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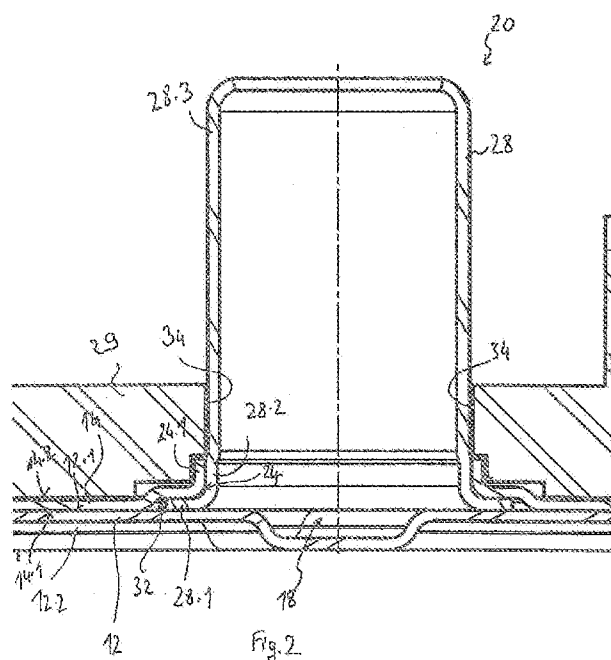
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Heat exchanger device for battery thermal regulation.

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A heat exchanger device for battery thermal regulation comprises a base plate (12) and a cover plate (14) assembled on top of another and configured to define at least one internal coolant channel (18) extending between an inlet and outlet port (20, 22). At least one of the ports, preferably both, comprises an orifice (24, 26) in a first one of the plates and a tubular connector (28, 30) pressfitted into the orifice (24, 26) from an inner side of the plate (14.1), before said cover plate (14) is assembled to said base plate (12). The tubular connector (28, 20) has an outwardly protruding annular flange (28.1, 30.1') that lies against the inner side (14.1)



Heat exchanger device for battery thermal regulation

FIELD OF THE INVENTION

The present invention generally relates to heat exchanger devices for battery thermal regulation in electric or hybrid vehicles.

5 BACKGROUND OF THE INVENTION

Battery thermal regulation in the automotive field, and mainly in the field of electric and hybrid vehicles, is commonly achieved by means of plate heat exchangers upon which a stack of adjacent battery cells or battery cell
10 containers housing one or more battery cells are arranged for cooling and/or regulating the temperature of a battery unit. Battery cells or battery cell containers are arranged so that at least one surface of each battery cell or battery cell container is in close contact with a surface of the heat exchanger.

Plate heat exchangers are designed to manage the heat dissipated by batteries by maintaining overall temperature level and temperature homogeneity across
15 the contact surface thanks to a cooling fluid circulation below the contact surface.

A conventional heat exchanger is generally composed by two metal plates fixed together by leaving room between them for coolant circulation. One of the plates is generally planar and facing the battery cell or battery container to be
20 thermally regulated, and the second plate is a deep-drawn or deformed plate which has meandering depressions. The depressions are closed by the first planar plate fastened to the second plate, such that coolant channels are formed between the two plates, extending between inlet and outlet openings. Fluid connectors (fittings) are typically fixed to the inlet and outlet openings, to
25 facilitate connection of the coolant channels of the heat exchanger to a coolant circulation system in the vehicle.

The mounting of the fluid connectors is somewhat critical, since they protrude from the otherwise generally flat heat exchanger, may be subject to shocks during handling, and will be subjected to mechanical stress during connection of

the coolant hose or piping of the vehicle coolant circulation system. Accordingly, for the sake of robustness, it is important that the connectors be mounted in solid and fluid tight manner to the heat exchanger plate.

Conventional designs of connector to plate joining are disclosed in the following documents.

WO 2016/168932 describes a battery cell heat exchanger, where the connectors are arranged within the inlet and outlet openings. The connectors have a base section with an outer diameter matching the inner diameter of the inlet and outlet openings. The connectors are thus engaged into the inlet and outlet openings from the outside of the heat exchanger, to a depth limited by an annular bulge provided on the outer side of the connector.

