 14 and enables a more efficient heat exchange with the environment. Other structures which enlarge the surface area are likewise suitable. The inner surfaces of the first polygon corners 14a and the inner surfaces of the receiving means 13 do not have any rib structure. The inner surfaces of the first polygon corners 14a form abutments 16 and interact with the receiving means 13. The surfaces of the abutment 16 and the receiving means 13 are adapted to the surfaces of the heating elements 10 for an efficient heat transfer.

[0046] The abutments 16 form a part of a press fit and have in the centre a convex-shaped region abutted in the mounted state by the heating elements 10 which are arranged on the inner part assembly 12. The convex region reduces the gap between the heating elements 10 and the first polygon profile 14 and thus enables a better heat transfer between the two assemblies. The abutments 16 can be configured differently for better fixing. For example, the abutments 16 can be shaped so that they enclose the heating elements in portions.

[0047] The inner part assembly comprises the second polygon profile 14', the heating elements 10 and a core 18. Receiving means 13 are formed centrally on the outer surfaces of the second polygon sides 14b'.

[0048] The receiving means 13 are each formed from two radially outwardly oriented wall portions 15. The inner surfaces of the receiving means 13 are adapted to the outer surfaces of the heating elements 10. The heating elements 10 are formed cylindrical and extend approximately over the entire axial length of the holding body. Other heating elements 10, in particular oval-cylindrical heating elements 10 and those with other lengths, are conceivable. The wall portions 15 do not surround the heating elements 10 completely but rather in such a manner

that the heating elements 10 are fixed in form-fitting manner radially outwards but are movable in the longitudinal direction. The two wall portions 15 of the receiving means 13 consequently together have an angle of curvature with K>180◦. Each one portion of the outer surfaces of the heating elements 10 which is oriented towards the inner surfaces of the first polygon profile 14 is not enclosed by the receiving means 13. These portions interact in the mounted state with the abutments 16 and form the press fit between the inner part assembly 12 and the outer part assembly 11. In addition the portions of the heating elements 10 not enclosed by the receiving means 13 have the function of transferring heat to the outer part assembly 11.

[0049] The core 18 is arranged concentrically within the second polygon profile 14'. The core 18 is connected by webs 19 to the insides of the second polygon corners 14a'. The second polygon sides 14b' can hereby build up a higher mechanical tension. The core 18 has an inner profile. The inner profile is configured as a hexagon. Alternatively other geometries of the inner profile are conceivable. The inner profile of the core 18 interacts during mounting with a tool, in particular with a hexagon key. The type and size of the tool depends on the form of the inner profile. Initiating the relative movement is consequently conceivable with other tools or by hand. A fastening point 24 is arranged on each of the two webs 19 of the core 18. The fastening points 24 correspond in their structural features to those which are arranged on the spacer frame 23. The fastening points 24 can be arranged at other positions.

[0050] A regulation unit 20 is arranged by screw connection on the fastening points 24. Other types of connection, for example brackets or lug hooks are possible for fixing purposes. The regulation unit 20 comprises a temperature regulator or a temperature monitor 21 and a thermal fuse 22. It is conceivable that the regulation unit 20 comprises other or additional components. The components of the regulation unit 20, as shown diagrammatically in Fig. 7, are electrically connected to the heating elements 10 via a star connection. Other types of switch connections are alternatively possible. The temperature regulator or the temperature monitor 21 has the function of keeping the temperature approximately constant. The

detection or regulation of the temperature can take place by thermistors, thermoelements or temperature switches of bimetal. The use of other methods is possible. The thermal fuse 22 is triggered in the event of a defect or failure of the temperature regulator or temperature monitor 21 and the simultaneous appearance of high temperatures. The thermal fuse 22 comprises an electric connection which melts at a specific temperature limit. On exceeding this temperature limit, the thermal fuse 22 breaks the electric circuit and switches off the heating apparatus in order to prevent damage. Once the thermal fuse 22 is triggered the heating apparatus is only ready for use again after inserting a new thermal fuse 22.

