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(54) Title: INTERCOOLER ARRANGEMENT FOR A SUPER-CHARGED PISTON ENGINE

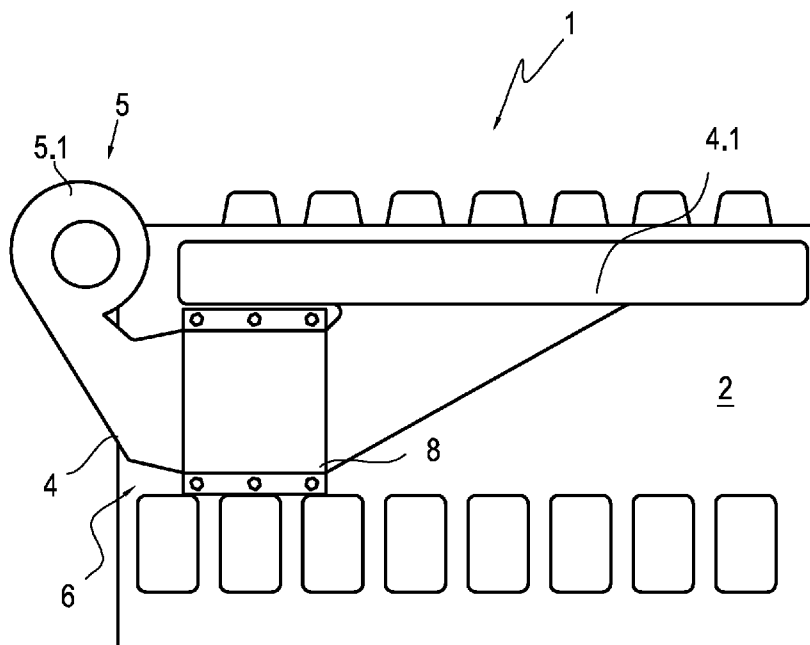


FIG. 1

(57) Abstract: The invention relates to an intercooler arrangement for a super-charged piston engine comprising an intercooler (6) for combustion air arranged in the feed air ductwork (4) of the piston engine, which intercooler comprises a heat exchanger space (12), into which at least one heat exchanger unit (20) is adapted, which unit is provided with at least one support element to support the flow channel of the heat exchanger unit. The support element (22) is detachably attached to the side wall/support structure (16) of the intercooler by means of an intermediate part (32).



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INTERCOOLER ARRANGEMENT FOR A SUPER-CHARGED PISTON ENGINE

5 The present invention relates to an intercooler arrangement for a super-charged piston engine according to the preamble of claim 1 comprising an intercooler for combustion air arranged in the feed air duct-work of the piston engine, which intercooler comprises a heat exchanger space consisting of essentially gastight side walls, into which space at least one heat exchanger unit is adapted, which unit is provided with at least one support element to support the flow channels of the heat exchanger unit.

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In a combustion engine provided with a supercharger it is known to use a so-called intercooler, which is adapted in the feed air duct-work of the engine after the compressor of the supercharger. The air heated in the compressor may be cooled by the intercooler, whereby the mass flow of the cooler air becomes larger and thus the combustion process obtains quantitatively more oxygen. The air cooled by the intercooler also cools down the components of the feed air duct-work and even the valves of the engine more efficiently.

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An intercooler is typically a heat exchanger transferring heat from the combustion air to a fluid of relatively low temperature, such as water. Typically, the fluid is arranged to flow inside the tubes of the intercooler, whereby the air, accordingly, is arranged to flow outside the tubes. The outer surfaces of the tubes are typically provided with fins, by means of which the heat-transfer coefficient of the outer surface is improved. The tubes are arranged side by side forming parallel tube bundles, in which the ends of the tubes are connected to one another as desired, e.g. by means of flow elbows and/or end collectors, thus forming a heat exchanger unit.

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One intercooler has typically a plurality of heat exchanger units consisting of tube bundles and arranged successively in the flow direction of air.

