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(54) HEAT EXCHANGER

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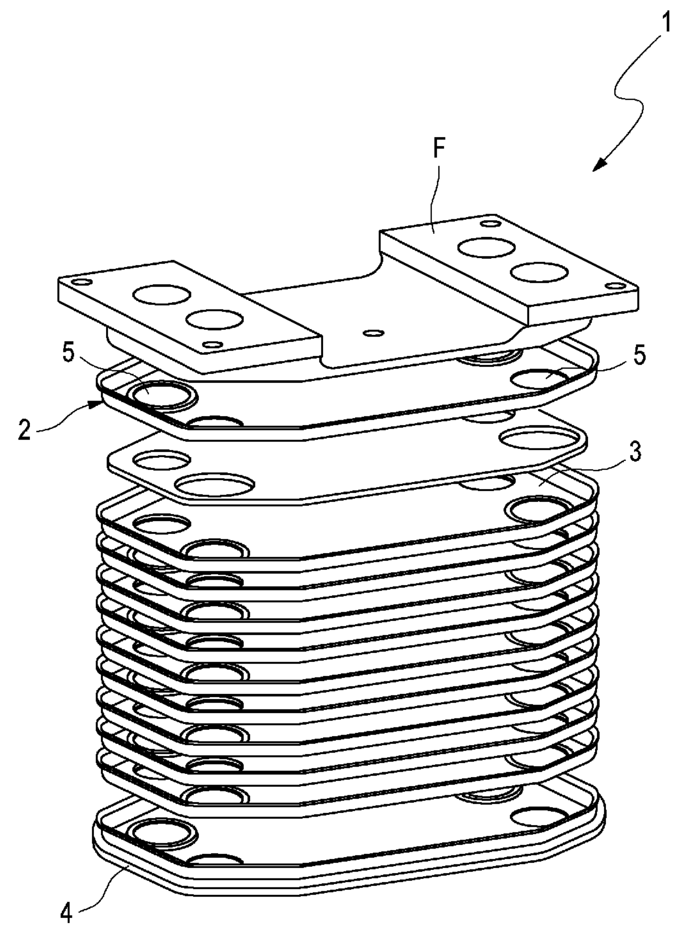
(57) **ABSTRACT**

A heat exchanger may include a plurality of layers arranged on top of each other, each of the layers having a first cavity for the passage of a medium and a second cavity for the passage of a coolant. Each layer may define a through hole for the passage of the medium and each layer may include a frame in which a turbulence insert may be inserted. Each frame may have an end region configured to define at least one channel closure and the through holds for the passage of the medium. The frame may have a guide opening for receiving an assembly aid and the guide opening may be formed between the through holes and the channel closure.



(S.d.T.)

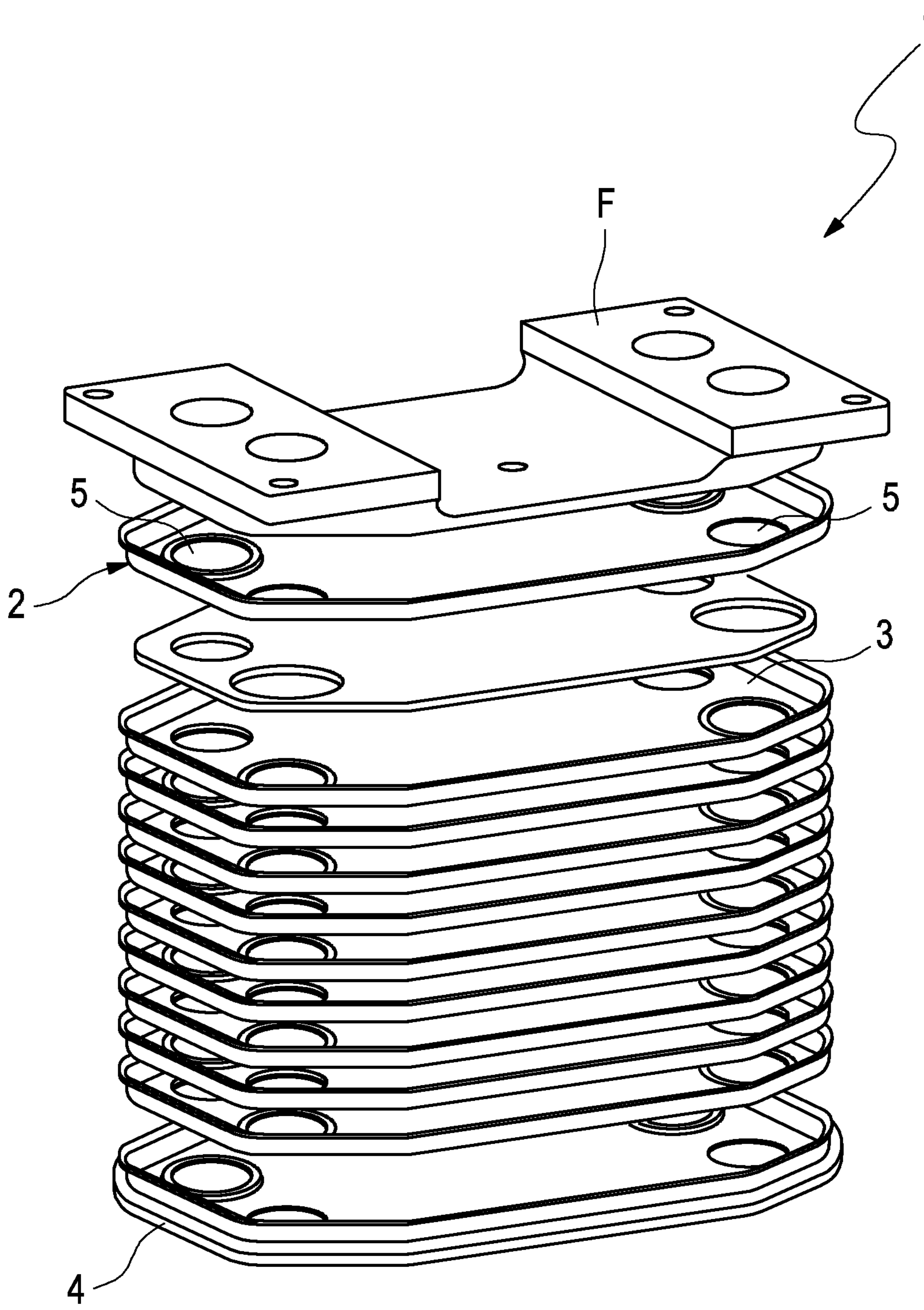


Fig. 1 (S.d.T.)