US 2015/0079442 A1 discloses a battery cell heat exchanger, where the fluid connection to the internal coolant channels is achieved through the use of an additional component. This additional component forms a distributor, which is typically a cast component. It provides reinforcement of the heat exchanger plate assembly in the collector region of the coolant plate and includes a connection for a coolant feed line. The connection is formed as a cylindrical receptacle into which the tube of the coolant feed line can be plugged and soldered. While the use of an additional distributor portion provides design flexibility, it implies additional manufacturing steps and more components, hence increasing costs.

OBJECT OF THE INVENTION

The object of the present invention is to provide a heat exchanger with an improved fluid connector design that is reliable and simple to implement.

This object is achieved by a heat exchanger as claimed in claim 1.

SUMMARY OF THE INVENTION

According to the present invention, a heat exchanger device for battery thermal regulation comprises a base plate and a cover plate assembled on top of

another and configured to define at least one internal coolant channel extending between an inlet and outlet port.

It shall be appreciated that at least one of the ports, preferably both, comprises an orifice in one of these plates and a tubular connector press-fitted into the
5 orifice from an inner side of the respective plate, before the cover plate is assembled to the base plate. The tubular connector has an outwardly protruding annular flange that lies against the inner side of the plate.

Hence, the present invention uses an advantageous design where the orifice /
connector junction is configured with an interference fit. During assembly, it
10 suffices to introduce the connector into the orifice up to the flange, for the connector to remain in place without need for additional fixing features or accessory. The connectors can thus be easily pre-mounted and safely manipulated thereafter, without risking any movement, dismounting or fall of the connector.

Moreover, since the interference fit is advantageously configured to extend over
15 the whole periphery of the connector, there is an intimate contact between the plate and the connector. Upon brazing, the two parts will be metallurgically joined at their interface, hence providing a fluid tight seal. No additional joints (rubber or soldered joints) are needed to ensure fluid-tightness of the
20 connection between the connector and the plate, thus eliminating the risk of fluid leaks due to joints drying and/or cracking and/or other solder formation problems.

Furthermore, the outwardly protruding annular flange of the tubular connector provides for an easy positioning of the connector during assembly and
25 increases the mechanical strength of the connector fixation.

Advantageously, the tubular connector comprises, adjacent the flange, a mounting section having an enlarged outer profile, which is dimensioned for press-fit engagement with the orifice. Hence, only a portion of the length of the connector is configured for the press-fit, so that the remainder of the connector
30 can easily be inserted.

In embodiments, the flange is provided at an end of the connector. It can easily be formed by plastic deformation as a bent edge. However, in principle the flange could also be provided at a certain distance of the internal extremity of the connector.

- 5 For ease of manufacturing and assembly, the connector is preferably made from a short straight tube of metallic material, e.g. a round metal sleeve. Although circular cross-sections are preferred for ease of positioning and sealing, other cross-sections can be envisaged. Also, those skilled in the art may use connectors of more complex shapes, e.g. bent. That is, a variety of
10 shapes can be contemplated, to the extent that the connector can pass through the orifice in the plate.

- Depending on the design, the heat exchanger can have one or more coolant channels and two or more ports. Part or all of the ports can be designed as disclosed herein, i.e. with an orifice and connector with flange. The ports can be
15 provided on the same side of the heat exchanger (same plate) or on both sides. Further, the ports can be arranged in a same region of the heat exchanger, or in a space manner. This is generally a matter of packaging, depending on the application.

- The plate which is meant to come into contact with the load to be cooled
20 (batteries) –typically the cover plate– is generally made from a material having good thermal conductivity, typically a metal, in particular aluminum or aluminum alloy. The other plate may also generally be made from metallic material, however plastic material can be considered. Fixation of the plates is done by any appropriate means.

- 25 Conventional technologies may be used for manufacturing the plates, in particular plastic deformation of metal, e.g. stamping, punching, embossing. Shaping the two plates from metallic material rationalizes the manufacturing and permits their assembly by brazing. In this connection, at least the inner surface of the cover plate is covered with a layer of cladding material (brazing
30 alloy).

In embodiments, the orifice is surrounded by an annular collar extending on an outer side of the first plate, the annular collar having the same passage cross-section as the orifice. The connector mounting section engages with the collar.