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The heat exchanger units of the intercooler as well as their tube bundles need to be supported so as not to vibrate substantially due to the excitations produced by the engine. Especially an intercooler attached in conjunction with a piston engine is, in addition to the mechanical vibration of the engine, exposed to air or gas vibration

prevailing in the feed air duct-work produced e.g. when the valve mechanism opens or closes the connection to the combustion chamber of the engine cylinders.

From prior art it is known to use tube supports in the tube bundles of the heat exchanger units for connecting adjacent tubes to one another in such a way that the
5 respective positions of the tubes are maintained. The tube supports are for instance thin plates provided with holes, through which the tubes in the tube bundle pass substantially perpendicularly with respect to the plane of the plate. The fit between the tubes and the holes is tight enough for preventing the tube from moving
10 essentially in the hole in a direction deviating from the longitudinal direction of the tube. Typically, the gas to be cooled, i.e. the air to be fed into the engine, is arranged to flow between the tubes mainly in perpendicular direction with respect to the tubes. In the arrangement of this kind, for attaching the heat exchanger unit to the body of the intercooler, it is known to utilise crossbars, the ends of which are
15 fastened to the body of the intercooler so that the crossbar is located at the tube support of the heat exchanger unit parallelly therewith. The tube support is typically a rectangular-shaped plate situated in the heat exchanger unit in the flow direction of air and its two opposite edges are supported onto the body of the intercooler and the two other edges are provided with said crossbar. The crossbars are fastened by
20 utilising pretension that compresses the tube support of the heat exchanger unit at the same time as the ends of the crossbars are attached to the body of the intercooler. In this way, the heat exchanger unit is squeezed between two crossbars.

The risk involved in the structure of this kind is that the supporting effect of the
25 crossbar for the tube support and thus for the tube bundle will be weakened in the course of time, e.g. due to the wear of both the crossbar and the tube support. Also, the loosening of the clamping of the crossbar ends may result in the weakening of the supporting effect.

Thus, the purpose of the present invention is to provide an improvement to the prior
30 art by disclosing an intercooler arrangement for a super-charged combustion engine, which is more durable and simpler to install than the prior art solutions.

The intercooler arrangement according to the invention is characterised in what is disclosed in the characterising part of the appended claim 1.

According to one embodiment of the present invention an intercooler arrangement
5 for a super-charged piston engine comprises an intercooler for combustion air arranged in the feed air duct-work of the piston engine, which intercooler comprises a heat exchanger space, into which at least one heat exchanger unit is adapted, and in which heat exchanger unit at least one support element is arranged to support the flow channels of the heat exchanger unit. It is characteristic of the intercooler
10 arrangement that the support element is detachably attached to the side wall/support structure of the intercooler by means of an intermediate part.

The support element is a plate structure, through which the flow channels of the heat exchanger unit are arranged to extend. The support element and the flow
15 channels are located in essentially perpendicular direction with respect to one another.

According to one embodiment, the flow channels of the heat exchanger unit comprise tubes, which form the face end of the heat exchanger unit, whereby the
20 support element protrudes at least partially out from the face end, and the support element is attached to the side wall/support structure of the heat exchanger arrangement by means of the protruding attaching part.

The intermediate part comprises preferably two sides, by means of which the
25 intermediate part is attached to both the attaching part and the side wall/support structure and which are located perpendicularly with respect to one another, and the shape of the surfaces of which corresponds to the shape of the contact surface of the attaching part arranged in the support element as well as to the shape of the contact surface of the side wall/support structure.

30 The intermediate part is detachably attached to the support element and to the side wall/support structure of the intercooler. The attaching is preferably realised by a screwed joint in such a way that the support element is attached to two opposite side walls/support structures of the heat exchanger arrangement. Then, one side of

the intermediate part comprises preferably a hole provided with an internal thread for attaching the intermediate part to the side wall/support structure.