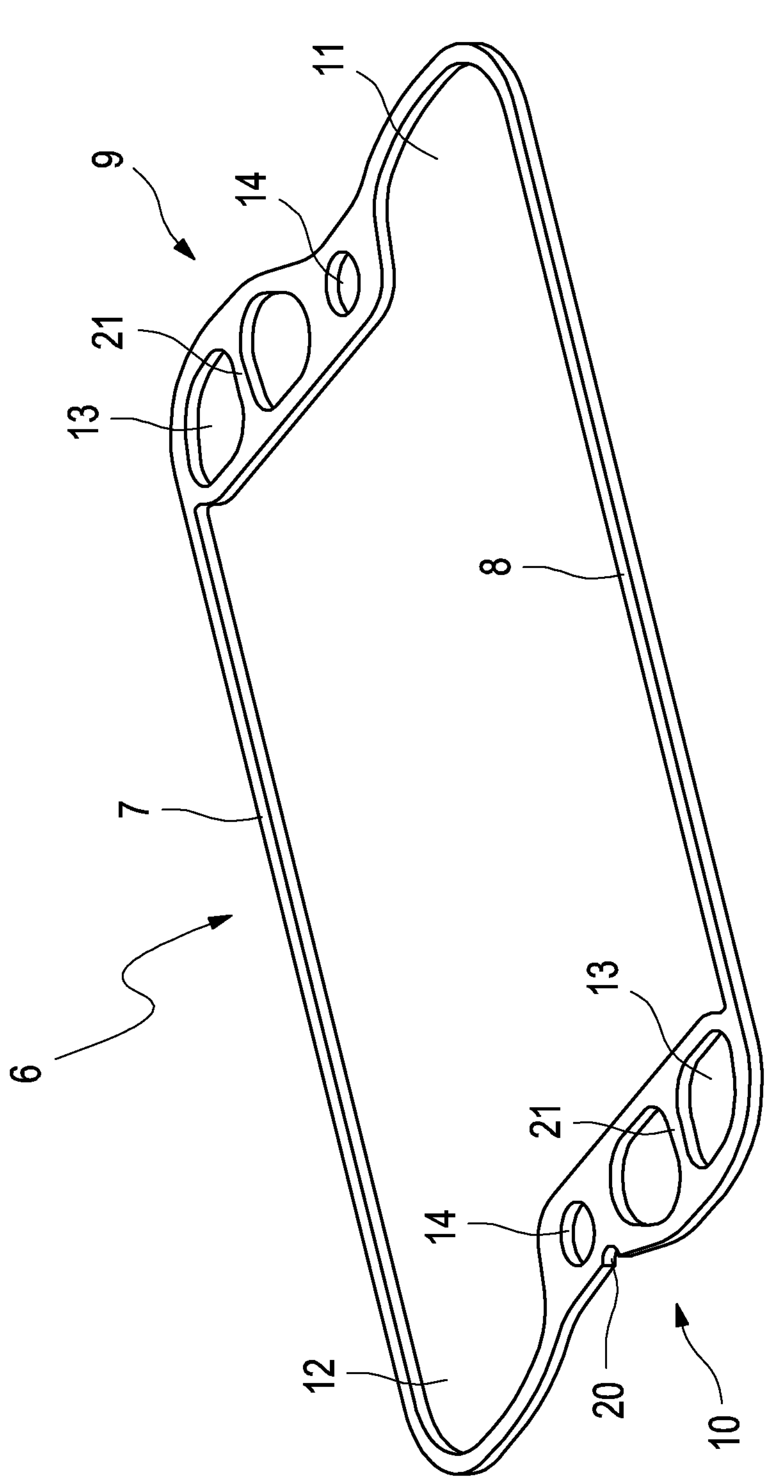


Fig. 2

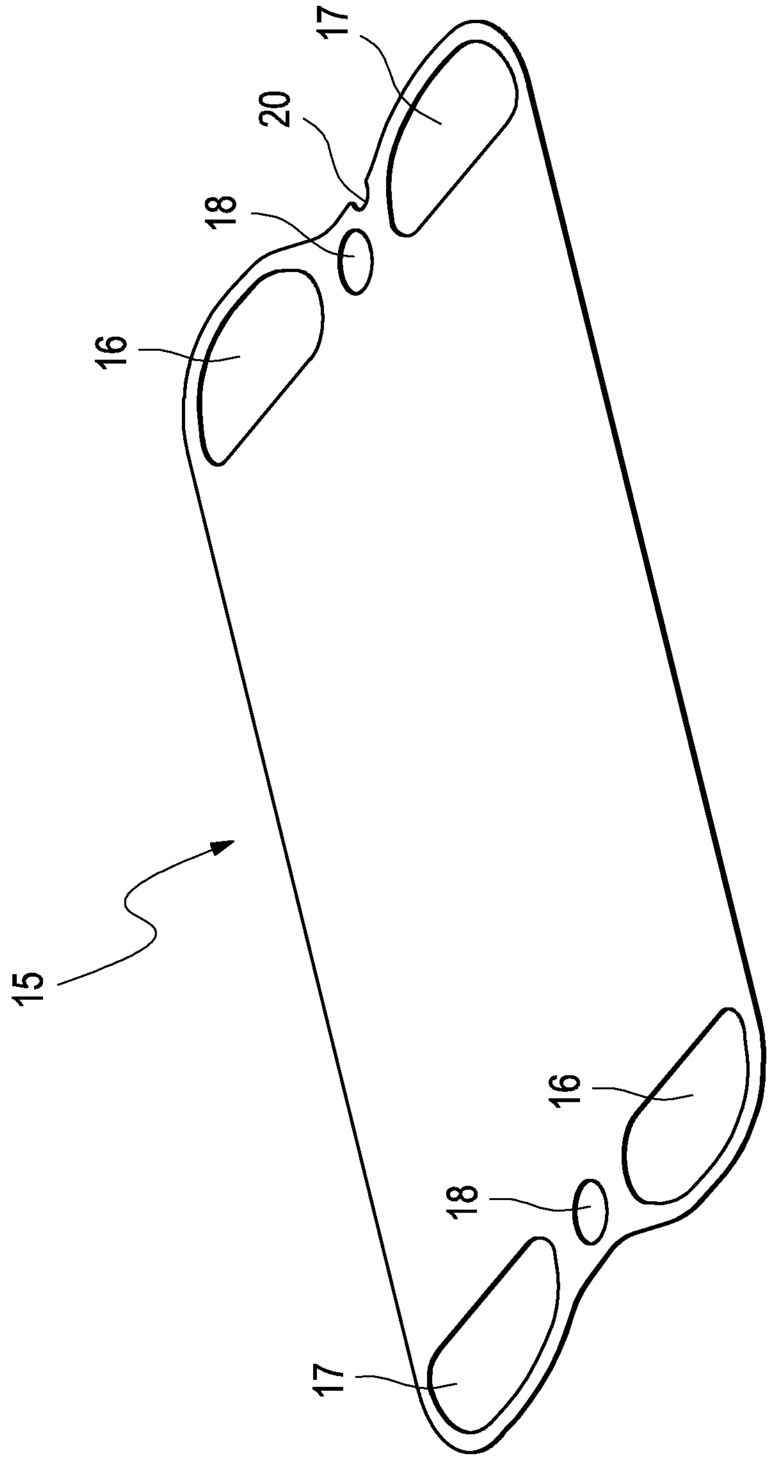


Fig. 3

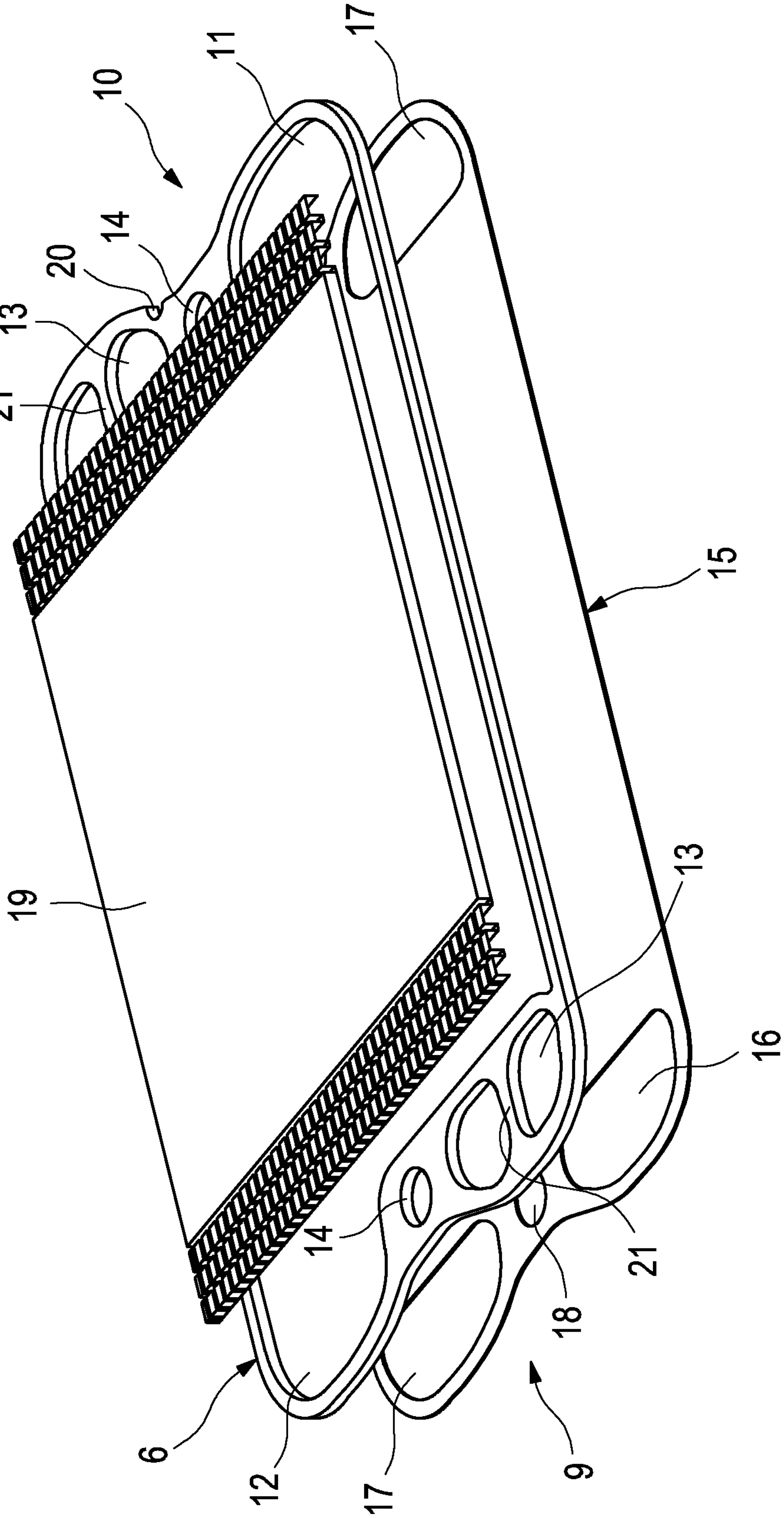


Fig. 4

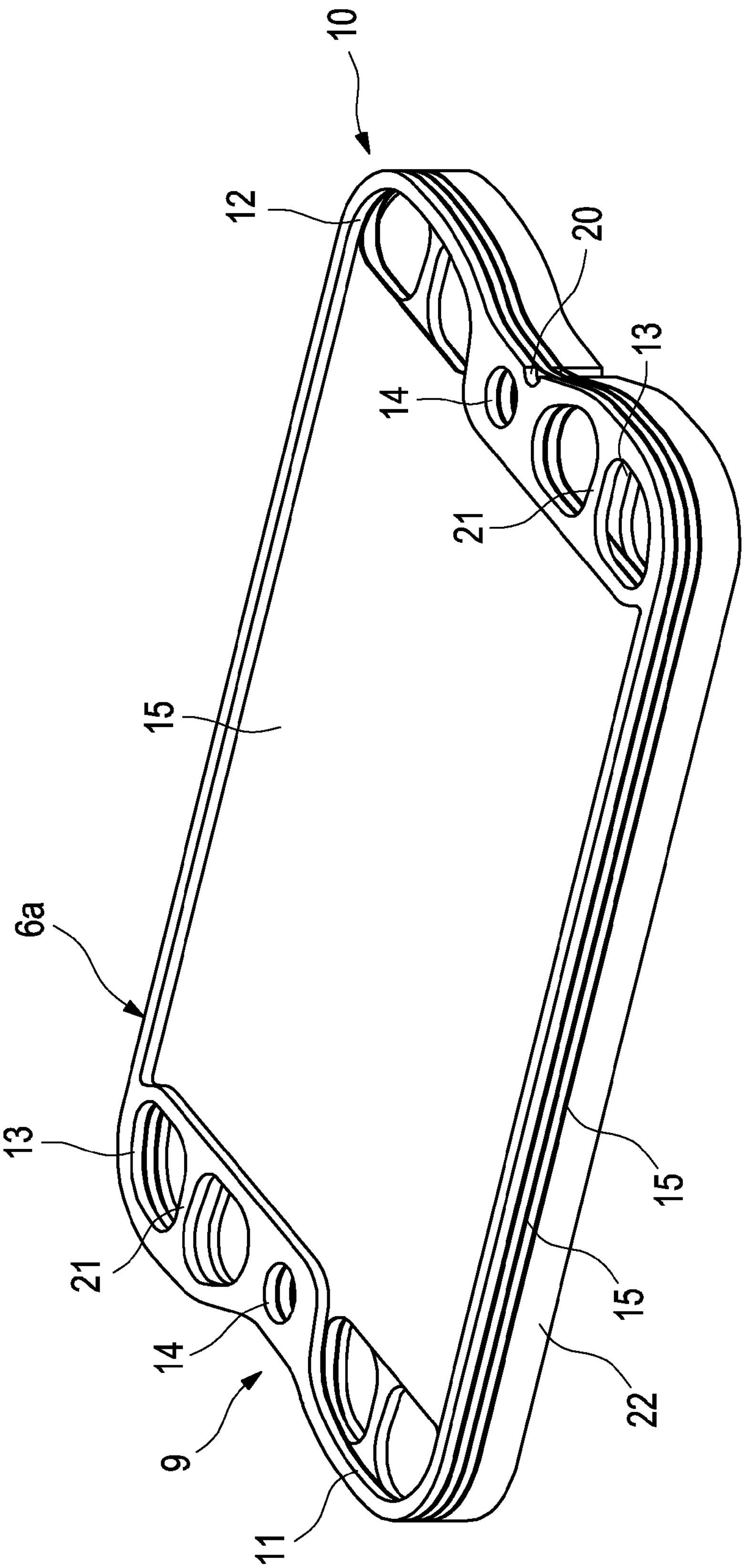


Fig. 5

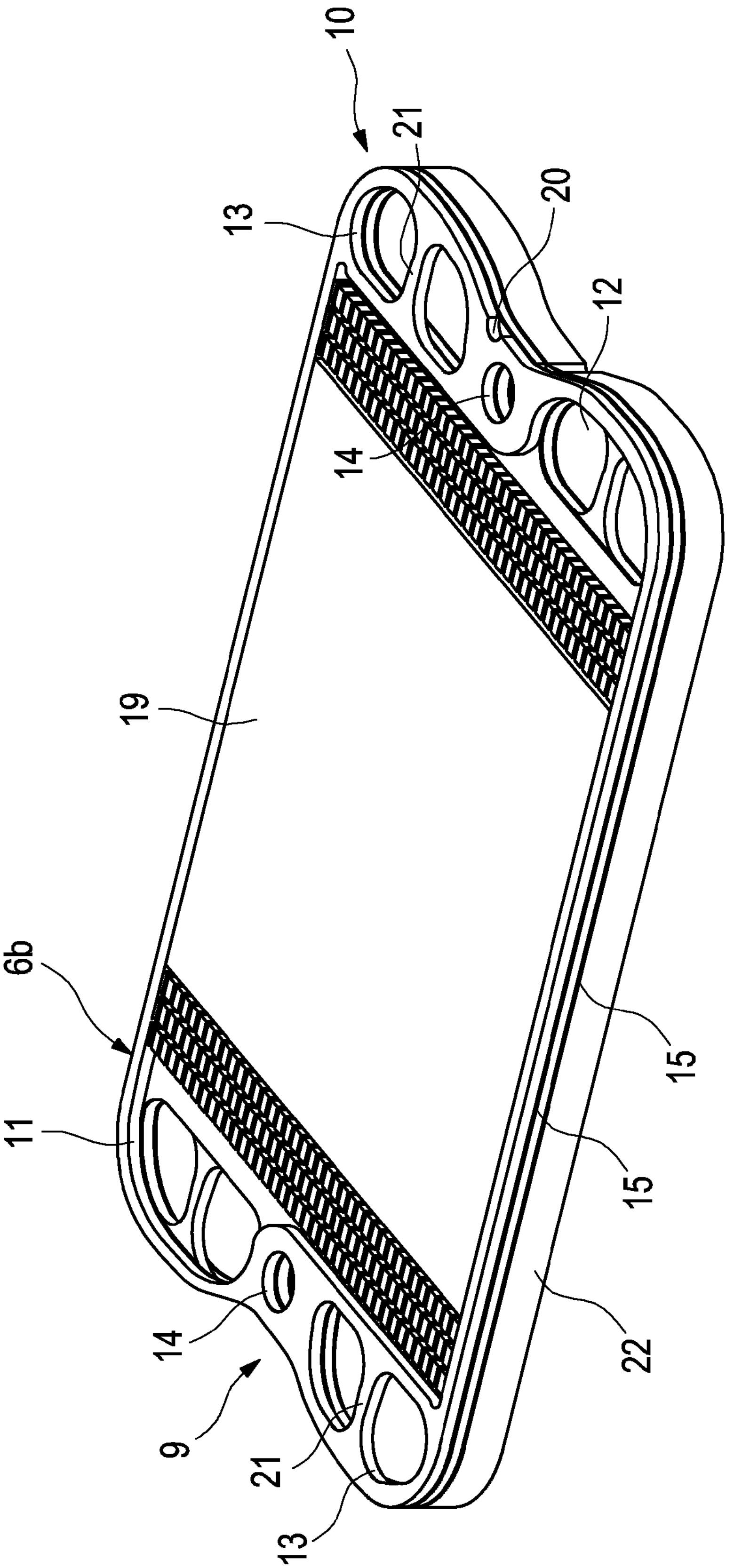