[0051] The second polygon profile 14' has a rib or lamella structure on the inner surfaces and on the outer surfaces of the second polygon corners 14a' and polygon sides 14b'. The webs 19 which connect the polygon profile 14' to the core 18 likewise have a rib structure. There is no rib structure on the inner surfaces of the receiving means 13 since here the closest flat contact between the receiving means 13 and the heating elements is required in order to enable good heat transfer. In general, all surfaces of the holding body which are not in direct contact with the heating elements 10 have a lamella structure, a rib structure or alternatively a different structure.

[0052] The radial expansions of the outer diameter of the inner part assembly 12 and of the inner diameter of the outer part assembly 11 of the holding body are dimensioned so that these preferably overlap in the regions of the receiving means 13 for the heating elements 10 whereby an oversize is formed each in the regions of the receiving means 13. The inner part assembly 12 is arranged prior to mounting in the outer part assembly 11 in such a way that the regions with the oversize of the outer part assembly 11 and of the inner part assembly 12 are offset from one another. A relative rotation is initiated by a tool, in particular by a hexagon key, which interacts with the core 18. Other tools adapted to the core 18 are also conceivable for initiating the relative rotation.

[0053] By initiating the relative rotation, the regions of the inner part assembly 12 and outer part assembly 11 with oversize overlap one another. A press fit is thereby

possible between the two assemblies which fixes the inner part assembly 12 in the outer part assembly 11. Through the relative rotation a contact between the two assemblies first arises in the regions with the oversize. More precisely, the contact arises between the heating elements 10 and the outer part or inner part assembly 11, 12. The inner part assembly 12 presses in the region of the receiving means 13 for the heating elements 10 the outer part assembly 11, in particular the first polygon profile 14 of the outer part assembly 11, radially outwards whereby the first and second polygon profiles 14, 14' elastically deform. The relative rotation is continued until the heating elements 10 are arranged in the receiving means 13 provided. The first and second polygon profiles 14, 14' remain elastically deformed after the relative rotation.

[0054] The mechanical tension or spring force induced by the elastic deformation in the first and second polygon profiles 14, 14' applies a contact pressing force on the heating elements 10. The convex form of the first polygon corners 14a and the concave form of the second polygon sides 14b' support the opposing mechanical tensions in the first and second polygon profiles 14, 14'. The heating elements 10 are fixed in a form-fitting and force-fitting manner in the receiving means 13 so that temperature changes have little effect on the contact pressing force.

[0055] Fig. 3 and Fig. 4 show a further exemplary embodiment of a holding body according to the invention.

[0056] The spacer frame 23 is identical with the spacer frame 23 described in Figs. 1 and 2.

[0057] In this exemplary embodiment no surface of the holding body has a rib or lamella structure. Basically however all surfaces of the holding body which are not in direct contact with the heating elements 10 are suitable for having a rib structure or another surface structure. It is therefore also conceivable that the spacer frame 23 has a rib or lamella structure.

[0058] The first polygon profiles 14, 14' correspond as regards their geometry

basically to the first and second polygon profiles 14, 14' of the exemplary embodiment according to Figs. 1 and 2. The differences will be explained more precisely in the following explanations.

[0059] As opposed to the exemplary embodiment according to Figs. 1 and 2, the receiving means 13 of the holding body shown in Figs. 3 and 4 are formed not on the inner part assembly 12 but on the outer part assembly 11. More precisely, the receiving means are situated on the inner surface of the first polygon corners 14a of the first polygon profile 14.

[0060] The wall portions 15 of the receiving means 13 extend radially inwards. The inner and outer surfaces of the wall portions 15 are curved. The angle of curvature of the wall portions 15 is $K > 180°$. More than half of the circumference of the heating elements 10 is enclosed by the wall portions 15 of the receiving means 13. The angle of curvature is selected so that the heating element 10 arranged in the receiving means 13 is movable only in the longitudinal axis of the holding body. Differently shaped heating elements 10 and consequently differently shaped receiving means 13 are conceivable. The heating elements 10 are not completely enclosed by the wall portions 15 of the receiving means 13. The radially outermost portion of the heating elements 10 that extends from the centre point of the holding body remains free. The portion of the heating elements 10 that remains free interacts with abutments 16 and forms the press fit between the inner part assembly 12 and the outer part assembly 11.

