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(54) **HEAT PUMP**

(57) The invention relates to a Heat pump comprising at least one electrically operated switch, an electrical cable assembly and a connection device for connecting said electrically operated switch to said electrical cable assembly, the device comprising:
a main body having a front surface to be oriented towards the switch and a rear surface to be oriented towards the cable assembly, and at least a through-hole extending along the main body and having a front opening for receiving a male plug of the switch and a rear opening for

receiving a terminal cable connector, in particular a female crimp terminal, the terminal cable connector having a first end connectable to the male plug of the switch and a second end connectable to a cable of the cable assembly, wherein the device further comprises fixing means located inside the through-hole for engaging the terminal cable connector and maintaining the terminal cable connector completely inserted in the through-hole and preventing the second end of the terminal cable connector from exiting the rear opening during a connection phase.

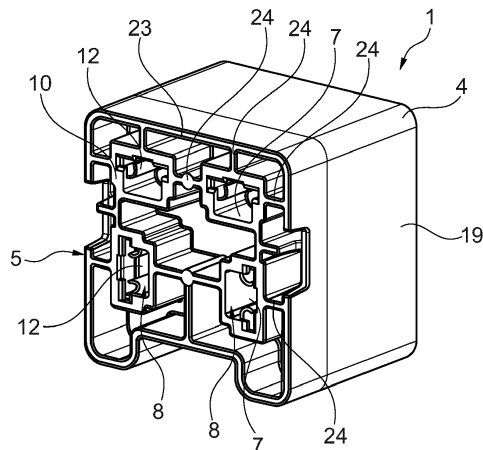


Fig. 2A

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Description

[0001] The invention relates to a heat pump comprising a connection device for connecting an electrically operated switch to an electrical cable assembly. Also, the invention relates to a method for producing said connection device. The invention furthermore relates to a combustion appliance for heating comprising said heat pump.

[0002] Currently, several heat pump products include an electrical back-up. This function is produced with the help of heating elements controlled by electrical relays or electrically operated switch. Each relay is connected to an electrical harness or cable assembly (power and command) through a connector. The end of each cable of the cable assembly usually comprises a crimp terminal that is inserted into the through-holes of the connector to establish an electrical contact with the plugs of the relay.

[0003] However, the reliability of this type of connectors is not always optimal. In fact, due to the plugging effort, the crimp terminals can go outside of the compartment in the connector during the connection phase, thereby causing electrical contact issues between the relay and the electrical harness. In addition, this type of connector is suspected to be the root cause of an overheating phenomenon. These effects can be responsible for early deteriorations on the relay board.

[0004] It is therefore desirable to obtain a reliable, safe, easy to assemble to a relay, and easy to manufacture connection device able to increase the stability of the electrical contacts between the relay and an electrical harness, thereby avoiding that the crimp terminal of the cables exits the through-holes of the connector during the operational phase.

[0005] The object is solved by a heat pump comprising:

at least one electrically operated switch,
 an electrical cable assembly and
 a connection device for connecting said electrically operated switch to said electrical cable assembly, the device comprising:
 a main body having a front surface to be oriented towards the switch and a rear surface to be oriented towards the cable assembly, and
 at least a through-hole extending along the main body and having a front opening (8) for receiving a male plug of the switch and a rear opening for receiving a terminal cable connector, in particular a female crimp terminal, the terminal cable connector having a first end connectable to the male plug of the switch and a second end connectable to a cable of the cable assembly,
 wherein the device further comprises fixing means located inside the through-hole for engaging the terminal cable connector and maintaining the terminal cable connector completely inserted in the through-hole and preventing the second end of the terminal cable connector from exiting the rear opening during

a connection phase.

[0006] Advantageously, connections issues can be avoided. In particular, the fixing means can hold the terminal cable connector inside the main body of the connector, without the risk that hazardous situations occur, e.g. active parts of the electrical contacts between the relay and the cable assembly are pushed outside the connection device and can be potentially reached with a finger. With cable assembly is intended for example a cable harness.

[0007] In particular, this connection device represents a connection interface between male plugs of an electrically operated switch and an electrical harness with crimpable female end pieces, wherein the switch allows to supply power from control signal. This connection interface allows a connection with many electrical wires and the electrical switch in easy and fast way. In fact, only one manipulation is required for the connection phase. Furthermore, the connection occurs in a simultaneous way, since the crimpable female end pieces are in contact at the same time with the male plugs of the electrical switch, and without using any specific connecting tool.

[0008] In addition, when the connection is created, the required effort to disconnect the interface is sufficient to prevent all unexpected disconnections.

[0009] In one example, the front surface is provided with a ribbed frame and an external edge enclosing said ribbed frame, wherein the front opening is connected to the external edge through at least a rib element.

[0010] In addition or in alternative, the connection device comprises a plurality of through holes and the front surface is provided with a ribbed frame and an external edge enclosing said ribbed frame, wherein each front opening is connected to a neighbor front opening through at least a rib element.

[0011] In addition or in alternative, the rear surface is provided with a ribbed frame and an external edge enclosing said ribbed frame, wherein the rear opening is connected to the external edge through at least a rib element.

[0012] In addition or in alternative, the connection device comprises a plurality of through holes and the rear surface is provided with a ribbed frame and an external edge enclosing said ribbed frame, wherein each rear opening is connected to a neighbor rear opening through at least a rib element.