Fig. 6

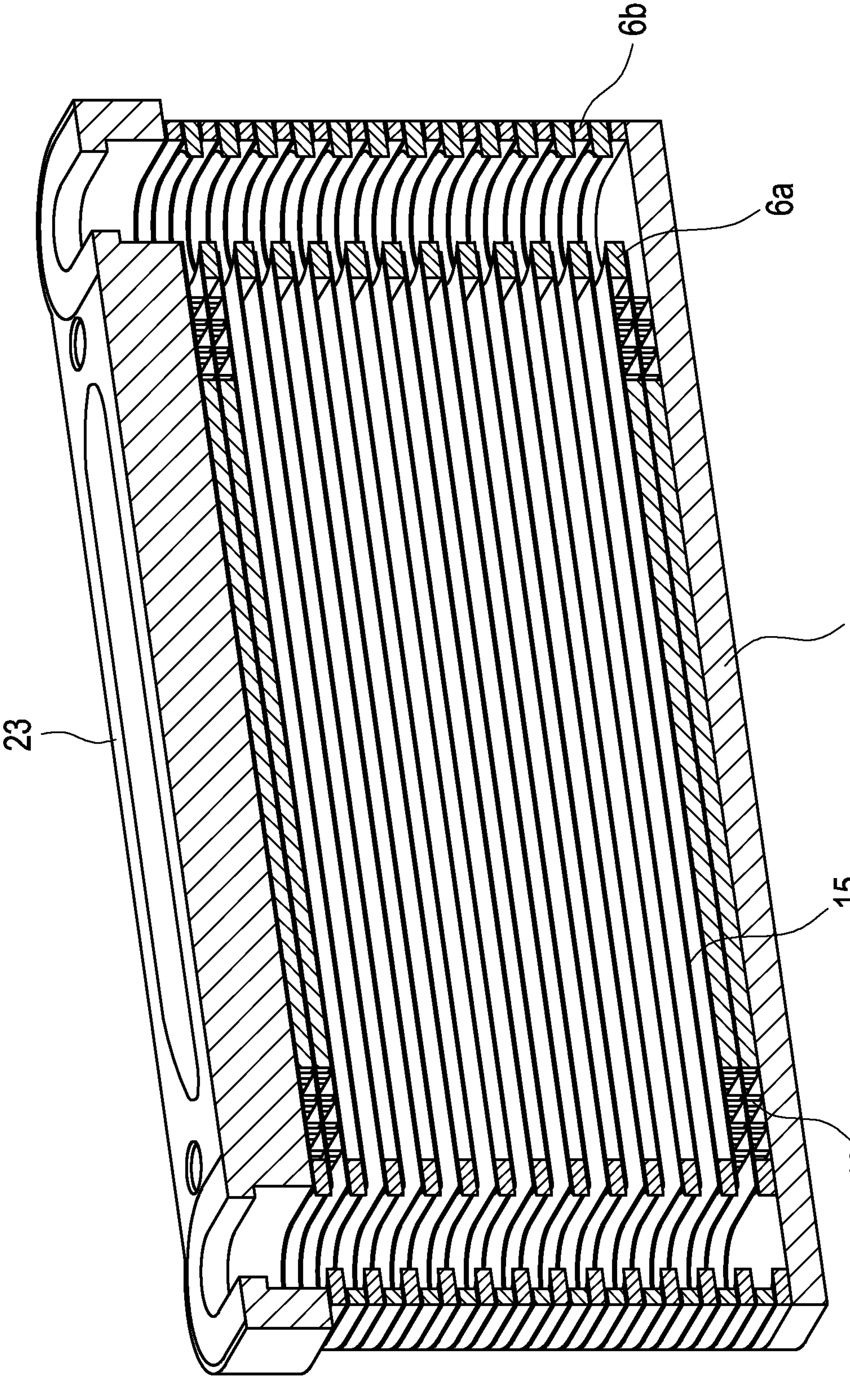


Fig. 7

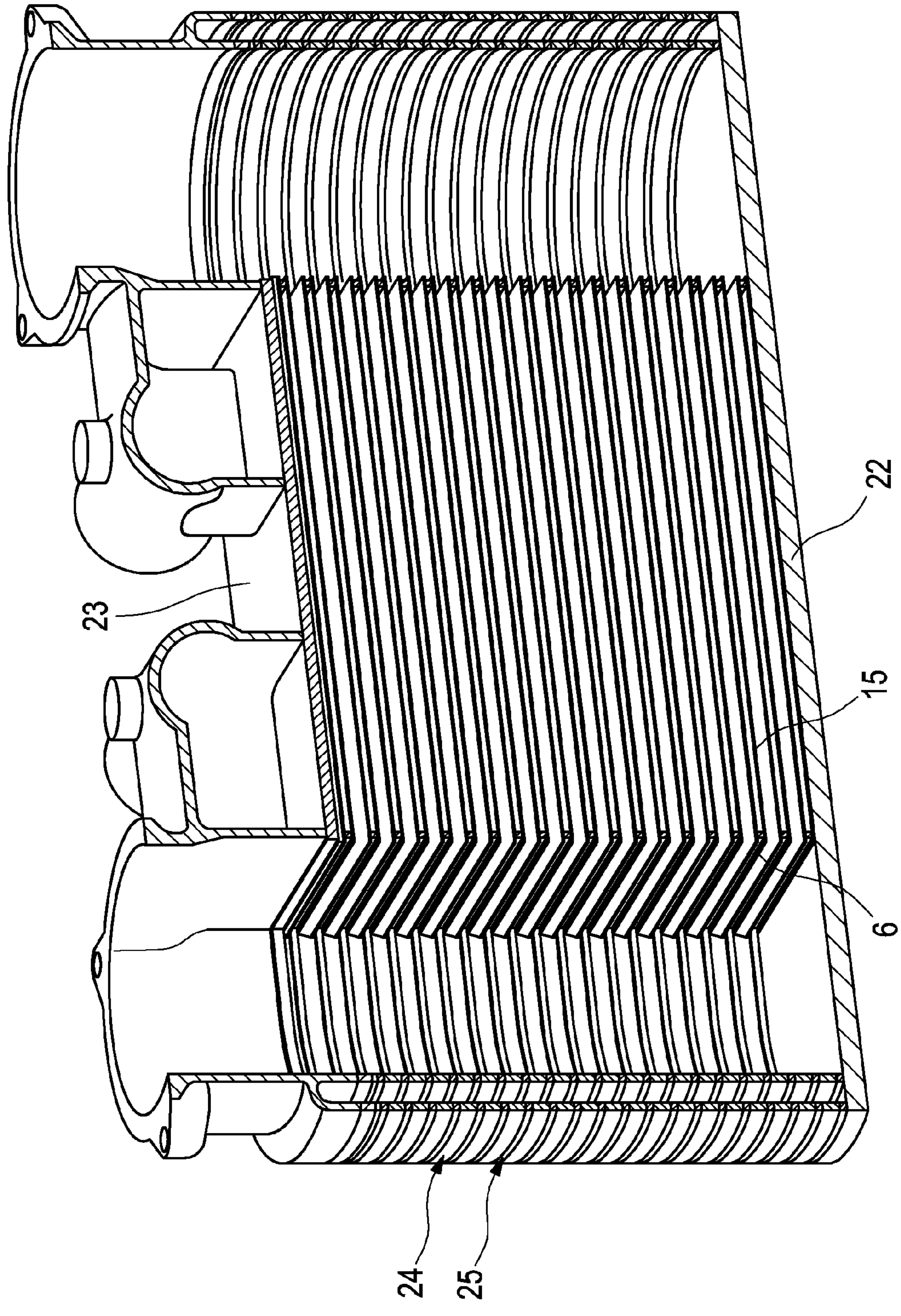


Fig. 8

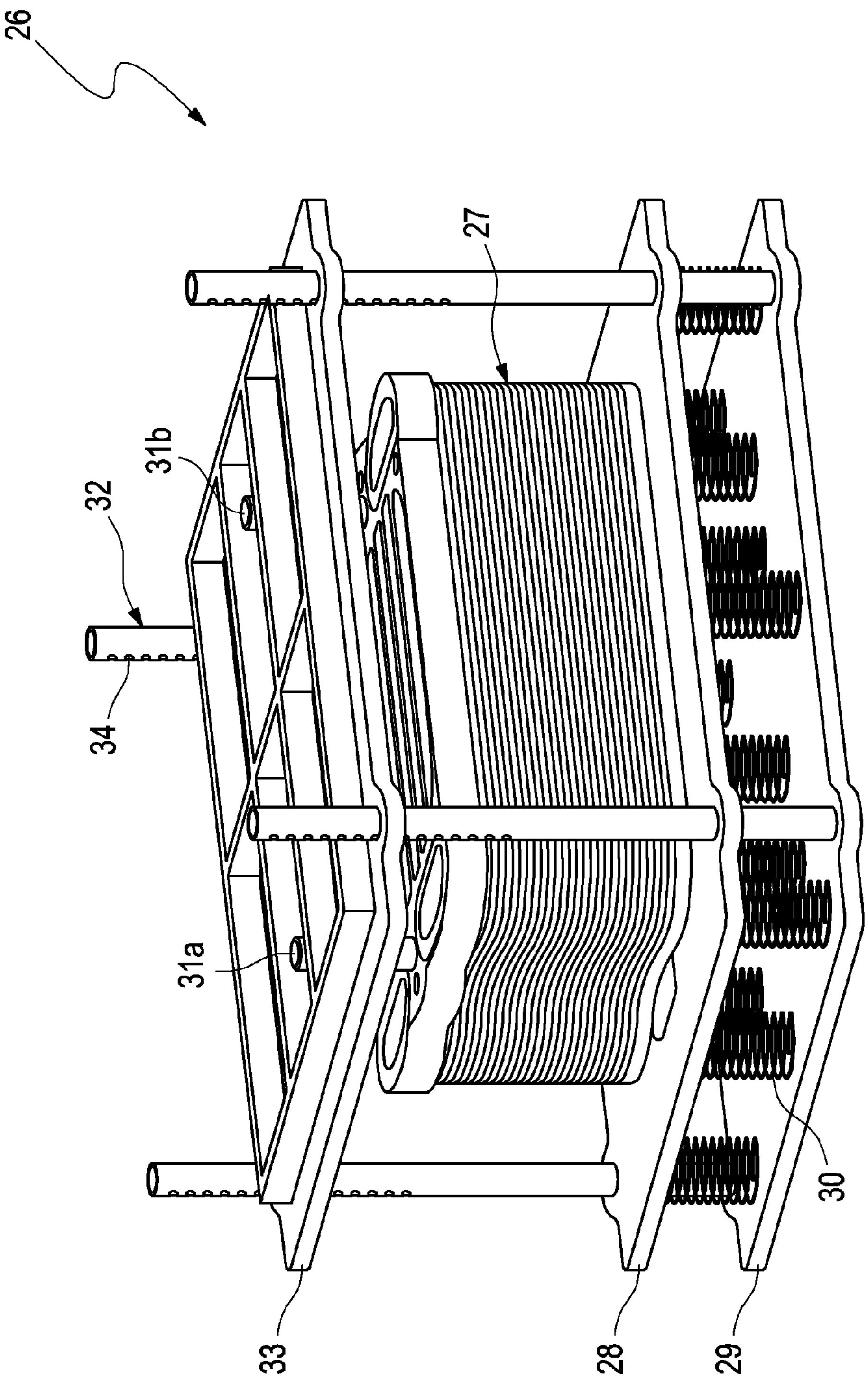


Fig. 9

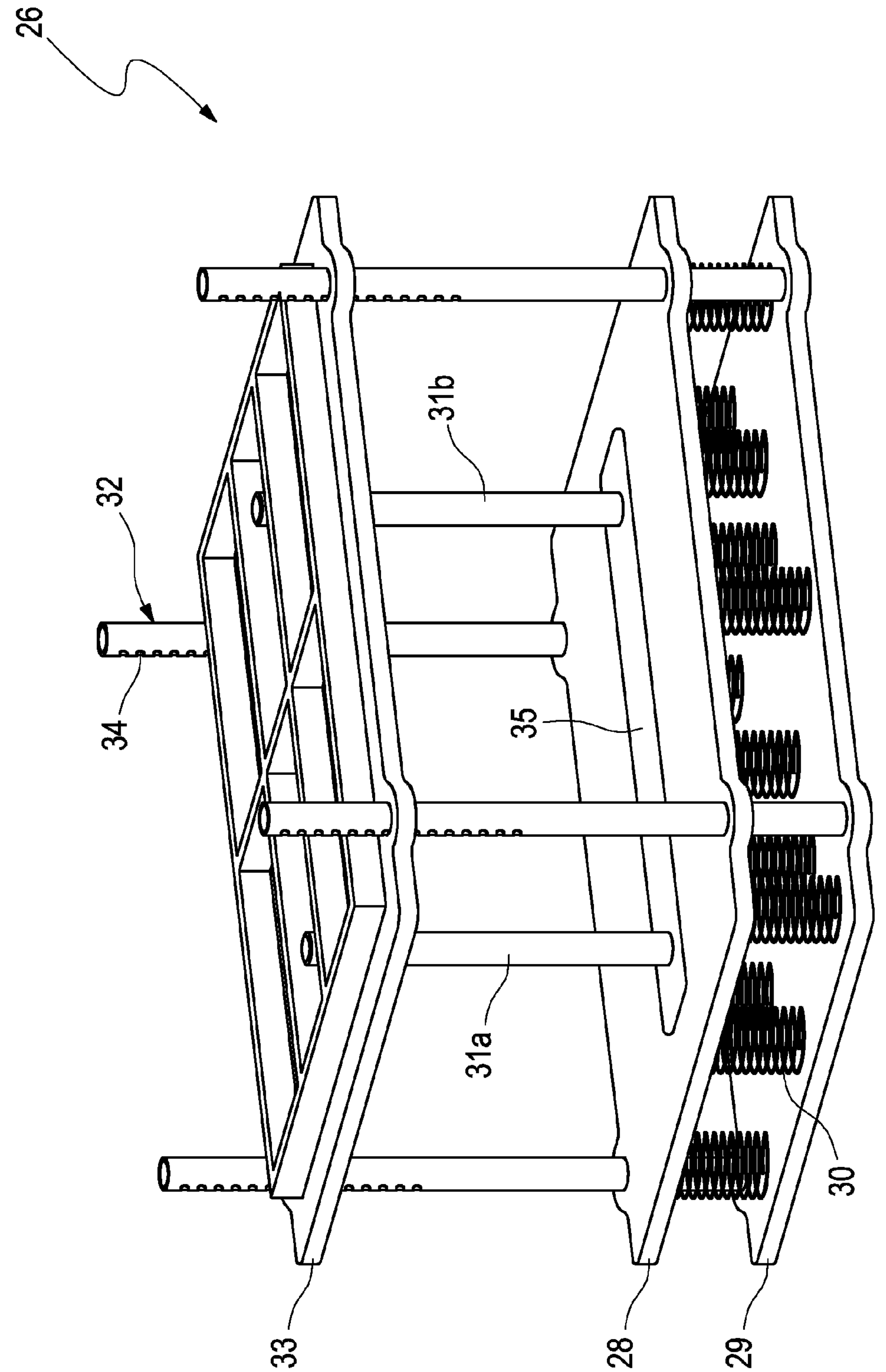


Fig. 10

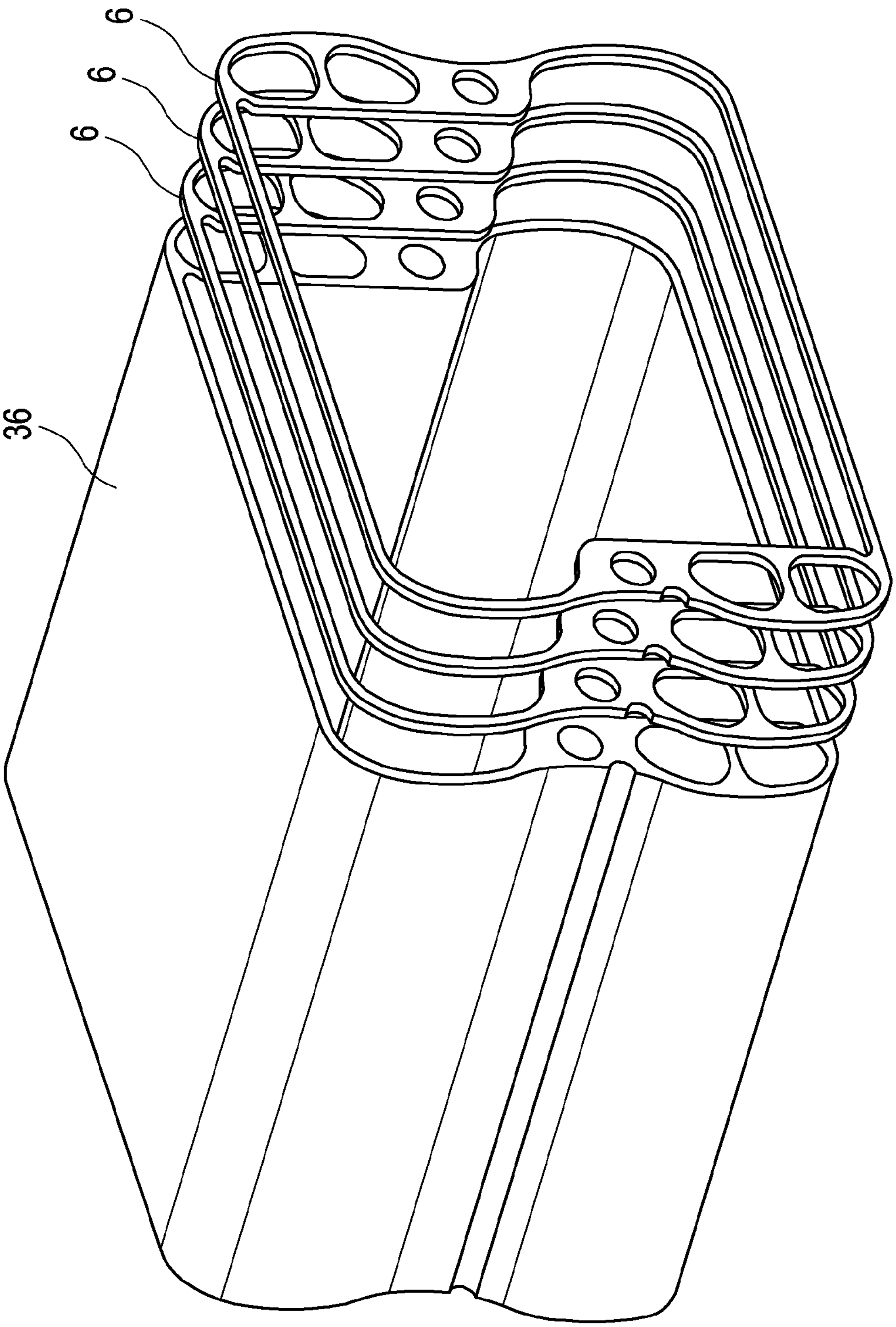