[0061] The abutments 16 are arranged on the inner part assembly 12. More precisely, the abutments 16 are formed on the outer surfaces of the second polygon sides 14b' of the second polygon profile 14'. The abutments 16 are adapted to the heating elements 10 and partly surround the heating elements 10. The abutments 16 have for this purpose an angle of curvature of $K < 180°$. The sum of the angles of curvature of the wall portions 15 and the abutments 16 preferably amounts to approximately 360°. The heating elements 10 are thus enclosed practically entirely by the receiving means 13 and the abutments 16 and have a practically optimum heat transfer from the heating elements 10 to the first and second polygon profiles

14, 14'.

[0062] The relative rotation of the inner part assembly 12 during which the inner part assembly 12 and the outer part assembly 11 are connected in form-fitting and force-fitting engagement with one another takes place in the exemplary embodiment according to Figs. 3 and 4 in an anti-clockwise direction due to their construction. One variation in which the mounting process is carried out by clockwise rotation is also conceivable.

[0063] A contact surface 17 is set in front of the abutment 16 in the direction of relative rotation. The contact surface 17 is formed as a concave curvature in the second polygon side 14b' of the second polygon profile 14'. Other forms for the contact surfaces 17 are also basically conceivable. The heating elements 10 are arranged on the contact surfaces 17 prior to the relative rotation when the inner part assembly 12 is inserted into the outer part assembly 11 in order to bring the two assemblies into a suitable position for the relative rotation. Since the contact surfaces 17 are arranged directly in front of the abutments 16 only a small rotational movement or a small rotary angle is necessary in order to fix the heating elements 10. This prevents the heating elements 10 from rubbing over the second polygon profile 14' and becoming damaged during relative rotation.

[0064] The core 18 corresponds substantially to the core 18 of the example shown in Figs. 1 and 2. The differences will be explained in further detail below.

[0065] The core 18 shown in Figs. 3 and 4 comprises no fastening points 24. The regulation unit 20 has a groove for a circlip. The regulation unit 20 can be arranged by the circlip in a holder 25 and be clamped together with the holder 25 in the centre of the inner profile of the core 18. For this purpose, the holder 25 has two clamping elements 26 which are arranged at the sides and which are oriented parallel to one another and which in the installed state interact with two opposing inner sides of the inner profile of the core, in particular the inner hexagon.

[0066] The clamping elements 26 extend axially opposite the installation direction

and each form an angle of at least 90°. In order to create a higher clamping force, the clamping elements 26 have teeth which extend opposite the installation direction and are angled towards the outside. A stop is formed at each free axial end of the clamping elements 26 and limits the installation depth of the holder 25.

[0067] Fig. 5 and Fig. 6 show a further exemplary embodiment of a holding body according to the invention.

[0068] The spacer frame 23 and the outer part assembly 11 are identical with the components of Figs. 3 and 4.

[0069] The inner part assembly 12 is formed in this example in such manner that the abutments 16 for the heating elements 10 are arranged on the second polygon corners 14a'. This has the result that the second polygon profile 14' is smaller than in the preceding examples. The abutments 16 correspond substantially to the abutments 16 of Figs. 3 and 4. Contrary to this, with the example illustrated in Figs. 5 and 6 there are no contact surfaces 17 since during the relative rotation the heating elements are in any case only in contact for a short portion with the second polygon side 14b'.

[0070] The core 18 corresponds substantially to the core of Figs. 1 to 4 with the difference that the webs 19 connect the core 18 to the inner surfaces of the second polygon sides 14b' and not to the inner surfaces of the second polygon corners 14a'. This has the advantage that a greater elastic deformation of the first and second polygon corners 14a, 14a' is possible.

[0071] The regulation unit 20 is arranged by a circular holder 25 inside the core 18. The holder 25 has clamping elements 26. The clamping elements 26 each form an angle of 90° and extend axially in the installation direction. The free axial ends are inclined inwards in order to be able to insert the holder 25 more easily into the core 18. The clamping elements 26 each have teeth which correspond substantially to the teeth of Figs. 3 and 4. Other forms or structures are alternatively conceivable which increase the clamping force.