[0013] The ribbed frame allows an easy grip and helps the positioning of the interface in relation to the electrical switch during the connection phase. This function is created by the external surface of the part. The ribs take part in the fool proofing function of the interface. Its external shape is designed to avoid collisions with the assembly surrounding (screw head, mounting support).

[0014] In another example, the fixing means comprise an elastic clip for holding the terminal cable connector and preventing said terminal cable connector from exiting the rear opening during the connection phase. In partic-

ular, the elastic clip is provided in each through hole and produces the hold and the non-return function of the crimpable electrical end pieces during the connection phase.

[0015] The fixing means can be in a locking configuration when the terminal cable connector is inserted through the rear opening and is pushed towards the front opening, thereby causing a downward movement followed by an upward movement of the fixing means. Also, the fixing means can be in an unlocking configuration when a disengagement tool is inserted in the front opening to push or pull said fixing means, thereby causing a downward movement of the fixing means in order to disengage the terminal cable connector.

[0016] In one example, in order to ensure that the needed center distance and the orientation of the electrical end pieces are correct to allow the mounting on the electrical switch, the device can further comprise guiding means located inside each through-hole for positioning and orienting the terminal cable connector inside the through-hole. The guiding means can be part of the fixing means. In other words, the fixing means can work at the same time as guiding means when the terminal cable connector is inserted into the rear opening. In addition or in alternative, the guiding means can have a wing shape defining a gradual cross section variation in the through-hole.

[0017] According to an example, the front opening has a different outline compared to the rear opening. The front opening can have a T-shaped outline with a first opening portion and a second opening portion, wherein the first opening portion is thinner than the second opening portion for receiving the male plug of the switch. The rear opening can have a rectangular outline. In this way, the connector is designed to avoid it to be inserted in the wrong way.

[0018] In another example, the front opening can comprise a chamfered edge for receiving the male plug of the switch. In addition or in alternative, the front opening can have a T-shaped outline with a first opening portion and a second opening portion, wherein the first opening portion comprises a chamfered edge.

[0019] It is noted that the particular outline and configuration of the front opening, allows a quick and safe connection between the male plug of the switch and the terminal cable connector and also the easy disassembly of the terminal cable connector using a tool like a flat-blade screwdriver.

[0020] In a further example, the front opening comprises abutting edges for preventing the terminal cable connector from exiting the front opening once inserted in the through-hole.

[0021] Advantageously, the device is realized as a one-piece structure. In other words, the device can be a single solid part. In particular, the main body can be made of a thermoplastic material, in particular a thermoplastic polymer with particular fire resistance such as PA66, PA6, ABS, POM, or PC or a thermoset as UP, PF, EP, PI. These materials can contain fiberglass.

[0022] In an example, the connection device comprises a plurality of through holes each having a hole length configured to prevent electrical interference among the connections of each cable of the cable assembly with the corresponding male plug of the switch during an operational phase.

[0023] In another example, the connection device comprises a plurality of through holes with a plurality of front openings, each front opening having an average first distance from an external edge of the front surface and an average second distance from a neighbor front opening, said first distance and second distance being configured to prevent electrical interference among the connections of each cable of the cable assembly with the corresponding male plug of the switch during an operational phase.

[0024] In a similar way, the connection device can comprise a plurality of through holes with a plurality of rear openings, each rear opening having an average first distance from an external edge of the rear surface and an average second distance from a neighbor rear opening, said first distance and second distance being configured to prevent electrical interference among the connections of each cable of the cable assembly with the corresponding male plug of the switch during an operational phase.

[0025] In particular, the deep of each through hole is designed according to the suitable creepage and clearance distances according to the voltage going through the harness. Touching the active parts with a finger when the circuit is on load is also prevented by this particular configuration of the connector. The opening on the rear side of each through hole (e.g. the rear opening on the rear surface) is configured to facilitate an angular movement of the wires, to make the assembly easier.

[0026] In a further example, the through-holes are arranged in rows and columns to form a matrix, wherein the cross section of the through-holes in one row is different from the cross section of the through-holes in a different row. Additionally or alternatively, the through-holes are arranged in rows and columns to form a matrix, wherein the cross section of the through-holes in one column is different from the cross section of the through-holes in a different column. Additionally or alternatively, the through-holes are arranged in rows and columns to form a matrix, wherein the through-hole in one element of the matrix is different from the cross section of the through-hole in a different element of the matrix.

[0027] According to one aspect of the invention, a method for producing the inventive connection device is provided. The method uses in particular an injection process of a thermoplastic material, in particular a thermoplastic polymer such as PA66, PA6, ABS, POM, or PC or a thermoset as UP, PF, EP, PI.

[0028] According to one aspect of the invention, a combustion appliance for heating, in particular a gas boiler, is provided, the combustion appliance comprising the connection device or the heating pump. Examples of combustion appliances for heating can include furnaces,

water heaters, boilers, direct/in-direct make-up air heaters, power/jet burners and any other residential, commercial or industrial combustion appliance.

[0029] In particular, the appliance for heating can be a gas boiler for the combustion of hydrogen gas. In this case, it is intended a fuel gas that comprises at least 20 mol% or more than 20 mol% hydrogen or natural gas or mixtures thereof.

[0030] In addition, the appliance for heating can be a climatic appliance for heating using a fluid as a medium.

[0031] In the figures, the subject-matter of the invention is schematically shown, wherein identical or similarly acting elements are usually provided with the same reference signs.

Figure 1 shows a schematic representation of a connection device according to an example.