Additional characteristic features of the invention are disclosed in the appended
5 claims.

In the following, the invention and its operation will be explained with reference to the appended schematic drawings, of which

- 10 - Figure 1 shows a super-charged piston engine according to one embodiment of the invention,
- Figure 2 shows an intercooler arrangement according to one embodiment of the invention,
- Figure 3 shows the cross-section III-III of Figure 2,
- 15 - Figure 4 shows an intercooler arrangement according to another embodiment according to the invention, and
- Figures 5 - 7 show yet some other intercooler arrangements according to the embodiments of the invention.

20 Figure 1 shows schematically a turbocharged piston engine 1. The engine comprises, inter alia, an engine body 2, to which e.g. the cylinders and cylinder heads are connected. The engine comprises feed air duct-work 4, which is arranged to transport combustion air to the cylinders of the engine 1. The first end of the combustion air duct-work comprises a distribution part 4.1, by which air is distributed
25 to each cylinder. The second end of the feed air duct-work 4 is in connection to the compressor part 5.1 of the supercharger 5. The feed air duct-work 4 is provided with an intercooler 6, which is arranged after the compressor part 5.1 in the flow direction of air. The intercooler 6 is attached to the engine 1 by means of the body 8 of the intercooler.

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The structure of the intercooler according to one embodiment of the invention is described with reference to Figures 2 and 3. In Figure 2, the intercooler 6 is shown as a cross-section at two different points in the flow direction of air. The section on the left in the figure is a cross-section of the inner part of the intercooler 6 in the

middle of one row of superimposed tubes 10. The section on the right is the intercooler seen from the front. Figure 3 shows the section III-III of Figure 2.

5 The intercooler is a heat exchanger, in which gas, i.e. combustion air, is arranged to flow in the heat exchanger space 12 of the heat exchanger. The intercooler comprises side walls or support structures 16 for supporting and/or attaching the heat exchanger. The reference number 16 may, depending on the embodiment, refer here to the actual gastight side wall, which delimits the heat exchanger space 12. Optionally, the reference number 16 may refer to the support structure 16, 10 whereby the heat exchanger unit 20 is supported onto the support structure 16. If the heat exchanger is supported onto a separate support structure, the support structure is adapted within a separate gastight enclosure or the support structure comprises a gastight enclosure.

15 A heat exchanger unit 20 with flow channels, here consisting of tubes 10, is arranged into the heat exchanger space 12. The tubes 10 are arranged mainly transversely with respect to the flow direction of air so that the air may flow past the tubes on the outside. A fluid, such as treated water, is arranged to flow inside the tubes, to which fluid the heat of the combustion air is transferred in the intercooler.

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10 Fins 14 are preferably arranged on the outer surface of the tubes, only a part of which fins are shown here for the sake of clarity. The type, shape and size of the fins may, as such, vary from case to case.

25 The tubes 10 of the heat exchanger unit 20 are supported onto one another by means of support elements 22. According to the invention, a support element is also an element, by means of which the heat exchanger unit is attached to the side walls/support structure 16 of the intercooler. The support element 22 is preferably a plate, into which openings 24 for the tubes 10 are arranged. The tubes and the 30 support element are located essentially in perpendicular direction with respect to one another. The support element comprises an attaching part 26, by means of which it is detachably attached to the side wall/support structure 16 of the intercooler. The attaching part 26 consists of the area of the support element 22 that is free from openings 24 and located in the periphery of the support element. The

size of the attaching part is such that e.g. a bolt joint 25 may be used reliably for the attachment. An intermediate part 32 is arranged onto the side wall/support structure 16 at the attaching part 26 for providing the attaching of the heat exchanger unit 22.