[0072] Fig. 7 shows an exemplary diagrammatic circuit diagram in which the heating elements 10 and the components of the regulation unit 20 are connected to one another by a star connection. The heating elements 10 are each connected to a phase of the voltage source. A temperature monitor 21 is arranged between the lines L1 and L3 and the heating elements 10. The thermal fuse 22 is arranged between the temperature monitor 21 and the heating elements 10 of the lines L1 and L3. Another arrangement of the components of the regulation unit 20 is conceivable. It is sufficient in the event of an excessive temperature to break two lines in order to switch off the heating apparatus.

[0073] Fig. 8 shows an exemplary embodiment of a heating apparatus. The heating apparatus comprises the holding body with the spacer frame 23 as well as the first and the second polygon profiles 14, 14'. The first and second polygon profiles 14, 14' have ribs. Otherwise the polygon profiles 14, 14' correspond substantially to the polygon profiles 14, 14' described in Figs. 1 and 2. The heating elements 10 are arranged between the polygon profiles 14, 14' analogous with Figs. 1 and 2. A grid structure 30 is arranged at the axial end, in the direction of the air stream, of the holding body. The grid structure 30 is or can be connected to the holding body by the fastening points 24.

[0074] A fitment 29 is arranged at the opposite axial end of the holding body. The fitment 29 comprises a ventilator 28, a circular disc 27 with webs and a grid structure 30'. The fitment 29 is connectable to the holding body, for example by pushing on and/or by the fastening points 24 or detent elements. The ventilator 28 is arranged inside the fitment 29, concentrically with the holding body. A circular disc 27 is arranged on the pressure side of the ventilator 28. The diameter of the circular disc 27 corresponds approximately to the diameter of the inner profile of the core 18. Other forms are conceivable for the circular disc 27. The circular disc has webs which extend radially and which can be connected to the fastening points 24. The circular disc 27 protects the ventilator 28 against heat radiation. The circular disc 27 furthermore directs the air stream into the edge regions of the holding body. I.e. the air steam does not flow through the inner profile of the core

18, but preferably only through the edge regions in which the heating elements 10 are preferably arranged. The heating elements 10 are arranged in the region of the highest air stream. A temperature regulator 21 and a thermal fuse 22 are arranged in the core 18.

5

Reference numeral list

[0075]

10	Heating elements
11	Outer part assembly
12	Inner part assembly
13	Receiving means
14	First polygon profile (outer part assembly)
14'	Second polygon profile (inner part assembly)
14a	First polygon corner (outer part assembly)
14a'	Second polygon corner (inner part assembly)
14b	First polygon side (outer part assembly)
14b'	Second polygon side (inner part assembly)
15	Wall portion
16	Abutment
17	Contact surface
18	Core
19	Web
20	Regulation unit
21	Temperature monitor
22	Thermal fuse
23	Spacer frame
24	Fastening points
25	Holder
26	Clamping elements
27	Circular disc
28	Ventilator
29	Spacer frame
30	Grid structure

Patentkrav

1. Holdelegeme til varmeelementer (10), især ovale og runde varmeelementer (10), med et yderdel-modul (11) og et inderdel-modul (12), der er anbragt inden for yderdel-modulet (11) og sammen med yderdel-modulet (11) danner en elastisk, under mekanisk spænding stående forbindelse, hvor yderdel-modulet (11) og/eller inderdel-modulet (12) har flere optagelser (13), der er anbragt fordelt i omkredsretningen, og i hvilke der hver gang er anbragt et varmeelement (10), og yderdel-modulet (11) og inderdel-modulet (12) hvert især omfatter et polygonprofil (14, 14') med polygonhjørner (14a, 14a') og polygonsider (14b, 14b'), som forbinder polygonhjørnerne (14a, 14a'),
kendetegnet ved, at
inderdel-modulet (12) og yderdel-modulet (11) kan drejes relativt i forhold til hinanden og er konstrueret sådan, at ved en relativ drejning mellem inderdel-modulet (12) og yderdel-modulet (11) deformeres polygonprofilerne (14, 14') elastisk sådan, at der i den monterede tilstand på grund af den inducerede mekaniske spænding er dannet en prespasning i varmeelementernes (10) område.