Figure 2A-2B show a perspective view of the front surface of the connection device according to an example.

Figure 3 shows a perspective view of the rear surface of the connection device according to an example.

Figure 4 shows a schematic representation of a cross section of the connection device according to an example.

[0032] With reference to figure 1 a representation of the connection device 1 is shown. Said connection device 1 is a part of a non-shown heat pump. The connection device 1 has a main body 4 and is interposed between an electrical relay or an electrically operated switch 2 and a cable assembly 3, wherein in particular the front surface 5 of the device 1 faces the switch 2 and the rear surface 6 of the device 1 faces the cable assembly 3. The electrical relay or electrically operated switch 2 and the cable assembly 3 are part of the non-shown heat pump. For the sake of simplicity, figure 1 shows a cable assembly 3 with only two cables. However, a higher number of cables can also be considered. It is noted that each cable of the cable assembly 3 is provided with a terminal cable connector 12, for example a female crimp terminal. The female crimp terminal 12 is fixable to the end of the cable that needs to be put into contact with the switch 2. As shown in the figure, the switch 2 is provided with a plurality of male plugs 20, (two male plugs 20 are represented in the figure). The electrical contact between the cable assembly 3 and the switch 2 occurs through the insertion of the male plug 20 into the corresponding female crimp terminal 12.

[0033] The connection device 1 helps to maintain stable said electrical contact. The connection device 1 is in fact provided with a plurality of through-holes 7 (two through-holes 7 are represented in the figure). Each fe-

male crimp terminal 12 is introduced into one of the through-holes 7 passing through the rear opening 9 (not shown in the figure) on the rear surface 6 and is pushed in the through-hole 7 towards the front surface 5. At a certain point, the female crimp terminal 12 is held in position by fixing means 11 that are put in a locking configuration and is prevented from moving forwards and/or backwards. The fixing means 11 are represented in the figure as small dots; this is of course just a symbolic representation for the sake of clarity of the figure. Once the female crimp terminal 12 is fixed inside the through-hole 7, the male plugs 20 of the switch 2 can be inserted in the corresponding female crimp terminals 12 passing through the front opening 8 (not shown in the figure) of the front surface 5. Accordingly, each female crimp terminal 12 is prevented from exiting the rear opening 9 during the connection phase. To disengage the female crimp terminals 12 from the connection device 1, the switch 2 can be first removed and a disengaging tool, such as a simple screwdriver, can be inserted in each of the front openings 8 to move the fixing means from the locking configuration to the unlocking configuration. Each female crimp terminal 12 can then be extracted from the through-hole 7 via the corresponding rear opening 9.

[0034] Figure 2A shows the front side of the connection device 1 and figure 2B shows a detail of the upper part of this front side. The front surface 5 shows a plurality, i.e., four, front openings 8 meaning that the device 1 comprises a plurality, i.e. four, through-holes 7. It is noted that the device 1 comprises a lateral surface 19 extending between the front surface 5 and the rear surface 6.

[0035] The front openings 8 are arranged in rows and columns to form a 2x2 matrix configuration. It is clear that other matrix configurations $n \times n$ or $n \times m$, with $n \neq m$, and $n, m > 2$, are also possible. The front openings 8 have a T-shaped outline with a first opening portion 15 thinner than a second opening portion 16. The outline of the front opening 8 is better shown in figure 2B, wherein the first opening portion 15 represents the top of the T-shaped outline and the second opening portion 16 represents the stem of the T-shaped outline. The first opening portion 15 is intended for the insertion of the male plugs 20 of the electrical switch. The particular configuration of this portion 15 ensures a fool proofing function during the connection phase and can let a disengaging tool, like a screwdriver, to go in to push against the fixing means 11 in order to disassemble the terminal cable connector 12.

[0036] In addition, the first opening portion 15 is provided with a chamfered edge 17 for facilitating the insertion of the male plug 20 of the switch 2 and for making the mounting easier. According to the figure, the chamfered edge 17 basically extends on the entire border of the first opening portion 15. However, the chamfered edge 17 can be provided on a partial region of the first opening portion 15.

[0037] It is noted that the cross-section of the through-holes 7 is not always the same. In other words, whereas the cross-section of the through-holes 7 located on the

top row is identical, i.e., the T-shaped outline of the two front openings 8 is oriented in the same way, the cross-section of the through-holes 7 located on the bottom row is different, i.e., the T-shaped outline of the front opening 8 on the left side in the figure is rotated by 180° compared to the T-shaped outline of the front opening 8 on the right side in the figure. Also, the cross-section of the through-holes 7 located in the first column (as well as in the second column) is different, i.e., the T-shaped outline of the front opening 8 on the top of the first column (as well as of the second column) is rotated by 90° compared to the T-shaped outline of the front opening 8 on the bottom in the figure. This configuration ensures a suitable creepage and clearance distances according to the voltage going through the cable assembly 3.

[0038] From the figure 2A can be appreciated that the female crimp terminals (terminal cable connectors) 12, when inserted in the through-holes 7, reach the front opening 8 but are prevented from exiting said front opening 8 by abutting edges 18.

[0039] The front surface 5 of the connection device 1 is provided with a ribbed frame 10 and an external edge 23 enclosing the ribbed frame 10. Each front opening 8 is connected to the external edge 23 through at least a rib element 24. Also, a rib element 24 connects each front opening 8 to a neighbor front opening 8. For example, two front openings 8 in the same row are connected by a rib element 24 having a longitudinal and circular cross-section and two front openings 8 in the same column are connected by a rib element 24 having a longitudinal cross-section.