5 The intermediate part 32 comprises two sides, which are located perpendicularly with respect to one another and the shape of the surfaces of which corresponds to the shape of the contact surface of the attaching part 26 and, on the other hand, to the shape of the contact surface of the side wall/support structure 16. A recess 321, preferably a blind drilling, is arranged on one of these sides, which recess is
10 provided with an internal thread 322. As there is a hole arranged in the side wall and/or in the support structure 16 at the point corresponding to the drilling 321, the intermediate part may be attached to the side wall and/or support structure by means of a screwed joint 323. The screw of the screwed joint 323 is inserted into the thread of the intermediate part from the outside. In this manner, the position of
15 the heat exchanger unit 20 on the side wall/support structure 16 is determined on the basis of the location of the holes arranged for the attachment of the intermediate part 32, and the position of the intermediate part 32 with respect to the support structure 16 can be easily changed. In this embodiment the intermediate part is a rectangular prism.

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Figure 5 shows an embodiment operating in a similar way. There, the intermediate part 32 consists of two planar parts located perpendicularly with respect to one another, one of which parts is provided with a recess. The recess 321 is preferably a blind drilling provided with an internal thread 322. The intermediate part according to
25 Figure 5 is preferably an angle iron.

The tubes of the heat exchanger unit 20 form a so-called face end S, which is located perpendicularly with respect to the flow direction A of gas (Figure 3). Preferably, the support element 22 protrudes out from the face end to the opposite
30 side with respect to the tubes of the heat exchanger unit. In Figure 3, the support element extends from the face end against the flow direction of gas.

The intercooler arrangement is embodied so that two sides 22.1 of the support element 22 are in mechanical connection to the side wall/support structure 16 in

such a way that the sides 22.1 of the support element are placed against the side walls/support structures 16. In practise, this arrangement supports the support elements and thereby also the heat exchanger units in their places. Although not shown in the figures, auxiliary elements between the wall and the support element, such as guide and/or safety rails, may be used for this purpose.

Figure 4 shows an embodiment, in which also a crossbar 30 is attached to the same intermediate part 32 as the attaching part 26 of the support element 22 in order to support the opposite sides 16 onto one another. Figure 6 shows another embodiment, in which the intermediate part 32 is formed of the end section of the crossbar 30, whereby a separate intermediate part is not necessarily required, and the crossbar is attached directly to the side wall/support structure 16 by means of a screw.

Figure 7 shows an embodiment, in which the intermediate parts 32 are placed on such sides 22.1 of the support element 22 that are in connection to the side wall/support structure 16. The sides 22.1 of the support element are placed against the side walls/support structures 16 and the support element comprises an attaching part 26 in the vicinity of the side 22.1, by which attaching part the support element is attached to the intermediate part 32. The intermediate part 32 is attached to the side wall/support structure 16 by means of a bolt joint in a similar way as in the other above-described embodiments.

It is to be noted that only a few most advantageous embodiments of the invention are described in the above. Thus, it is clear that the invention is not limited to the above-described embodiments, but may be applied in many ways in conjunction with different piston engines within the frame of the appended claims. The cross-section of the tubes may also be, e.g., oval instead of round, and plate structures may as well be utilised instead of tubes. The invention may be applied both to four-stroke and two-stroke engines, which are driven by liquid and/or gaseous fuel. The features described in conjunction with the different embodiments may be used in conjunction with other embodiments as well and/or various combinations of the described features may be made within the frame of the basic idea of the invention, if so desired, and if technical feasibility for this exists.