2. Holdelegeme ifølge krav 1,
kendetegnet ved, at
varmeelementerne (10) i den monterede tilstand er anbragt mellem polygonsiderne (14b, 14b') og/eller polygonhjørnerne (14a, 14a').

3. Holdelegeme ifølge krav 1 eller 2,
kendetegnet ved, at
optagelserne (13) hver især har vægafsnit (15), der er tilpasset til varmeelementerne (10) og i det mindste delvist omslutter disse i varmeelementernes (10) omkredsretning.

4. Holdelegeme ifølge krav 3,
kendetegnet ved, at
en optagelses (13) vægafsnit (15) hver gang delvist er dannet af yderdel-modulet (11) og inderdel-modulet (12), hvor et første vægafsnit (15) har en krumningsvinkel på $K \geq 180°$, og et andet vægafsnit (15) er fladt eller har en krumningsvinkel på $K < 180°$.

5. Holdelegeme ifølge et af de foregående krav,
kendetegnet ved, at
yderdel-modulet (11) danner optagelserne (13), og inderdel-modulet (12) vederlag (16) for varmeelementerne (10) eller omvendt, hvor varmeelementerne (10) i den monterede tilstand er presset mod vederlaget (16).

6. Holdelegeme ifølge krav 5,
kendetegnet ved, at
der i montageretning før vederlagene (16) hver gang er anbragt en kontaktflade (17) for varmeelementerne (10) for at positionere varmeelementerne (10) i en egnet stilling for montagen.

7. Holdelegeme ifølge krav 6,
kendetegnet ved, at
kontaktfladerne (17) er udformet skråt eller konkavt.

8. Holdelegeme ifølge et af de foregående krav,
kendetegnet ved, at
en kerne (18) er anbragt koncentrisk i inderdel-modulet (12) og ved hjælp af ribber (19) er forbundet med inderdel-modulet (12), og/eller kernen (18) danner et indvendigt profil til optagelse af et værktøj, især at kernens (18) indvendige profil er udformet som indvendig sekskant til optagelse af et værktøj.

9. Holdelegeme ifølge krav 8,
kendetegnet ved, at
der på kernen (18) er anbragt en reguleringsenhed (20), der omfatter en temperaturvogter (21) henholdsvis en temperaturregulator og en temperatursikring (22), der er elektrisk forbundet med varmeelementerne (10) ved hjælp af en stjernekobling.

10. Holdelegeme ifølge et af de foregående krav,
kendetegnet ved, at
polygonprofilerne (14, 14') omfatter i det mindste tre polygonhjørner (14a, 14a') og tre polygonsider (14b, 14b').

11. Holdelegeme ifølge krav 10,
kendetegnet ved, at
polygonprofilernes (14, 14') tilstødende polygonhjørner (14a, 14a') hver især har den samme afstandsvinkel, og/eller polygonprofilernes (14, 14') polygonhjørner (14a, 14a') i den monterede tilstand er forskudt sådan i forhold til hinanden, at polygonhjørnerne (14a, 14a') er orienteret i det mindste tilnærmelsesvist i midten i forhold til de overfor anbragte polygonsider (14b, 14b').

12. Holdelegeme ifølge krav 11,
kendetegnet ved, at
polygonprofilernes (14, 14') polygonhjørner (14a, 14a') i den monterede tilstand er orienteret tilnærmelsesvist ens.

13. Holdelegeme ifølge et af de foregående krav,
kendetegnet ved, at
polygonprofilerne (14, 14') afsnitsvist er udformet konkavt, konvekst eller lige, og/eller polygonprofilerne (14, 14') har en ribbestruktur eller en lamelstruktur.

14. Holdelegeme ifølge et af de foregående krav,
kendetegnet ved, at
yderdel-modulet (11) er sammenføjet af flere dele og er lukket med plader, især aluminiumsplader.

15. Varmeapparat med et holdelegeme ifølge et af de foregående krav, hvor en aksial ende af holdelegemet er forbundet med en ventilator sådan, at holdelegemet i længderetningen kan gennemstrømmes med luft.