Fig. 11

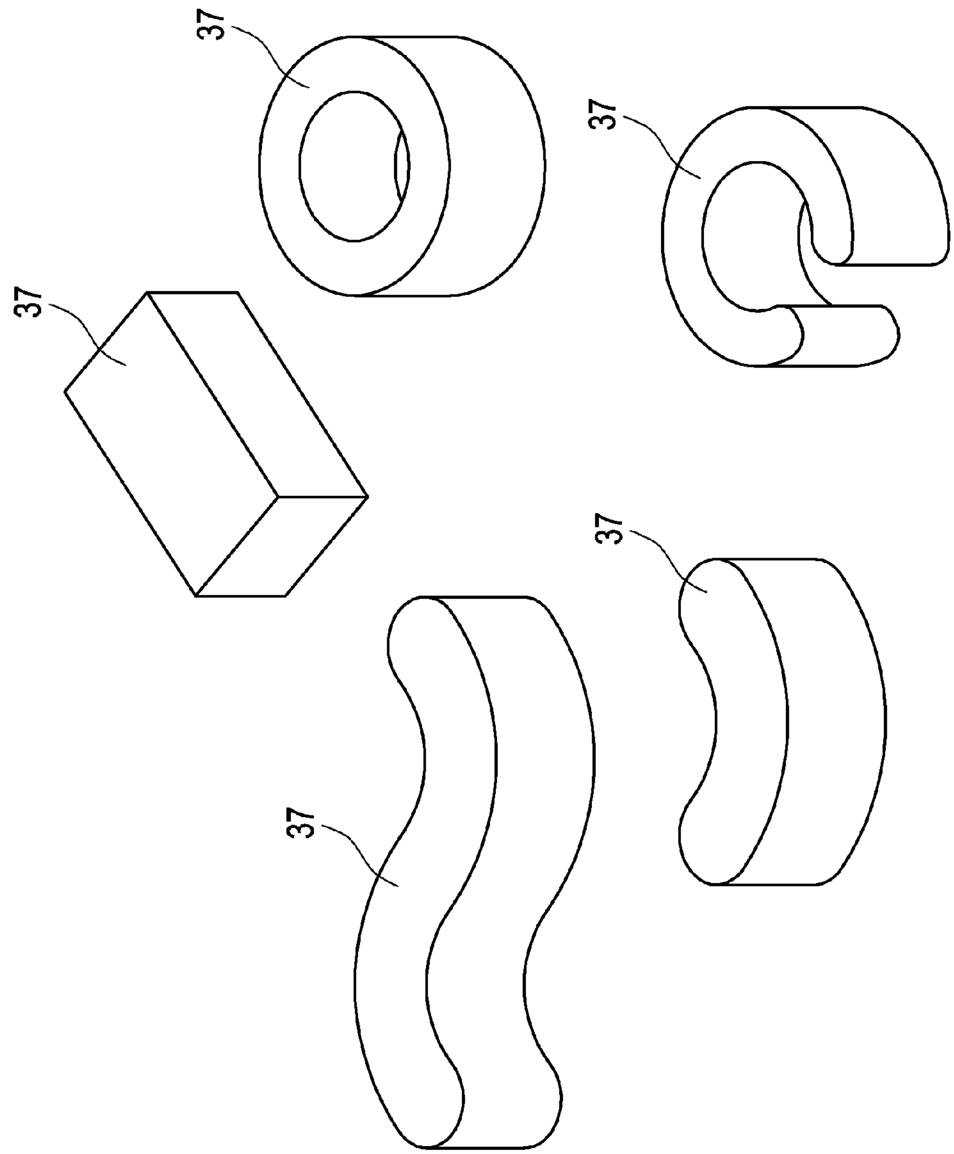


Fig. 12

HEAT EXCHANGER

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to German Patent Application 10 2010 025 576.9 filed on Jun. 29, 2010, and International Patent Application PCT/EP2011/060639 filed on Jun. 24, 2011, both of which are hereby incorporated by reference in their entirety.

TECHNICAL FIELD

[0002] The invention relates to a heat exchanger, consisting of a plurality of layers arranged on top of each other, which layers have in each case a cavity for the passage of a medium to be cooled and delimit a further cavity for the passage of a coolant, wherein in each layer a through hole is formed for the passage of the medium to be cooled.