CLAIMS

- 5 1. An intercooler arrangement for a super-charged piston engine comprising an intercooler (6) for combustion air arranged in the feed air duct-work (4) of the piston engine, which intercooler comprises a heat exchanger space (12), into which at least one heat exchanger unit (20) is adapted, and in which heat exchanger unit at least one support element (22) is arranged to support a flow channels (10) of the
- 10 heat exchanger unit, **characterised** in that the support element (22) is detachably attached to the side wall/support structure (16) of the intercooler by means of an intermediate part (32).
2. An intercooler arrangement according to claim 1, **characterised** in that the
- 15 support element (22) is attached to two opposite side walls/support structures (16) of the heat exchanger arrangement.
3. An intercooler arrangement according to anyone of the preceding claims, **characterised** in that the support element (22) comprises a plate structure, through
- 20 which the flow channels (10) of the heat exchanger unit are arranged to extend.
4. An intercooler arrangement according to claim 2 or 3, **characterised** in that the support element (22) and the flow channels (10) are located in essentially perpendicular direction with respect to one another.
- 25 5. An intercooler arrangement according to claim 1, **characterised** in that the support element (22) is arranged in conjunction with the side wall/support structure (16) at its two sides.
6. An intercooler arrangement according to claim 1 or 2, **characterised** in that the
- 30 flow channels of the heat exchanger unit comprise tubes (10), which form the face end of the heat exchanger unit, and that the support element (22) protrudes at least partially out from the face end.

7. An intercooler arrangement according to claim 1 or 6, **characterised** in that the support element (22) is attached to the side wall/support structure (16) of the heat exchanger arrangement by means of an attaching part (26) arranged in the support element.

5

8. An intercooler arrangement according to claim 6, **characterised** in that the support element (22) is attached to the side wall/support structure (16) of the heat exchanger arrangement by means of an attaching part (26) protruding out from the face end (S).

10

9. An intercooler arrangement according to claim 1, **characterised** in that the intermediate part (32) comprises two sides, which are located perpendicularly with respect to one another and the shape of the surfaces of which corresponds to the shape of the contact surface of the attaching part (26) arranged in the support element (22) and to the shape of the contact surface of the side wall/support structure (16).

15

10. An intercooler arrangement according to claim 1, **characterised** in that the intermediate part (32) is detachably attached to the support element (22) and to the side wall/support structure (16) of the intercooler.

20

11. An intercooler arrangement according to claim 1, **characterised** in that the intermediate part (32) comprises on one side a hole (321) provided with an internal thread for attaching the intermediate part (32) to the side wall/support structure (16).

25

12. An intercooler arrangement according to anyone of the preceding claims, **characterised** in that each support element (22) is attached to the side wall/support structure (16) of the intercooler by means of at least two intermediate parts (32).

30

13. An intercooler arrangement according to anyone of the preceding claims 1 - 11, **characterised** in that the position of the heat exchanger unit (20) on the side wall/support structure (16) is determined on the basis of the position of the holes arranged for the attachment of the intermediate part (32).