16. Fremgangsmåde til montage af et holdelegeme ifølge krav 1, ved hvilken varmeelementerne (10) anbringes i de tilhørende optagelser (13), inderdel-modulet (12) derefter indføres i yderdel-modulet (11) og drejes med et værktøj, der samvirker med kernen (18), indtil varmeelementerne (10) på grund af den mekaniske spænding, der er induceret af den elastiske deformering af polygonprofilerne (14), er fikseret mellem inderdel-modulet (12) og yderdel-modulet (11).

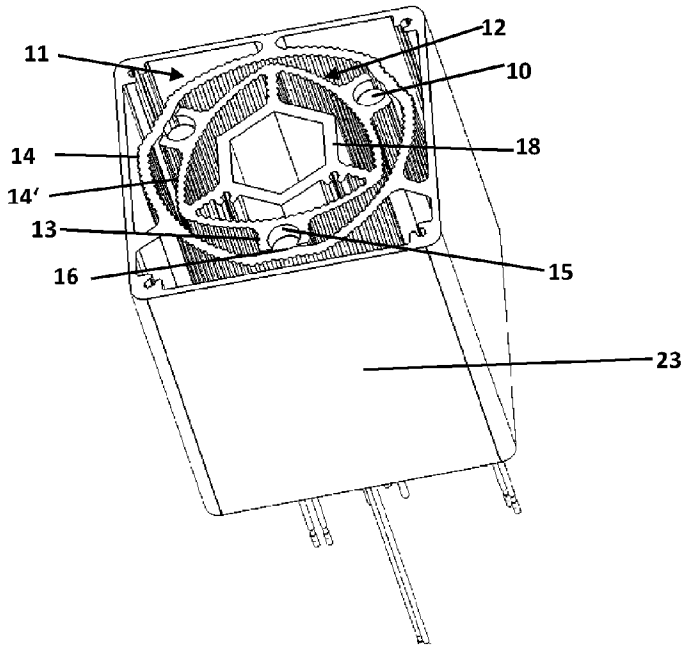
11
12
10
14
18
14'
13
15
16
23

Fig. 1

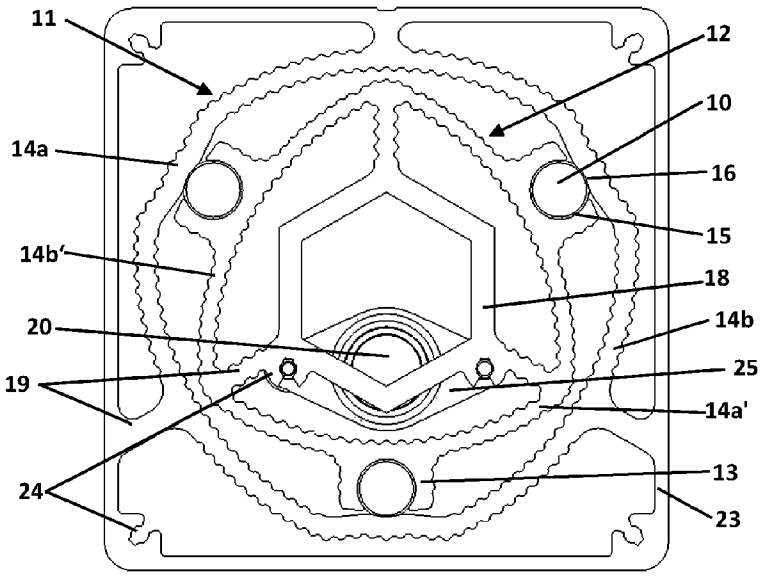
11
12
14a
10
16
15
14b'
18
20
14b
19
25
14a'
24
13
23