5 In embodiments, the orifice is provided —seen from the inner side of the first plate— in a recessed region providing a clearance to accommodate the connector flange therein. The recessed region has a depth corresponding to a wall thickness of the flange. The flange is preferably held between the first and second plates.

10 According to another aspect, the invention concerns a method for manufacturing a heat exchanger device as claimed in claims 13 and 14.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

15 Fig. 1: is a cross-sectional view of an embodiment of the present heat exchanger device; and

Fig. 2: is a detail view of Fig.1 showing more closely the connector.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

20 Fig.1 shows, in transversal section view, a heat exchanger device 10 (also simply heat exchanger) according to an embodiment of the present invention, for application to the thermal management of battery cells in an automotive vehicle. The heat exchanger 10 comprises a base plate 12 and a cover plate 14 that are positioned on top of another and configured to define between them at least one internal coolant channel 18. In use, the cover plate 14 is in contact (directly or not) with the battery to be cooled. The cover plate 14 and the base

25 plate 12 are typically metal plates of generally rectangular shape; they are dimensioned in accordance with the size of the battery cell or battery cell container to be thermally regulated. Referring to the coordinate system (X, Y, Z), axis Y indicates the length direction of the plates 12, 14, while the thickness

of the heat exchanger device 10 is along axis Z. Accordingly, axis X extends across the width of the heat exchanger 10.

In Fig.1, the cover plate 14 is the upper plate, while the base plate 12 is at the bottom. Each plate has an inner side 12.1, 14.1 and an opposite outer side
5 12.2, 14.2. The inner sides 12.1, 14.1 of the plates face each other and both plates are actually in contact with another through their internal sides 12.1, 14.1, at a plurality of locations and in particular along the edges of the internal coolant channels.

Conventionally, one of the plates, here the base plate 12, is deformed to
10 provide meandering depressions therein, corresponding to a desired coolant circuit. The other plate, the cover plate 14, is arranged on top of the base plate 12, thus closing the base plate meanders and defining the coolant channel 18 between them.

The internal coolant channel 18 extends between an inlet port 20 and an outlet
15 port 22, that are here on the same side of the heat exchanger 10, namely on the cover plate 14. At each port 20, 22, an orifice 24, 26 is provided in the cover plate 14 and a tubular connector (or fitting), indicated 28, 30, is arranged therein. The connectors 28, 30 facilitate connection of the heat exchanger 10 to hoses or piping of a coolant circulation system in the vehicle (not shown). Fresh
20 coolant is supplied to the heat exchanger 10 via port 20 and warm coolant is discharged via port 22.

In the present embodiment, the heat exchanger device 10 comprises a single internal coolant channel 18 as well as one inlet port 20 and one outlet port 22. This is however only an example and, depending on the design, there may be
25 two or more coolant channels. Also, the coolant channels can be configured as meanders (serpentine), of crossflow (single or multiple U flow) or for spiral flow. The number of inlet and outlet ports may be adapted in accordance with the number of coolant channels, and depending on whether a single inlet/outlet is desired or more of them. Also, the location of the connectors may vary
30 depending on packaging needs (e.g. same or opposite side, next to another or spaced).

In the present embodiment, both ports 20 and 22 have same design and could in fact be alternatively used as inlet or outlet.

The connection of the connector 20 to the cover plate 14 will now be explained with reference to Fig.2. The connector 20 is generally tubular and, here, is
5 straight with a circular cross-section. The connector 20 is arranged in opening 24 and more specifically press-fitted therein from the inner side 14.1 of the cover plate 14.

As can be seen, the connector 20 comprises an outwardly protruding annular flange 28.1, which lies against the inner side 14.1 of the cover plate 14. The
10 annular flange 28.1 is obtained by bending the lower end of the tubular connector 28. The outer diameter of flange 28.1 is larger than the diameter of orifice 24.

The connector region proximate to the cover plate 14 is referred to as 'mounting section' (designated 28.2) and the opposite region, the 'connection section'
15 28.3, is for engagement with a piping or hose of the coolant system.

Also, the mounting section 28.2 is radially enlarged, compared to the remainder of the connector towards the connecting section 28.3. Hence, the mounting section 28.3 is dimensioned for press-fit engagement with orifice 24. This is here obtained by plastic deformation of the connector tube 28, with similar wall
20 thickness. That is, the inner and outer diameters are larger in the mounting section 28.2. Alternatively, the mounting section could be of larger thickness, with same inner diameter, so that only the outer diameter is enlarged.