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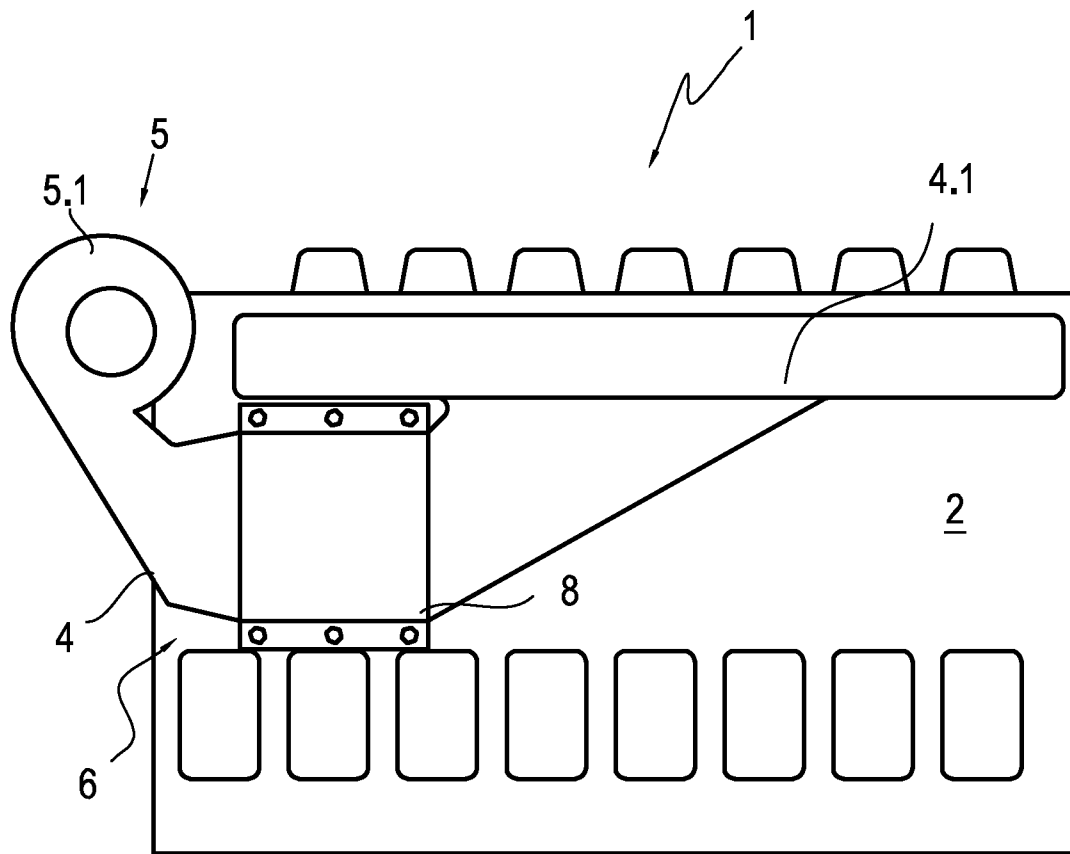
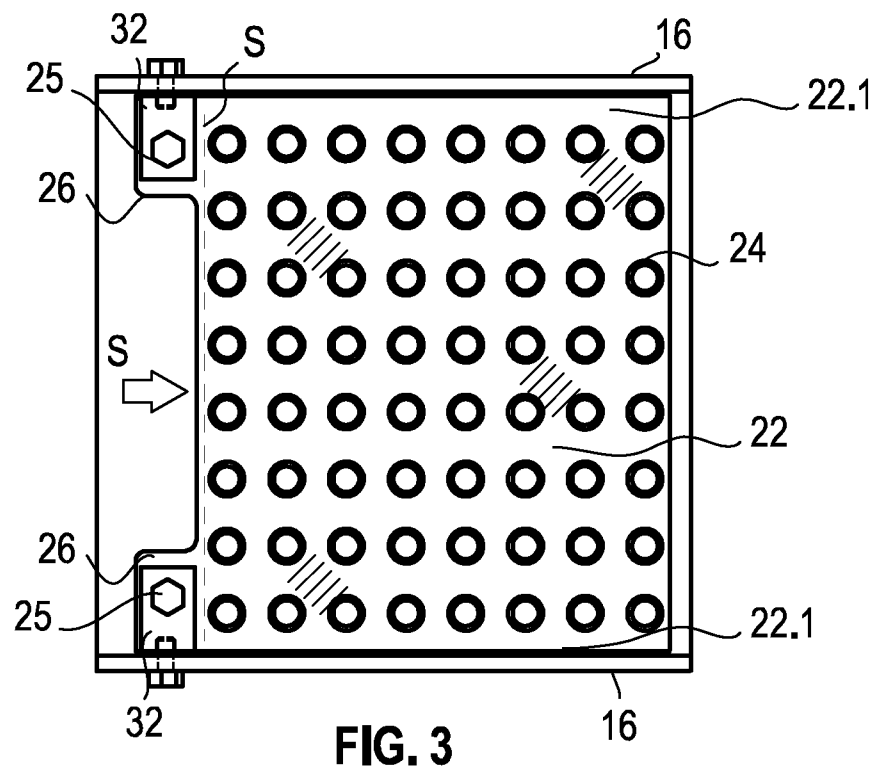
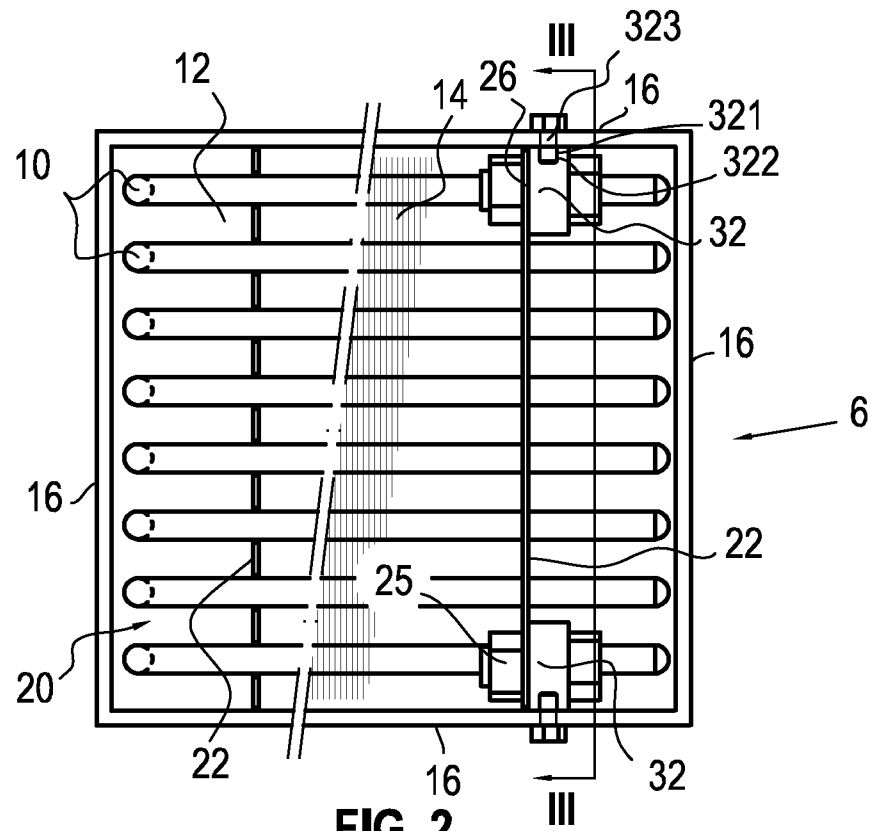