Fig. 2

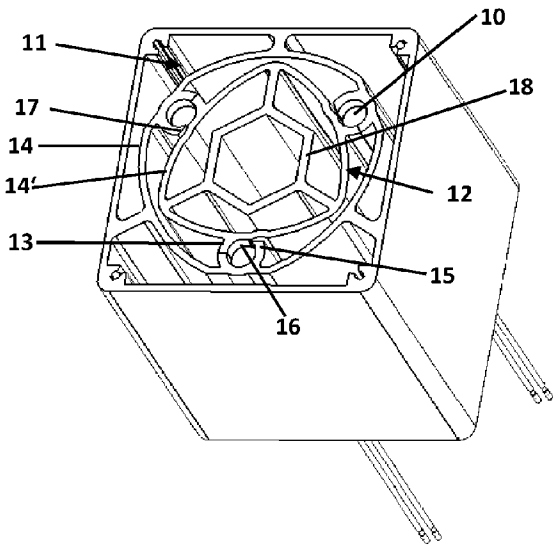
11
10
18
17
14
14'
12
13
15
16

Fig. 3

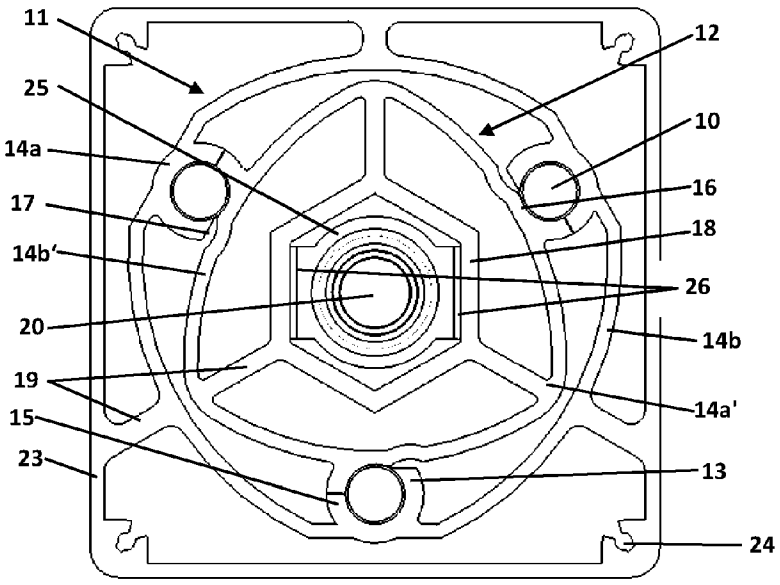
11
12
25
10
14a
16
17
18
14b'
26
20
14b
19
14a'
15
23
13
24