As can be seen, orifice 24 is provided in cover plate 14 at a position above a portion of coolant channel 18 (or alternatively in a manifold region of the cooling
25 plate). The orifice 24 is located in a recessed region 32 of the cover plate 14, as seen from the inside. Seen from the outside, orifice 24 is thus arranged in a protruding area. The recess 32 is obtained by material deformation. The recess 32 provides a clearance for receiving the flange 28.1 therein. The depth of the recess 32 (in thickness direction) corresponds to the wall thickness of the flange
30 28.1.

Moreover, the mounting section 28.2 is in engagement with an annular collar 24.1 that surrounds orifice 24 and extends on the outer side of the cover plate 14, away therefrom. The annular collar 24.1 offers the same passage cross-section as orifice 24.

- 5 The annular collar 24.1 and the mounting section 28.2 have about the same length (along axis Z). The forces of the interference fit can thus be adjusted by modifying this length and the diameters at the mounting section. The mounting section enhances the strength of the connector to cover junction, and permits formation of an annular seal at the interface, which is generally favourable to
- 10 robustness. Also to be noted, this design permits positioning the connector 28 in orifice 24 during assembly, in a simple and efficient way. Due to the interference fit, the connector 28 remains in place without the need for any accessory or additional mounting means.

For increased robustness, the base plate is configured so that the flange is, at

15 least on part of its circumference, maintained between the two plates. As can be seen in Fig.2, flange 28.1 lies with its upper surface against the bottom of recess 32, whereas its lower surface is against the inner side 12.1 of base plate 12. There will be an interruption, e.g. at the coolant channels, but this configuration increases the mechanical strength of the connector mounting.

- 20 As indicated, ports 20 and 22 have same design, i.e. the arrangement and configuration of connector 30 (with flange 30.1, mounting section 30.2, annular collar 26.1) in orifice 26 is the same as for connector 28.

In the present embodiment, cover plate 14 and base plate 12 are made of metal, e.g. aluminium or aluminium alloy, in order to exhibit good thermal

25 conductivity and ensure efficient heat exchange between the coolant and the battery. Likewise, the connectors are made from aluminium or an alloy thereof. Conventionally, the plates are formed through appropriate metal deformation processes, such as stamping, embossing, punching, deep drawing, etc. The connectors are simple straight sleeves that are plastically deformed to provide

30 the flange, mounting section, and e.g. an inwardly bent edge at the connecting section.

Fixation of the cover plate 14 to the base plate 12 can be achieved through various fixation methods, including but without being limited to brazing, screwing, crimping or clipping and a skilled person would adapt the fixation method to technical constraints such as the final desired dimensions of the heat exchanger device 10 or the plates manufacturing process.

In this embodiment, the cover plate 14, base plate 12 and connectors 16 are brazed together. The cover plate 14 is clad on its internal side with a cladding material. Any appropriate cladding material can be used, in particular any aluminium brazing alloy from the series AA4XXX. Cladding of the internal side of the cover plate 14 is sufficient to ensure a tight connection of the cover plate 14 with the fluid connectors 16 and with the base plate 12. By cladding the entire internal side of the cover plate 14, cover plate 14 and base plate 12 are brazed between meanders of the coolant channel 18, thereby improving the fluid-tightness of said coolant channel 18 and avoiding any unwanted passage of fluid from one meander of the coolant channel 18 to another.

Upon shaping of the base and cover plates, assembly of the heat exchanger device 10 is conveniently done as follows. The fluid connectors 28 are inserted in their respective orifices 24, 26 from the inner side 14.1 of the cover plate 14. Additional force is exerted to engage the mounting section due to the interference fit with the collar, and bring the flange 28.1 against the inner side 14.1. The cover plate is then positioned on top of the base plate. In the assembled configuration, the protruding flanges 20 are interposed between the base plate 12 and the cover plate 14, so that each said flange 20 substantially fills the recess 32 surrounding each orifice. The resulting assembly is then placed in a furnace to be heated up and braze the components together.