FIG. 1

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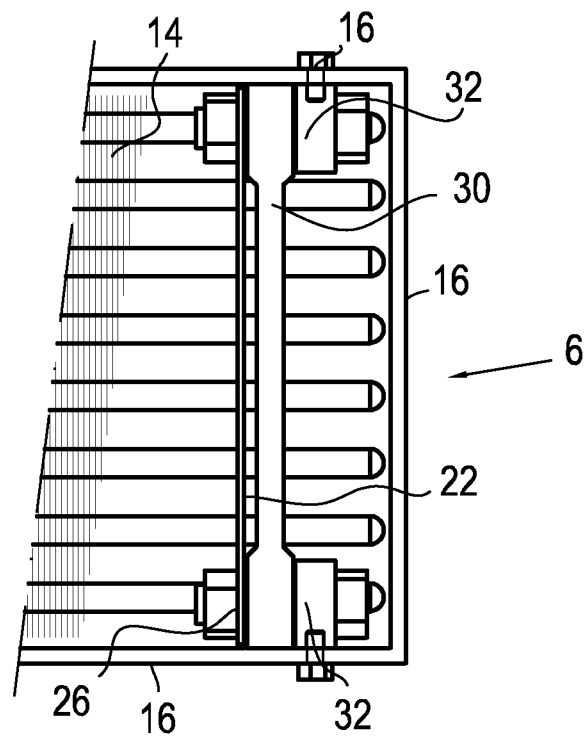