[0040] Figure 3 shows the rear side of the connection device 1 already shown in figures 2A and 2B. Accordingly, the rear surface 6 shows four rear openings 9 arranged in a 2x2 matrix. The rear openings 9 have a different outline compared to the front openings 8. In particular, the rear openings 9 have a rectangular outline. Similar to the configuration of the front openings 8, the rectangular outline of the two rear openings 9 in the top row is oriented in the same way, whereas, the rectangular outline of the rear opening 9 on the left side in the bottom row is rotated by 180° compared to the rectangular outline of the rear opening 9 on the right side. Also, the cross-section of the rectangular outline of the rear opening 9 on the top of the first column (as well as of the second column) is rotated by 90° compared to the rectangular outline of the rear opening 9 on the bottom in the figure.

[0041] Similar to the front surface 5, the rear surface 6 of the connection device 1 is provided with a ribbed frame 10 and an external edge 23 enclosing the ribbed frame 10. Each rear opening 9 is connected to the external edge 23 through at least a rib element 24. Also, a rib element 24 connects each rear opening 9 to a neighbor rear opening 9. For example, two rear openings 9 in the same row are connected by a rib element 24 having a longitudinal and circular cross-section and two rear openings 9 in the same column are also connected by a rib element 24 having a longitudinal and circular cross-

tion.

[0042] As shown in the figures 2A, 2B and 3, the device 1 is a single solid part and is realized as a one-piece structure. Advantageously, the main body is made of a thermoplastic polymer using an injection process.

[0043] From the figure 3 can be appreciated that the female crimp terminals (terminal cable connectors) 12, can be inserted into the through-holes 7 passing through the rear openings 9.

[0044] By comparing figures 2B and 3, it is noted that each front opening 8 and each rear opening 9 have an average first distance d_1 from the external edge 23 and an average second distance d_2 from a neighbor front opening 8 and each rear opening 9. In particular, the average first distance d_1 represents the distance between the external edge 23 and the middle of the front/rear opening 8, 9, whereas the average second distance d_2 represents the distance between the middle of two neighbor front/rear openings 8, 9. Although the figures show the distance d_2 between two openings in the same row, the same concept is also valid for two openings in the same column. It is clear that based on the different outlines of the front and rear opening 8, 9 and based on the different orientation of the through-holes in a row or in a column of the front/rear opening matrix, d_1 and d_2 can vary based on the position of the opening. The values of d_1 and d_2 are chosen in order to prevent electrical interference among the connections of each cable of the cable assembly 3 with the corresponding male plug 20 of the switch 2 during the operational phase.

[0045] Figure 4 shows a lateral cross section of the connection device 1, wherein the female crimp element 12 is inserted in the through-hole 7 and fixed in position by the fixing means 11. In particular, the female crimp terminal 12 comprises a first end 21 connectable to the male plug 20 of the switch 2 and a second end 22 connectable to the cable of the cable assembly 3. It is noted that the through hole 7 has a hole length L configured to prevent electrical interference among the connections of each cable of the cable assembly 3 with the corresponding male plug 20 of the switch 2 during an operational phase. In addition, the hole length L is such that, when held in position by the fixing means 11, the female crimp terminal 12 is maintained in the through-hole 7, thereby preventing the second end 22 from exiting the rear opening 9.

[0046] In order to hold the female crimp terminal 12, the fixing means 11 comprise an elastic clip 13. In particular, in a locking configuration of the fixing means 11, the female crimp terminal 12 (i.e., the first end 21 of the female crimp terminal 12) is inserted through the rear opening 9 and is pushed towards the front opening 8, thereby causing a downward movement followed by an upward movement of the clip 13. The first end 21 of the female crimp terminal 12 abuts against the abutting edge 18 of the front opening 8. This is shown in figure 4.

[0047] In the unlocking configuration of the fixing means 11, a disengagement tool (not shown) can be in-

serted in the front opening 8 to push the fixing means 11, thereby causing a downward movement of the clip 13 in order to disengage the female crimp terminal 12.

[0048] It is noted that guiding means 14 are located inside each through-hole 7 for positioning and orienting the female crimp terminal 12 inside the through-hole 7. The guiding means 14 can also be seen from the rear opening 9, as shown in figure 3. The guiding means 14 are part of the fixing means 11 and have a wing or slope shape defining a gradual cross section variation in the through-hole 7.

Reference Signs

[0049]

1	Connection device
2	Switch
3	Cable assembly
4	Main body
5	Front surface
6	Rear surface
7	Through-hole
8	Front opening
9	Rear opening
10	Ribbed surface
11	Fixing means
12	Terminal cable connector
13	Elastic clip
14	Guiding means
15	First opening
16	Second opening
17	Chamfered edge
18	Abutting edge
19	Lateral surface
20	Male plug
21	First end
22	Second end
23	External edge
24	Rib element
L	Hole length
d1	First distance
d2	Second distance

Claims

1. Heat pump comprising:

at least one electrically operated switch (2), an electrical cable assembly (3) and a connection device (1) for connecting said electrically operated switch (2) to said electrical cable assembly (3), the device (1) comprising: a main body (4) having a front surface (5) to be oriented towards the switch (2) and a rear surface (6) to be oriented towards the cable assembly (3), and

at least a through-hole (7) extending along the main body (4) and having a front opening (8) for receiving a male plug (20) of the switch (2) and a rear opening (9) for receiving a terminal cable connector (12), in particular a female crimp terminal, the terminal cable connector (12) having a first end (21) connectable to the male plug (20) of the switch (2) and a second end (22) connectable to a cable of the cable assembly (3), wherein the device (1) further comprises fixing means (11) located inside the through-hole (7) for engaging the terminal cable connector (12) and maintaining the terminal cable connector (12) completely inserted in the through-hole (7) and preventing the second end (22) of the terminal cable connector (12) from exiting the rear opening (9) during a connection phase.