BACKGROUND

[0003] FIG. **1** illustrates a stacked plate heat exchanger which consists of different plates **2** which are arranged on top of each other and which have in each case one turbulence insert. The turbulence insert **3** is lasered and stamped and is adapted in this manner to the shape of the plate **2**. The plates **2** mounted on top of each other are arranged on a base plate **4**. At the end regions of each plate **2**, there are through holes **5** which are used for guiding the medium to be cooled or for guiding the coolant. Above the plates **2**, the stacked plate heat exchanger **1** is closed with a flange F which represents the interface to the internal combustion engine and to the coolant supply system. Here, the plates **2** are stamped or deep-drawn shaped parts. For producing such shaped parts, tools have to be prepared, wherein a plurality of tools is required for the different sizes of the plates **2**. The multiplicity of tools increases the investment costs because the tools are not variable and for each plate size, a separate tool has to be prepared. Depending on the type of heat exchanger, up to four different tools for each plate size may be required. In particular in the case of prototype production in which likewise a tool for each new size has to be prepared, long production times for the tools are to be expected. Due to the small quantities of plates **2** for prototypes and small series, the investment in tools cannot be amortized.

SUMMARY

[0004] It is therefore an object of the invention to propose a heat exchanger which can be produced in a variable manner and for which the investment costs for tools, in particular, for prototypes or small series can be reduced.

[0005] According to the invention, this object is achieved in that a layer consists of a frame into which a turbulence insert is inserted. This has the advantage that the frame can be cut out in a simple manner from sheet metal by means of laser beams or water jets, wherein the path of the laser beams or the water jets is controlled by a computer. In particular in case of high quantities, stamping is also conceivable for producing the frame. Thus, any computer-controlled laser beam tool or water jet tool can be used with a special shape-generating computer program for the fabrication of the frame. Producing an expensive tool is completely eliminated so that investment costs are reduced or are completely eliminated. Such a computer program can be varied in a simple manner so that frames in many different sizes and quantities can be produced without a significant increase of costs. Furthermore, the development times for a heat exchanger are reduced. Since due to the invention, the heat exchangers can adopt any possible outer contour, optimal utilization of installation space or adaptation to existing installation space in the motor vehicle is possible.

[0006] Advantageously, the frame completely encloses the turbulence insert and has in particular an approximately rectangular shape. The turbulence insert is held in place by the frame, wherein the height of the frame is adapted to the height of the turbulence insert. The turbulence insert simply has to be stamped out of a larger piece. Cutting the turbulence insert for adapting it to the shape of the frame is eliminated so that the production costs for the heat exchanger are further reduced.

[0007] In one configuration, a separating arrangement is inserted between two layers, which layers each consist of the frame and the turbulence insert. This separating arrangement separates the flows of media of the medium to be cooled and the coolant. Since the separating arrangement can be produced in a simple manner from a film or thin sheet metal, this also results in a reduction of the production costs for the heat exchanger.

[0008] In one refinement, the separating arrangement that is formed in a plate-like has a solder layer on both sides. This solder layer ensures that during soldering the pre-assembled heat exchanger in a solder furnace, the frames and the turbulence inserts are firmly connected to each other via the separating arrangement, thereby achieving high stability of the heat exchanger.

[0009] In one variant, in each case one through hole for guiding the medium to be cooled and one channel closure are formed in an end region of the frame. Due to this configuration, the heat exchanger based on frames corresponds in terms of its geometry to a stacked plate heat exchanger so that the corresponding flanges which, after assembly of the heat exchanger, are attached as a closure onto the heat exchanger, can also be used for the heat exchanger implemented as frame-type construction. This eliminates the need of fabricating new flanges for the heat exchanger produced as a frame-type construction.

[0010] In order to ensure that the medium to be cooled is guided through the turbulence insert, the first through hole to the inlet of the medium to be cooled and the second through hole to the outlet of the medium to be cooled are formed in the frame so as to oppose each other diagonally or simply oppose each other.

[0011] Furthermore, for receiving an assembly aid, the frame has a guide opening. This guide opening ensures that the frames arranged on top of each other match exactly so that the through holes to the inlet or, respectively, to the outlet of the medium to be cooled or the coolant are reliably positioned on top of each other.

[0012] In a particularly space-saving variant, the guide opening is formed between the through hole and the energy closure.

[0013] In one refinement, between two frames positioned in a first predetermined position to each other, in each case one further frame is mounted in a second predetermined position which is turned or rotated relative to the first position. Through this alternating positioning of the frames relative to each other, the cavities for the passage of a medium to be cooled and for the coolant are created so that the medium and the coolant are always conveyed alternately to each other, and the coolant can dissipate the heat of the medium to be cooled in a sufficient manner.

[0014] In one configuration, the frame has on its outer edge at least one marking pin. This marking pin has the advantage that after the assembly of the heat exchanger, said marking pin leaves a symmetrical pattern on the outside of the heat exchanger so that the person carrying out the stacking can immediately identify if the individual frames are in the correct position relative to each other.

[0015] The invention allows numerous embodiments. Some of them shall be illustrated in more detail by means of the figures illustrated in the drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] In the figures:

[0017] FIG. **1** shows a stacked plate heat exchanger according to the prior art,

[0018] FIG. **2** shows a frame of a heat exchanger,

[0019] FIG. **3** shows a separating plate of a heat exchanger,

[0020] FIG. **4** shows an exploded illustration for the arrangement of the frame according to FIG. **2** and the separating plate according to FIG. **3**,

[0021] FIG. **5** shows a top view of a first positioning of the frame in the heat exchanger,

[0022] FIG. **6** shows a top view of a second positioning of the frame in the heat exchanger,

[0023] FIG. **7** shows a section through an oil heat exchanger,

[0024] FIG. **8** shows a section through an intercooler,

[0025] FIG. **9** shows a soldering device with the heat exchanger,

[0026] FIG. **10** shows a changeable soldering device,

[0027] FIG. **11** shows the manufacture of a frame from an extruded profile,

[0028] FIG. **12** shows possible designs of the heat exchanger.

[0029] Identical features are designated by identical reference numbers.

DETAILED DESCRIPTION

[0030] FIG. **2** shows a frame as it is cut out by a computer-controlled laser beam tool or water jet tool. Here, the frame **6** has an approximately rectangular shape and has in its longitudinal extension two rib-shaped longitudinal edges **7** and **8**, while on the narrow side, the end regions **9** and **10** are widened. The end region **9** comprises an inlet **11** for a liquid medium, a channel closure **13** for a liquid medium, and a guide opening **14** for an assembly aid. Diagonally opposite to the channel closure **13** of the end region **9**, there is also a channel closure **13** that is formed in the end region **10**. Also, the outlet **12** for the liquid medium in the end region **10** is arranged diagonally opposite to the inlet **11** in the end region **9**. Between the channel closure **13** and the inlet **11** of the end region **9** and the outlet **12** and the channel closure **13** in the end region **10**, guide openings **14** are arranged so that they oppose each other symmetrically when forming the frame **6**.

[0031] In FIG. **3**, a separating arrangement is illustrated which is formed as a separating plate **15** and the outer contours of which are adapted to the outer contours of the frame **6**. The separating plate **15** is formed planarly and has openings **16** and **17**, respectively, at its narrow ends, which openings are formed approximately ovally and span over the channel closure **13** and, respectively, the inlet **11** or the outlet **12** of the frame **6**. The opening **18** which is arranged in the centre and which is formed on both sides of the separating plate **15** is situated exactly under the guide opening **14**.

[0032] FIG. **4** shows how the frame **6** illustrated in FIGS. **2** and **3** and the separating plate **15** are mounted on top of each other. Here, the frame **6** rests on the separating plate **15**, wherein the inside of the frame **6** is filled with a turbulence insert **19**. This turbulence insert **19** is simply inserted into the frame **6** and has only to be stamped for this reason. Cutting the turbulence insert **19** into a particular shape is eliminated. In addition to the already mentioned openings such as inlet **11** or outlet **12** or guide opening **14**, and the channel closure **13**, the frame **6** has a marking pin **20** on an end region **10**. Moreover, the channel closure **13** is provided with a rib **21** which enables an exceptional stability of the frame **6**. With said rib **21** it is ensured that the frame **6** cannot bulge in the end region **9**, **10**.