It remains to be noted that battery cells or battery cell containers are often not in direct contact with the cover plate of the heat exchanger. Reference sign 29 designates a thermal pad for facilitating thermal exchange between the battery and the cover plate 14. Through holes 34 are provided for the fluid connectors

Claims

1. A heat exchanger device for battery thermal regulation comprising a base plate (12) and a cover plate (14) assembled on top of another and configured to define at least one internal coolant channel (18) extending
5 between an inlet and outlet port (20, 22), **characterized in that** at least one of said ports, preferably both, comprises an orifice (24, 26) in a first one of said plates and a tubular connector (28, 30) press-fitted into said orifice (24, 26) from an inner side of said plate (14.1), before said cover plate (14) is assembled to said base plate (12), said tubular connector (28, 20) having an
10 outwardly protruding annular flange (28.1, 30.1) that lies against said inner side (14.1).
2. The heat exchanger device according to claim 1, wherein said tubular connector (28, 30) comprises, adjacent said flange, a mounting section (28.2, 30.2) having an enlarged outer profile, which is dimensioned for
15 press-fit engagement with said orifice (24, 26).
3. The heat exchanger device according to claim 1 or 2, wherein said orifice (24, 26) is surrounded by an annular collar (24.1, 26.1) extending on an outer side of said first plate, said annular collar having the same passage cross-section as said orifice, said mounting section of said connector
20 engaging said collar.
4. The heat exchanger device according to claim 1, 2 or 3, wherein, seen from the inner side of said first plate, said orifice is provided in a recessed region (32) providing a clearance to accommodate said connector flange (28.1) therein.
- 25 5. The heat exchanger device according to any one of the preceding claims, wherein said recessed region has a depth corresponding to a wall thickness of said flange (28.1).
6. The heat exchanger device according to any one of the preceding claims, wherein said flange (28.1) is held between said first and second plates 12,
30 14).

7. The heat exchanger device according to any one of the preceding claims, wherein said tubular connector (28, 30) is of circular shape.
8. The heat exchanger device according to any one of the preceding claims, wherein said orifice(s) are made by stamping or embossing.
- 5 9. The heat exchanger device according to any one of the preceding claims, wherein said inlet and/or outlet ports (20, 22) are arranged in said cover plate (14).
- 10 10. The heat exchanger device according to any one of the preceding claims, wherein said first plate (14) is provided with cladding material on its inner side.
11. The heat exchanger device according to any one of the preceding claims, wherein said at least one coolant channel (18) is formed in said base plate (12) and sealingly closed by said cover plate (14).
12. The heat exchanger device according to any one of the preceding claims,
15 comprising a thermal pad (29) on top of said contact plate, said connectors protruding from said thermal pad through respective holes.
13. A method for manufacturing a heat exchanger device comprising:
 - providing a base plate (12) and a cover plate (14) configured to define, in
20 an assembled state, at least one internal coolant channel (18), wherein at least two orifices (24, 26) are provided to form inlet and outlet ports (20, 22) for said internal coolant channel;
 - providing at least one tubular connector (28, 30), preferably two, said tubular connector(s) having an outwardly protruding annular flange (28.1, 30.1);
 - 25 - introducing said tubular connector(s) (28, 30) into the respective orifice(s) (24, 26) from an inner side (14.1) of the respective plate, such that the flange lies against said inner side, whereby the orifice and connector are configured for a press-fit engagement; and
 - assembling the base plate (12) and the cover plate (14) on top of another;
 - 30 - subjecting the assembly to brazing.

14. The method for manufacturing a heat exchanger device according to claim 13, wherein base and cover plates, with said orifice(s) are made by stamping or embossing.