2. Heat pump according to claim 1, characterized in that

- the front surface (5) is provided with a ribbed frame (10) and an external edge (23) enclosing said ribbed frame (10), wherein the front opening (8) is connected to the external edge (23) through at least a rib element (24), and/or
- the connection device (1) comprises a plurality of through holes (7) and the front surface (5) is provided with a ribbed frame (10) and an external edge (23) enclosing said ribbed frame (10), wherein each front opening (8) is connected to a neighbor front opening (8) through at least a rib element (24); and/or
- the rear surface (6) is provided with a ribbed frame (10) and an external edge (23) enclosing said ribbed frame (10), wherein the rear opening (9) is connected to the external edge (23) through at least a rib element (24), and/or
- the connection device (1) comprises a plurality of through holes (7) and the rear surface (6) is provided with a ribbed frame (10) and an external edge (23) enclosing said ribbed frame (10), wherein each rear opening (9) is connected to a neighbor rear opening (9) through at least a rib element (24).

3. Heat pump according to any one of claims 1 to 2, characterized in that

- the fixing means (11) comprise an elastic clip (13) for holding the terminal cable connector (12) and preventing said terminal cable connector (12) from exiting the rear opening (9) during the connection phase, and/or
- the fixing means (11) are in a locking configuration when the terminal cable connector (12) is inserted through the rear opening (9) and is pushed towards the front opening (8), thereby

- causing a downward movement followed by an upward movement of the fixing means (11), and/or
 c. the fixing means (11) are in a unlocking configuration when a disengagement tool is inserted in the front opening (8) to push or pull said fixing means (11), thereby causing a downward movement of the fixing means (11) in order to disengage the terminal cable connector (12).
4. Heat pump according to any one of claims 1 to 3, **characterized in that** the device (1) further comprises guiding means (14) located inside each through-hole (7) for positioning and orienting the terminal cable connector (12) inside the through-hole (7).
5. Heat pump according to claim 4, **characterized in that**:
- a. the guiding means (14) are part of the fixing means (11), and/or
 b. the guiding means (14) have a wing shape defining a gradual cross section variation in the through-hole (7).
6. Heat pump according to any one of claims 1 to 5, **characterized in that**:
- a. the front opening (8) has a different outline compared to the rear opening (9); and/or
 b. the front opening (8) has a T-shaped outline with a first opening portion (15) and a second opening portion (16), wherein the first opening portion (15) is thinner than the second opening portion (16) for receiving the male plug (20) of the switch (2), and/or
 c. the rear opening (9) has a rectangular outline.
7. Heat pump according to any one of claims 1 to 6, **characterized in that**:
- a. the front opening (8) comprises a chamfered edge (17) for receiving the male plug (20) of the switch (2), and/or
 b. the front opening (8) has a T-shaped outline with a first opening portion (15) and a second opening portion (16), wherein the first opening portion (15) comprises a chamfered edge (17).
8. Heat pump according to any one of claims 1 to 7, **characterized in that** the front opening (8) comprises abutting edges (18) for preventing the terminal cable connector (12) from exiting the front opening (8) once inserted in the through-hole (7).
9. Heat pump according to any one of claims 1 to 8, **characterized in that**
- a. the device (1) is realized as a one-piece structure, and/or
 b. the main body (4) is made of a thermoplastic material, in particular a thermoplastic polymer such as PA66, PA6, ABS, POM, or PC or a thermoset as UP, PF, EP, PI.
10. Heat pump according to any one of claims 1 to 9, **characterized in that**
- a. the connection device (1) comprises a plurality of through holes (7) each having a hole length (L) configured to prevent electrical interference among the connections of each cable of the cable assembly (3) with the corresponding male plug (20) of the switch (2) during an operational phase, and/or
 b. the connection device (1) comprises a plurality of through holes (7) with a plurality of front openings (8), each front opening (8) having an average first distance (d1) from an external edge (23) of the front surface (5) and an average second distance (d2) from a neighbor front opening (8), said first distance (d1) and second distance (d2) being configured to prevent electrical interference among the connections of each cable of the cable assembly (3) with the corresponding male plug (20) of the switch (2) during an operational phase, and/or
 c. the connection device (1) comprises a plurality of through holes (7) with a plurality of rear openings (9), each rear opening (9) having an average first distance (d1) from an external edge (23) of the rear surface (6) and an average second distance (d2) from a neighbor rear opening (9), said first distance (d1) and second distance (d2) being configured to prevent electrical interference among the connections of each cable of the cable assembly (3) with the corresponding male plug (20) of the switch (2) during an operational phase.
11. Heat pump according to any one of claims 1 to 10, **characterized in that**
- a. the through-holes (7) are arranged in rows and columns to form a matrix, wherein the cross section of the through-holes (7) in one row is different from the cross section of the through-holes (7) in a different row, and/or
 b. the through-holes (7) are arranged in rows and columns to form a matrix, wherein the cross section of the through-holes (7) in one column is different from the cross section of the through-holes (7) in a different column, and/or
 c. the through-holes (7) are arranged in rows and columns to form a matrix, wherein the through-hole (7) in one element of the matrix is

different from the cross section of the through-hole (7) in a different element of the matrix.