FIG. 4

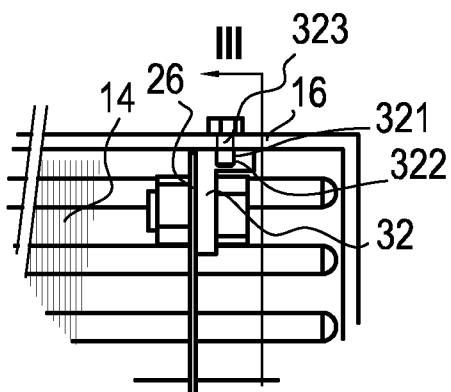


FIG. 5

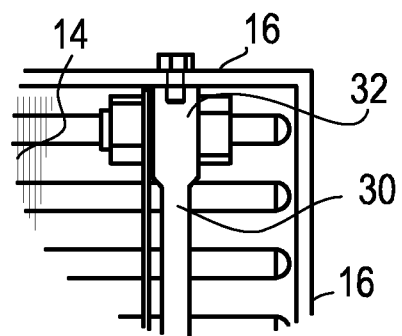
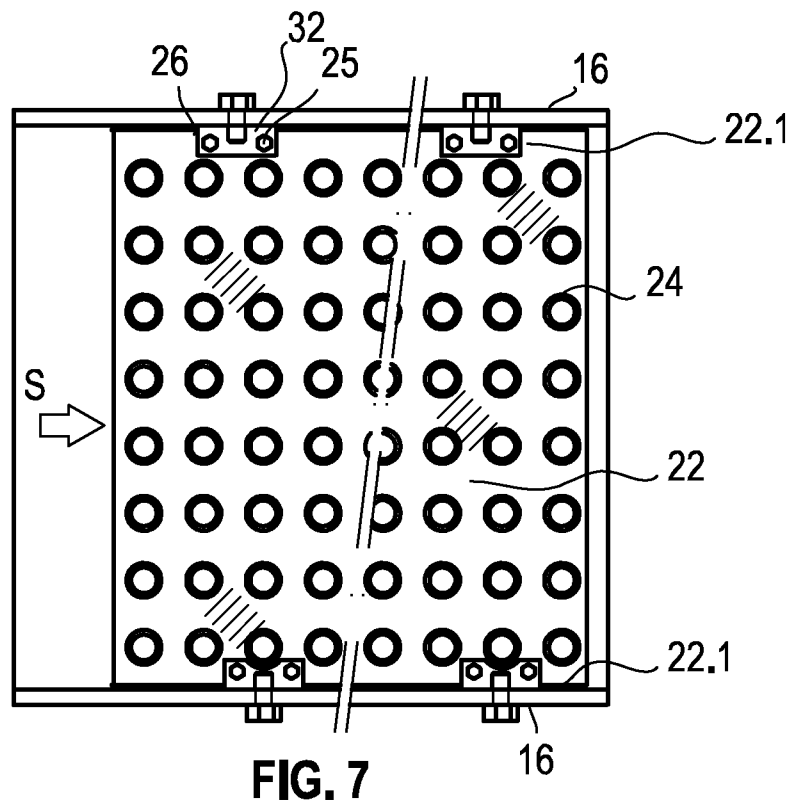


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No
PCT/FI2009/050699

A. CLASSIFICATION OF SUBJECT MATTER
INV. F02B29/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 036 756 A1 (GARRETT CORP [US]) 30 September 1981 (1981-09-30) the whole document	1-2,4-13
X	US 4 476 842 A (BELSANTI JAMES F [US]) 16 October 1984 (1984-10-16) the whole document	1-5
X	EP 0 079 217 A2 (GARRETT CORP [US]) 18 May 1983 (1983-05-18) the whole document	1-2,4-6, 13
X	US 4 474 162 A (MASON JOHN L [US]) 2 October 1984 (1984-10-02) the whole document	1-2,4-13
X	DE 34 03 001 A1 (LAENGERER & REICH KUEHLER [DE]) 8 August 1985 (1985-08-08) the whole document	1-4,6

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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