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REVENDICATIONS

- 5 1. Dispositif échangeur de chaleur pour régulation thermique de batterie
comprenant une plaque de base (12) et une plaque de recouvrement
(14) assemblées l'une par-dessus l'autre et configurées pour définir au
moins un canal de fluide de refroidissement interne (18) s'étendant entre
une ouverture d'entrée et une ouverture de sortie (20, 22), **caractérisé**
10 **en ce qu'**au moins une desdites ouvertures, de préférence les deux,
comprend un orifice (24, 26) dans une première desdites plaques et un
connecteur tubulaire (28, 30) ajusté par pression dans ledit orifice (24,
26) depuis un côté interne de ladite plaque (14.1), avant que ladite
15 plaque de recouvrement (14) soit assemblée à ladite plaque de base
(12), ledit connecteur tubulaire (28, 20) présentant une bride annulaire
faisant saillie vers l'extérieur (28.1, 30.1) qui repose contre ledit côté
interne (14.1).
- 20 2. Dispositif échangeur de chaleur selon la revendication 1, dans lequel
ledit connecteur tubulaire (28, 30) comprend, adjacente à ladite bride,
une section de montage (28.2, 30.2) présentant un profil externe agrandi,
qui est dimensionné pour une mise en prise à ajustement par pression
avec ledit orifice (24, 26).
- 25 3. Dispositif échangeur de chaleur selon la revendication 1 ou 2, dans
lequel ledit orifice (24, 26) est entouré par un col annulaire (24.1, 26.1)
s'étendant sur un côté externe de ladite première plaque, ledit col
annulaire présentant la même section transversale de passage que ledit
orifice, ladite section de montage dudit connecteur se mettant en prise
30 avec ledit col.
4. Dispositif échangeur de chaleur selon la revendication 1, 2 ou 3, dans
lequel, vu depuis le côté interne de ladite première plaque, ledit orifice

est fourni dans une région renforcée (32) fournissant un espace pour loger ladite bride de connecteur (28.1) dans celle-ci.

- 5 5. Dispositif échangeur de chaleur selon l'une quelconque des revendications précédentes, dans lequel ladite région renforcée présente une profondeur correspondant à une épaisseur de paroi de ladite bride (28.1).
- 10 6. Dispositif échangeur de chaleur selon l'une quelconque des revendications précédentes, dans lequel ladite bride (28.1) est maintenue entre lesdites première et seconde plaques (12, 14).
- 15 7. Dispositif échangeur de chaleur selon l'une quelconque des revendications précédentes, dans lequel ledit connecteur tubulaire (28, 30) est de forme circulaire.
- 20 8. Dispositif échangeur de chaleur selon l'une quelconque des revendications précédentes, dans lequel ledit ou lesdits orifices sont obtenus par emboutissage ou estampage.
- 25 9. Dispositif échangeur de chaleur selon l'une quelconque des revendications précédentes, dans lequel lesdites ouvertures d'entrée et/ou de sortie (20, 22) sont agencées dans ladite plaque de recouvrement (14).
- 30 10. Dispositif échangeur de chaleur selon l'une quelconque des revendications précédentes, dans lequel ladite première plaque (14) est pourvue d'un matériau de revêtement sur son côté interne.
11. Dispositif échangeur de chaleur selon l'une quelconque des revendications précédentes, dans lequel ledit au moins un canal de

fluide de refroidissement (18) est formé dans ladite plaque de base (12) et fermé de manière étanche par ladite plaque de recouvrement (14).

- 5 12. Dispositif échangeur de chaleur selon l'une quelconque des revendications précédentes, comprenant un tampon thermique (29) par-dessus ladite plaque de contact, lesdits connecteurs faisant saillie à partir dudit tampon thermique à travers des trous respectifs.
- 10 13. Procédé de fabrication d'un dispositif échangeur de chaleur comprenant :
- 15 - la fourniture d'une plaque de base (12) et d'une plaque de recouvrement (14) configurées pour définir, dans un état assemblé, au moins un canal de fluide de refroidissement interne (18), dans lequel au moins deux orifices (24, 26) sont fournis pour former des ouvertures d'entrée et de sortie (20, 22) pour ledit canal de fluide de refroidissement interne ;
 - la fourniture d'au moins un connecteur tubulaire (28, 30), de préférence deux, ledit ou lesdits connecteurs tubulaires présentant une bride annulaire faisant saillie vers l'extérieur (28.1, 30.1) ;
 - 20 - l'introduction dudit ou desdits connecteurs tubulaires (28, 30) dans le ou les orifices respectifs (24, 26) à partir d'un côté interne (14.1) de la plaque respective, de telle sorte que la bride repose contre ledit côté interne, moyennant quoi l'orifice et le connecteur sont configurés pour une mise en prise à ajustement par pression, et
 - 25 - l'assemblage de la plaque de base (12) et de la plaque de recouvrement (14) l'une par-dessus l'autre ;
 - la soumission de l'assemblage à un brasage.
- 30 14. Procédé de fabrication d'un dispositif échangeur de chaleur selon la revendication 13, dans lequel les plaques de base et de recouvrement, avec ledit ou lesdits orifices, sont obtenues par emboutissage ou estampage.