Fig. 4

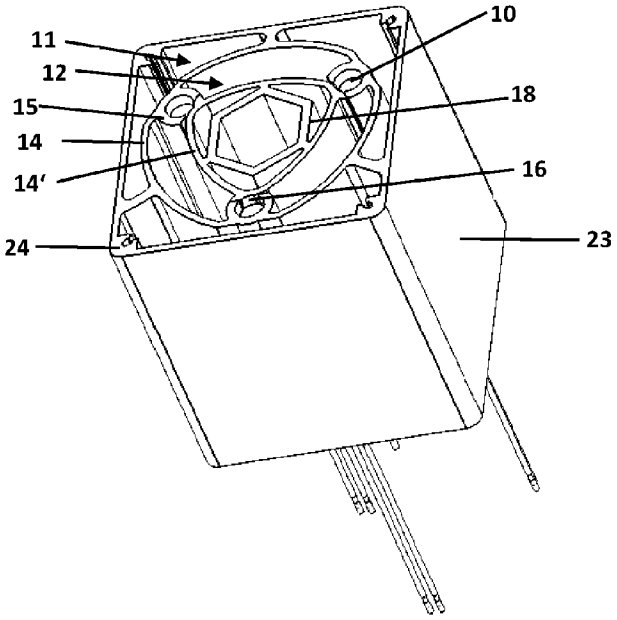
11
12
15
14
14'
24
10
18
16
23

Fig. 5

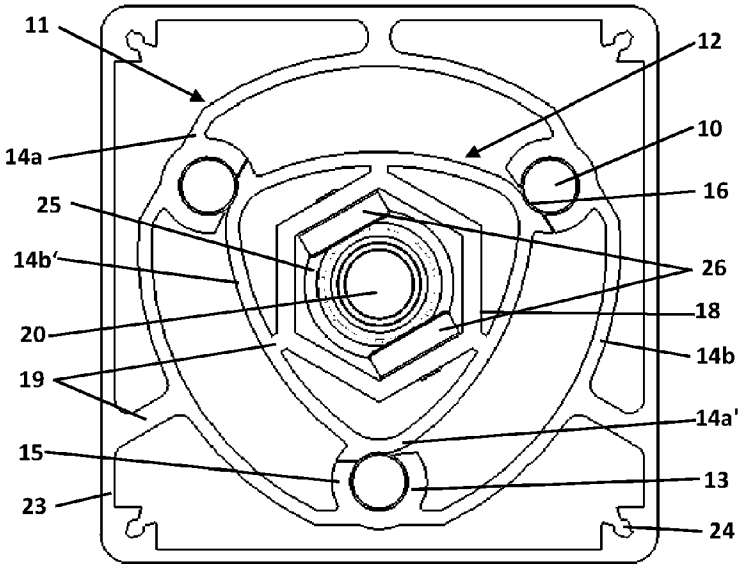
11
14a
25
14b'
20
19
15
23
12
10
16
26
18
14b
14a'
13
24

Fig. 6

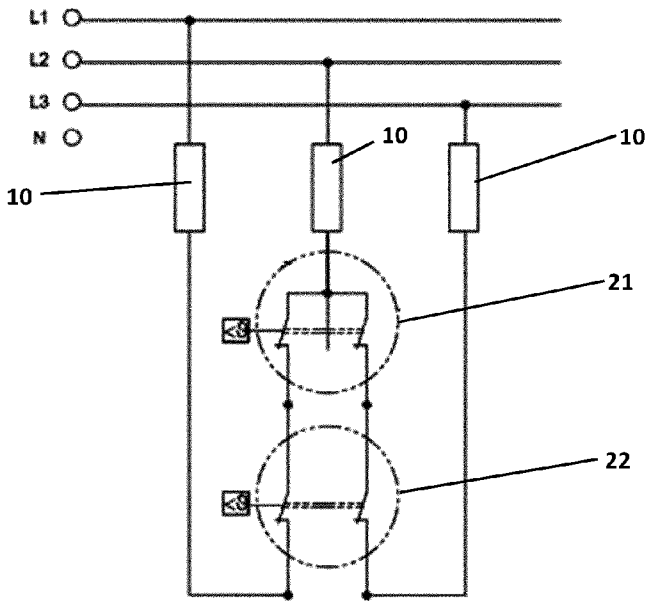

Fig. 7

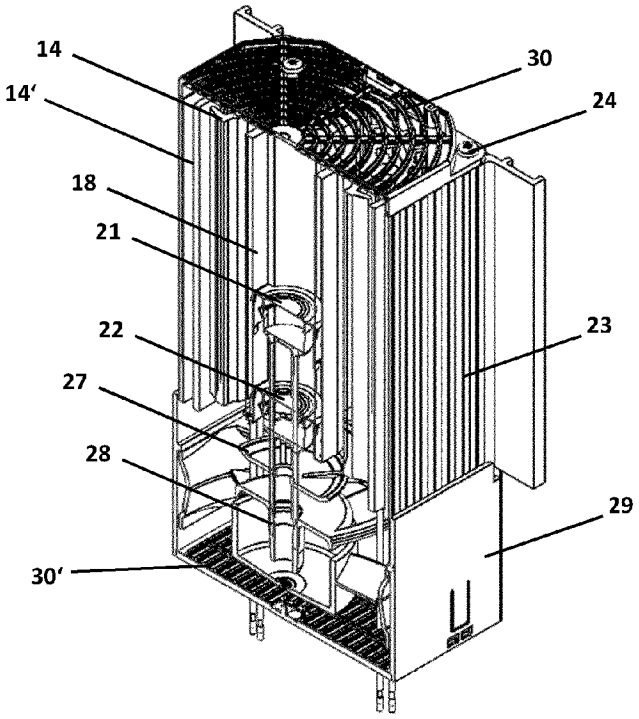

Fig. 8