12. Method for producing a connection device for using in a heat pump according to any one of claims 1 to 11, **characterized in that** an injection process of a thermoplastic material, in particular a thermoplastic polymer such as PA66, PA6, ABS, POM, or PC or a thermoset as UP, PF, EP, PI, is used.
13. Combustion appliance comprising a heat pump according to any one of claims 1 to 11.

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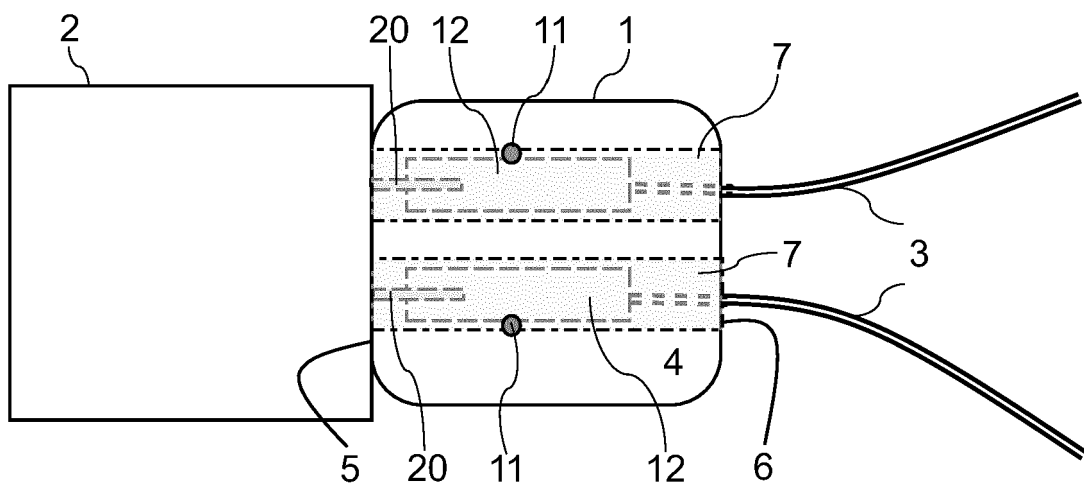