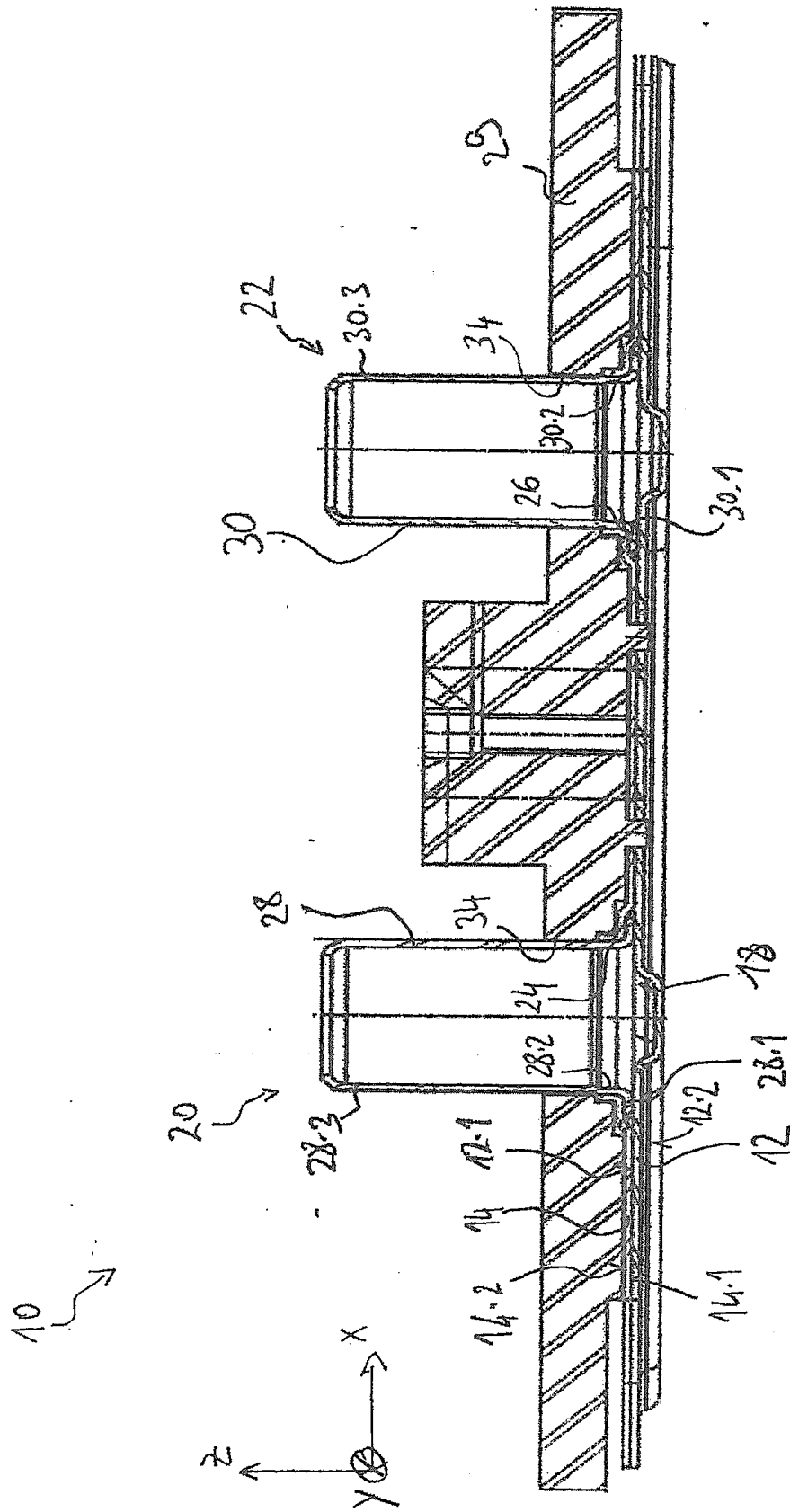


Fig. 1