[0033] In FIG. **5**, the separating plate **15** and the frame **6** are layered alternately one above the other and are positioned on a base plate **22**. Here, the frame **6** does not include the turbulence inserts. In this top view, the position of a frame **6***a* is shown. The end region **9** of the frame **6***a* is positioned on the left side of the base plate **22** while the end region **10** of the frame **6***a* is arranged on the right side of the base plate **22**. The inlet **11** of the end region **9** for a liquid medium is arranged diagonally opposite to the outlet **12** for the liquid medium in the end region **10** of the frame **6***a*. Here, the guide openings **14** are arranged opposite to each other. Also, the channel closure **13** of the end region **9** and the end region **10** are arranged diagonally opposite to each other in this positioning of the frame **6***a*.

[0034] In FIG. **6**, a second position of a further frame **6***b* is shown which is positioned above the frame **6***a* illustrated in connection with FIG. **5**. In comparison to the frame **6***a* of FIG. **5**, the frame **6***b* is rotated about its longitudinal axis by 180°. This results in that the channel closure **13** of the end region **9** is now positioned at the position where the inlet **11** of the frame **6***a* placed therebelow is positioned. With regard to the end region **10**, the channel closure **13** and the outlet **12** are also interchanged. In this position, the turbulence insert **19** is inserted in the frame **6***b*. Thus, the medium to be cooled can discharge from the inlet **11** and flows in the longitudinal direction of the frame **6***b* through the turbulence insert **19** so as to flow out again through the outlet **12** and out of the frame **6***b*.

[0035] FIG. **7** illustrates a completely fabricated oil heat exchanger in which a plurality of frames **6***a*, **6***b* are layered on top of each other, wherein the frames **6***a*, **6***b* are separated by a separating plate **15**. The turbulence inserts **19** are only indicated in this example. The frames **6***a*, **6***b* are alternately mounted, separated by a separating plate **15**, on the base plate **22** and are closed by a flange **23**. Prior to the assembly, the separating plates **15** are coated on both sides with solder which effects that in a solder process, the frames **6***a*, **6***b* and the turbulence insert **19** are firmly connected to each other.

[0036] FIG. **8** illustrates an intercooler having the explained frame-type construction, wherein here too, the frames **6***a*, **6***b* are arranged alternately on a base plate **22**, wherein the frames **6***a*, **6***b* are separated in each case by a separating plate **15**. The different channels for the passage of air used as coolant or for the passage of the medium to be cooled are particularly clearly shown in this section. The arrow **24** indicates the profile on the air side, while the arrow **25** illustrates the profile on the coolant side. The intercooler is also covered with a flange **23**.

[0037] In FIG. **9**, a heat exchanger **27** built as frame-type construction is inserted in a soldering device **26**. Here, the heat exchanger **27** is mounted on a first plate **28** which is guided by means of four guide bolts **32**, wherein between the first plate **28** and a second plate **29**, a plurality of springs **30** is arranged. In order to be able to securely position the frames **6***a*, **6***b* and the separating plates **15**, in each case one bolt **31***a*, **31***b* is inserted through the guide openings **14** of the heat exchanger **27**. The cover plate **33** covers the heat exchanger **27**. The cover plate **33** is set at the openings **34** of the guide bolts **32** in such a manner that the heat exchanger **27** is preloaded against the springs **30**. As already explained, in the preassembled heat exchanger **27**, the separating plates **15** are provided on both sides with a solder layer. The heat exchanger **27** clamped in such a manner in the soldering device **26** is slid into a solder furnace, where the heat exchanger with its individual parts is soldered together during a soldering process.

[0038] FIG. **10** illustrates a variable soldering device **26** which can be adjusted for different sizes of the heat exchangers **27**. The bolts **31***a*, **31***b* which engage in the guide openings **14** of the frame **6** of the heat exchanger **27** can be adjusted vertically as well as horizontally. In addition, they are secured on a stacking aid **35** which can be removed again after clamping. Thus, a soldering device **26** can be used for each shape of the heat exchangers **27** fabricated as a frame-type construction.

[0039] As already explained, the frame **6** of the heat exchanger **27** is cut out or stamped by means of a laser beam or a water jet, wherein the tool is controlled by a computer program. Alternatively, the frames **6** can also be produced as extruded profiles **36**, as illustrated in FIG. **11**. The drawn extruded profile **36** generated in a single work process is subsequently divided to form the frames **6**.

[0040] However, the invention is not limited to a heat exchanger having an approximately rectangular footprint. By means of the frame-type construction it is possible that all conceivable shapes of heat exchangers **37** can be formed, as illustrated in FIG. **12**. In particular, by using a computer program which controls a laser beam tool or a water jet tool, annular contours as well as S-shaped or circular-segment-shaped shapes can be produced. Thus, the shape of the heat exchanger **37** can always be adapted to the installation position in the motor vehicle.

1. A heat exchanger, comprising:

a plurality of layers arranged on top of each other, wherein each of the layers has a first cavity for the passage of a medium to be cooled and a second cavity for the passage of a coolant, wherein each layer has a through hole for the passage of the medium to be cooled,

wherein each layer includes a frame in which a turbulence insert is inserted,

wherein each frame has an end region and each end region defines at least one channel closure and the through hole for the passage of the medium to be cooled,

wherein the frame has a guide opening for receiving an assembly aid, and

wherein the guide opening is formed between the through hole and the channel closure.

2. The heat exchanger according to claim **1**, wherein the channel closure is provided with a rib.

3. The heat exchanger according to claim **1**, wherein the frame completely encloses the turbulence insert and has an approximately rectangular shape.

4. The heat exchanger according to claim **1**, wherein a separating arrangement is inserted between at least two of the layers, each layer including the frame and the turbulence insert.

5. The heat exchanger according to claim **4**, wherein the separating arrangement is formed in a plate-like manner and has a solder layer on both sides.

6. heat exchanger according to claim **1**, wherein the first through hole is fluidly connected to an inlet of the medium to be cooled and the second through hole is fluidly connected to an outlet of the medium to be cooled and further wherein the first through hole and the second through hole are formed in the frame and arranged diagonally opposite each other.

7. The heat exchanger according to claim **1**, wherein two of the frames are in a first predetermined position, and at least one other of the frames is arranged between the two frames and is in a second predetermined position at least one of turned or rotated relative to the first position.

8. The heat exchanger according to claim **1**, wherein the frame has at least one marking pin on its outer edge.

9. The heat exchanger according to claim **2**, wherein the frame completely encloses the turbulence insert and has an approximately rectangular shape.

10. The heat exchanger according to claim **9**, wherein a separating arrangement is inserted between at least two of the layers, each layer including the frame and the turbulence insert.

11. The heat exchanger according to claim **10**, wherein the separating arrangement is formed in a plate-like manner and has a solder layer on both sides.

12. The heat exchanger according to claim **11**, wherein the first through hole is fluidly connected to an inlet of the medium to be cooled and the second through hole is fluidly connected to an outlet of the medium to be cooled and further wherein the first through hole and the second through hole are formed in the frame and arranged diagonally opposite each other.

13. The heat exchanger according to claim **12**, wherein two of the frames are in a first predetermined position, and at least one other of the frames is arranged between the two frames and is in a second predetermined position at least one of turned or rotated relative to the first position.

14. The heat exchanger according to claim **13**, wherein the frame has at least one marking pin on its outer edge.

15. The heat exchanger according to claim **2**, wherein a separating arrangement is inserted between at least two of the layers, each layer including the frame and the turbulence insert.

16. The heat exchanger according to claim **2**, wherein the separating arrangement is formed in a plate-like manner and has a solder layer on both sides.

17. The heat exchanger according to claim **2**, wherein the first through hole is fluidly connected to an inlet of the medium to be cooled and the second through hole is fluidly connected to an outlet of the medium to be cooled and further wherein the first through hole and the second through hole are formed in the frame and arranged diagonally opposite each other.

18. The heat exchanger according to claim **2**, wherein two of the frames are in a first predetermined position, and at least one other of the frames is arranged between the two frames and is in a second predetermined position at least one of turned or rotated relative to the first position.

19. The heat exchanger according to claim **2**, wherein the frame has at least one marking pin on its outer edge.

20. The heat exchanger according to claim **3**, wherein the frame has at least one marking pin on its outer edge.

* * * * *