Fig. 1

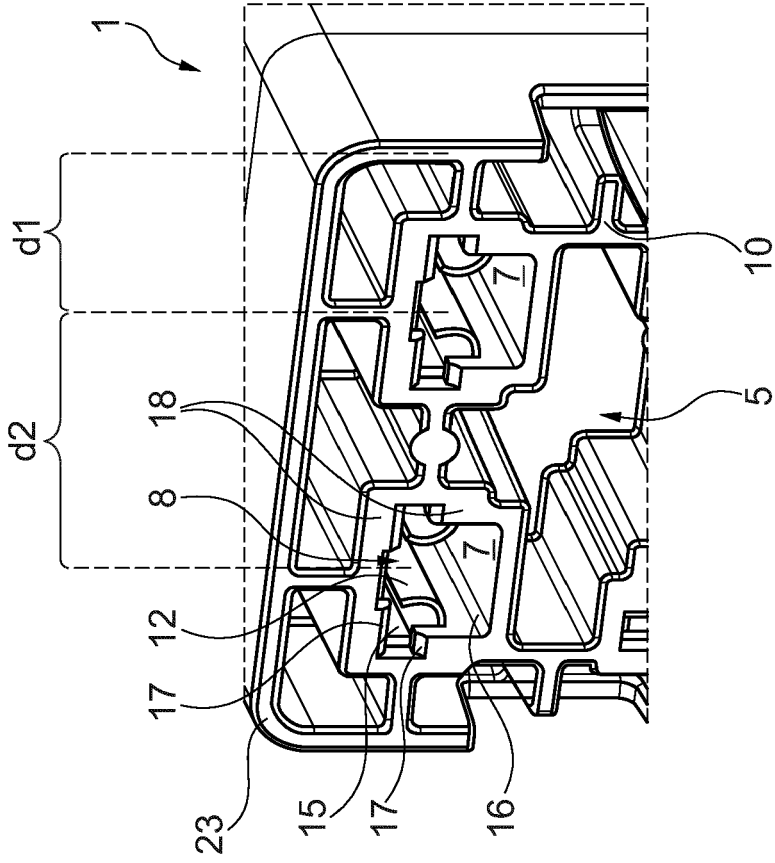


Fig. 2B

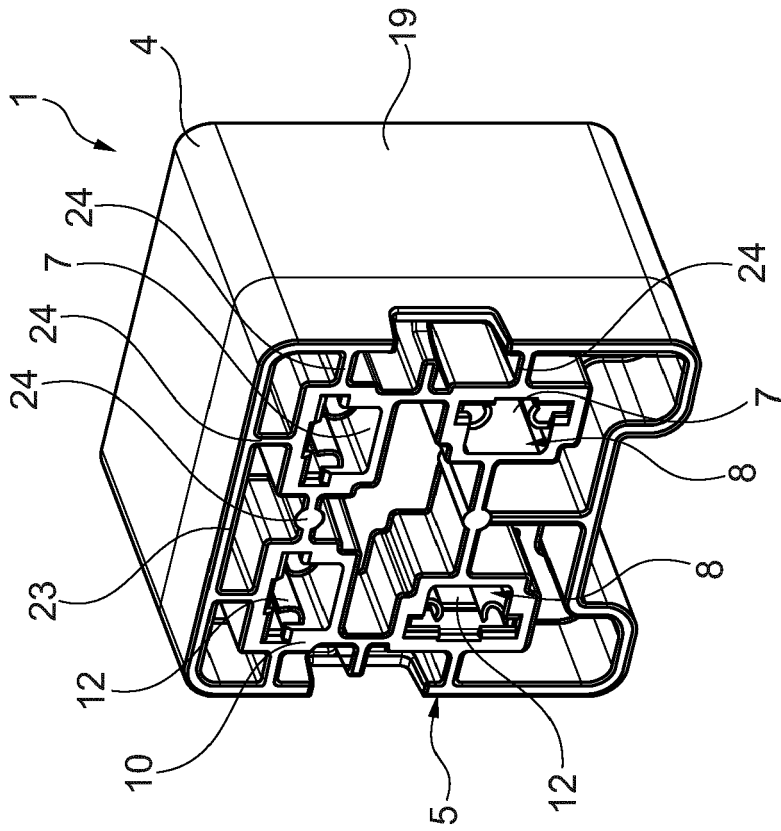


Fig. 2A

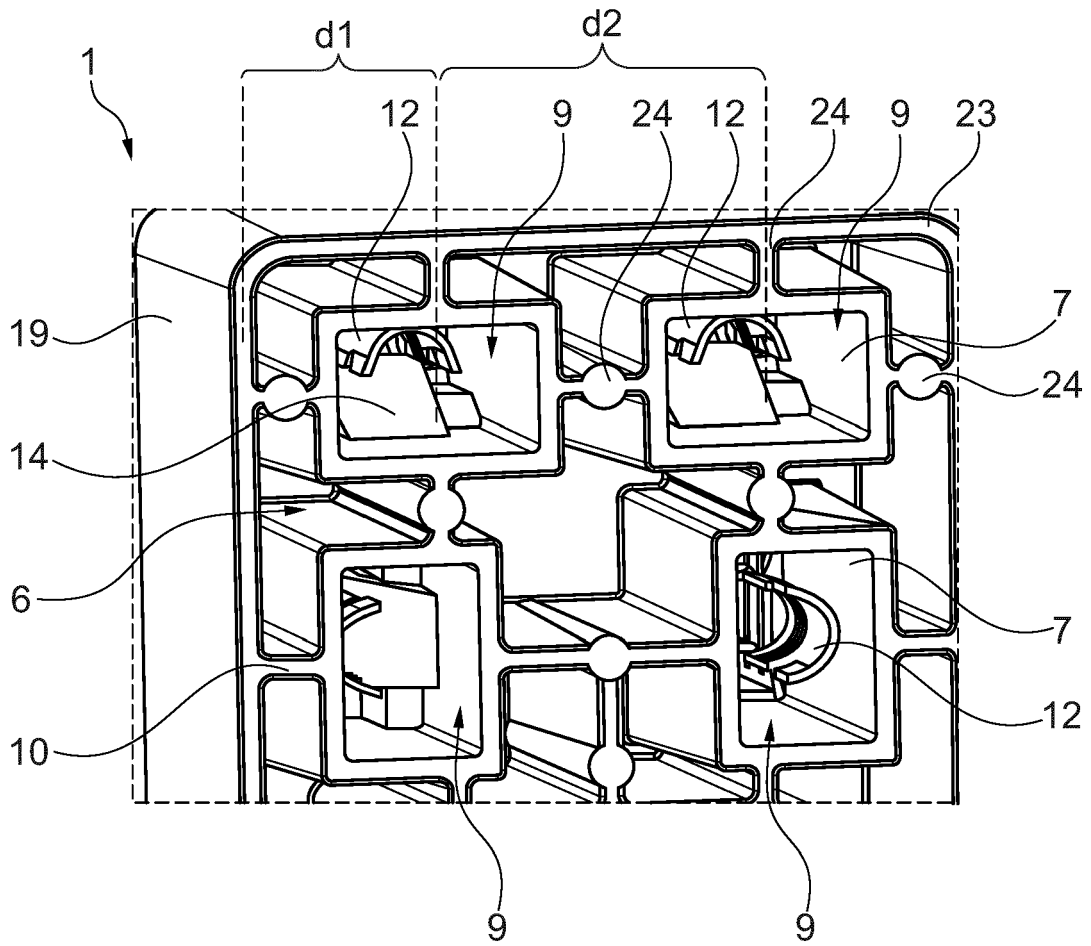


Fig. 3

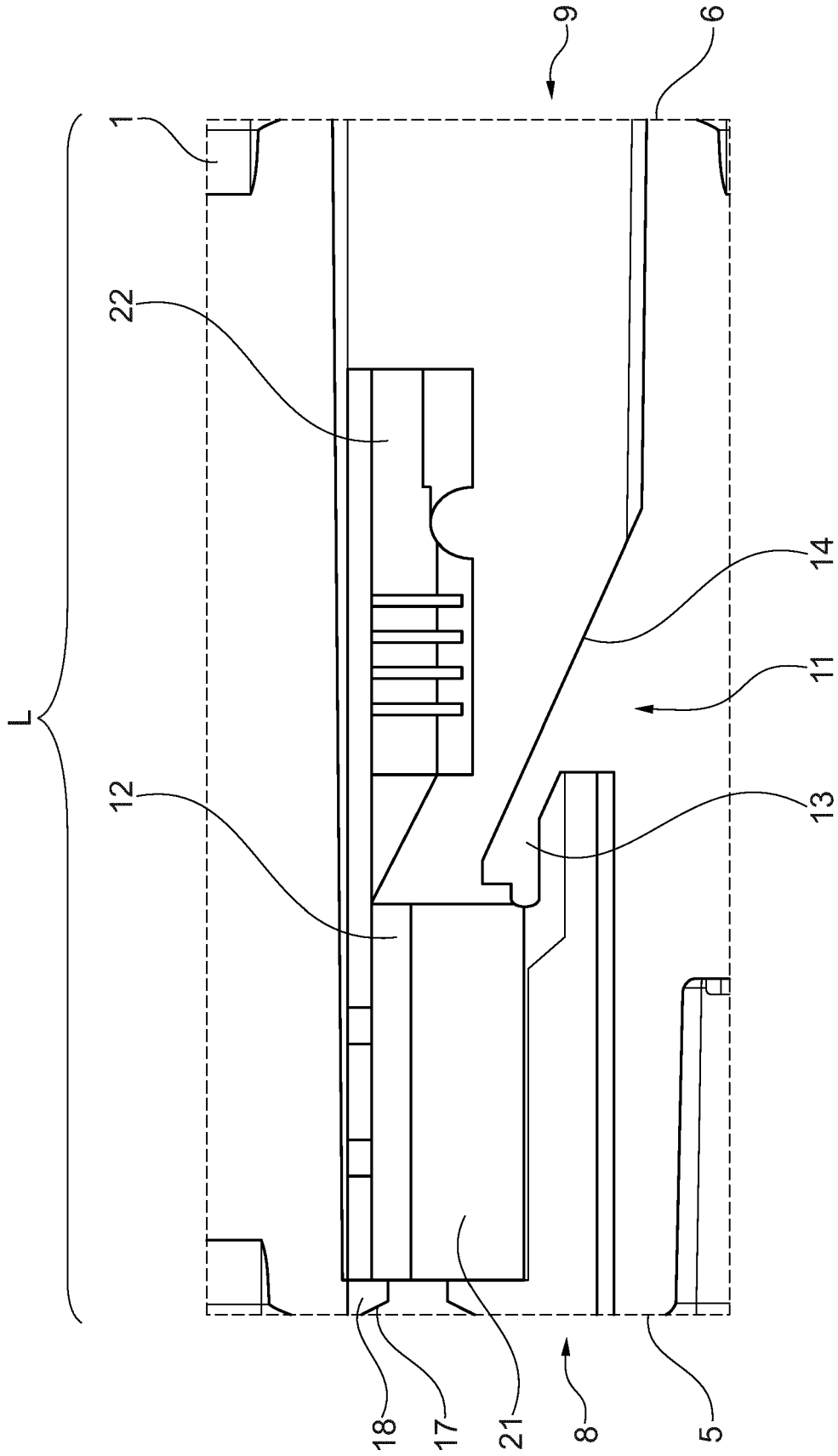


Fig. 4



PARTIAL EUROPEAN SEARCH REPORT

Application Number

under Rule 62a and/or 63 of the European Patent Convention.
This report shall be considered, for the purposes of subsequent proceedings, as the European search report

EP 22 16 1660

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 4 295 698 A (CHOW WEICHIE) 20 October 1981 (1981-10-20) * the whole document *	1, 4, 7, 12, 13	INV. H01R13/422 F25B13/00
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X	US 2004/203287 A1 (ITOU TOMONARI [JP] ET AL) 14 October 2004 (2004-10-14) * the whole document *	1, 4, 7, 12, 13	
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INCOMPLETE SEARCH			
The Search Division considers that the present application, or one or more of its claims, does/do not comply with the EPC so that only a partial search (R.62a, 63) has been carried out.			
Claims searched completely :			
Claims searched incompletely :			
Claims not searched :			
Reason for the limitation of the search: see sheet C			
Place of search The Hague		Date of completion of the search 27 October 2022	Examiner Gomes Sirenkov E M.
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	

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INCOMPLETE SEARCH
SHEET CApplication Number
EP 22 16 1660

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Claim(s) completely searchable:

1, 4, 7, 12, 13

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Claim(s) not searched:

2, 3, 5, 6, 8-11

Reason for the limitation of the search:

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The expression and/or used throughout the claims obscures the sope of the claims, since the claims contain so many options, variables, possible permutations and/or provisos, that the claims are unclear to the extent that the presentation of the claim obscures the subject matter for which protection is sought (Art. 84 EPC).

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Non-compliance with the substantive provisions is such that a meaningful search of the whole claimed subject-matter of claims 2, 3, 5-7, 9-11 can not be carried out (Rule 63 EPC and Guidelines B-VIII, 3).

The search has been restricted to the subject-matter indicated by the applicant in his letter of 21-10-2022 filed in reply to the invitation pursuant to Rule 62a(1) and/or Rule 63(1) EPC:

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"The subject-matter to be searched should be for Claims 1, 4, 7, 12, 13 which the Search Division consider to be able to search in respect of their entire scope."

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ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

EP 22 16 1660

5 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.

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