A heat exchanger including a plurality of longitudinal flat tubes stacked together with space between the broad sides of adjacent tubes, and inlet and outlet collecting tanks. The inlet collecting tank distributes a first medium into the tubes, and has a wall extending around the periphery of one end the stack of flat tubes over a selected longitudinal section, the wall having at least one of an inlet and outlet for a second medium distributed in the space between the stacked tubes. The outlet collecting tank receives the first medium from the tubes. Longitudinal internal inserts in the flat tubes are metallically connected to the broad sides of the associated flat tube. At least one row of cutouts is between the longitudinal ends of the internal inserts and in the selected longitudinal section, with the row of cutouts extending substantially across the broad width of the insert.
HEAT EXCHANGER AND FLAT TUBES

CROSS REFERENCE TO RELATED APPLICATION(S)

[0001] Not applicable.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not applicable.

REFERENCE TO A MICROFICHE APPENDIX

[0003] Not applicable.

TECHNICAL FIELD

[0004] The present invention is directed toward heat exchangers, and particularly toward flat tube heat exchangers subject to alternating temperature loads.

BACKGROUND OF THE INVENTION AND TECHNICAL PROBLEMS POSED BY THE PRIOR ART

[0005] Heat exchangers are, of course, old in the art in a variety of configurations. For example, a heat exchanger type includes an inlet collecting tank which distributes a medium to flat heat exchanger tubes and an outlet collecting tank which receives the medium from the flat heat exchanger tubes. An internal insert is arranged in the flat heat exchanger tubes, with the insert being metallically connected to the two broad sides of the heat exchanger tube.

[0006] In one particular form, the collecting tank has a wall that extends around the periphery of the end of a stack of heat exchanger tubes and over a certain length section of the heat exchanger tubes, in which the wall has at least one inlet and/or one outlet for the other medium which flows between the heat exchanger tubes. This particular form of the heat exchanger and heat exchanger tube described above are described in the not previously published European Patent Application with Application No. EP 040 27 604.0, in which a slit on the end of the internal insert or a conical cutout open toward the end is provided. In accordance with that description, both expediency led to a noticeable improvement with respect to compensation of alternating temperature loads.

[0007] However, even with improvements of that described structure, it is still desirable to provide heat exchangers and heat exchanger tubes which can even better withstand the enormous alternating temperature loads encountered, for example, in an exhaust heat exchanger in an exhaust gas recirculation system.

[0008] The present invention is directed toward overcoming one or more of the problems set forth above.

SUMMARY OF THE INVENTION

[0009] In one aspect of the present invention, a heat exchanger is provided, including a plurality of longitudinal flat tubes stacked together with space between the broad sides of adjacent tubes, and inlet and outlet collecting tanks. The inlet collecting tank distributes a first medium into the tubes, and has a wall extending around the periphery of one end the stack of flat tubes over a selected longitudinal section, the wall having at least one of an inlet and outlet for a second medium distributed in the space between the stacked tubes. The outlet collecting tank receives the first medium from the tubes. Longitudinal internal inserts in the flat tubes are metallically connected to the broad sides of the associated flat tube. There is at least one row of cutouts between the longitudinal ends of the internal inserts and in the selected longitudinal section, with the row of cutouts extending substantially across the broad width of the insert.

[0010] In one form of this aspect of the present invention, the internal insert is a sheet corrugated in the longitudinal and transverse directions and the at least one row of cutouts includes at least two rows of cutouts with a connecting insert portion between the rows of cutouts. In a further form, the corrugated sheet includes wave flanks, and the connection insert portion is in the wave flanks. In another further form, the rows of cutouts extend no more than one third (1/3) of the total length of the internal insert and the remaining length of the internal insert has substantially no cutouts. In still another further form, the size and shape of the cutouts and the connecting insert portion is variable. In yet another further form, a row of end cutouts is open on the end of the internal insert in the selected longitudinal section, and an end connecting insert portion is between the row of end cutouts and an adjacent row of cutouts, and in a still further form the internal insert includes fingers in the crests and valleys of the corrugated sheet adjacent opposite sides of the end cutouts, with the fingers soldered on the side wall of the associated flat tube.

[0011] In another form of this aspect of the present invention, the at least one row of cutouts includes at least two rows of cutouts with a connecting insert portion between the rows of cutouts, and further includes at least one rupture site in the connecting insert portion.

[0012] In still another form of this aspect of the present invention, the tubes are two flat tube halves connected on their longitudinal edges.

[0013] In yet another form of this aspect of the present invention, outwardly projecting embossings are on the broad sides of the tubes, with the embossings defining the space between the broad sides of adjacent tubes in the stack of tubes.

[0014] In another form of this aspect of the present invention, the collecting tank wall has deformations adapted to stabilize the tank while providing elasticity during alternating temperature loads.

[0015] In still another form of this aspect of the present invention, the selected longitudinal section is bounded by first and second connection planes at one end of the stack of tubes, and the one inlet or outlet for the second medium is in the collecting tank wall between the two planes. In a further form, a tube plate is connected to the collecting tank wall at the first connection plane, with the tube plate having connectors for the ends of the stack of flat tubes. In another further form, an intermediate plate having the peripheral contour of the stack of flat tubes is connected to wall in the first connection plane. In still another further form, the second connection plane is defined by a contour cut in the collecting tank wall and matching the peripheral contour of the stack of flat tubes. In yet another further form, the contour cut in the collecting tank wall has slits matching an end flange on the flat tubes and also has protrusions closing
furrows at the space between adjacent flat tubes. In another
further form, the broad sides of the heat exchanger tubes
include protrusions in the region of the first connection plane
to divide the flow of the second medium in the space
between adjacent tubes.

[0016] In another form of this aspect of the present invention,
the inlet collecting tank includes a diffuser for the first
medium, and one of an outlet and outlet for the second
medium is in the selected longitudinal section.

[0017] In still another form of this aspect of the present
invention, the heat exchanger is an exhaust heat exchanger
cooled with liquid in the exhaust gas recirculation system of
vehicles.

[0018] In yet another form of this aspect of the present
invention, the heat exchanger is a charge air cooler.

[0019] In another aspect of the present invention, a tube is
provided for use with a heat exchanger with the tube
including an end section connectable to a wall of at least one
collecting tank, including a longitudinal flat tube with broad
sides, and a longitudinal internal insert metallically
connected to the tube broad sides and including at least one row
of cutouts between the longitudinal ends of the internal
insert in the end and extending substantially across the broad
width of the insert.

[0020] In one form of this aspect of the present invention,
the internal insert is corrugated and the at least one row of
cutouts includes at least two rows of cutouts with a con-
ecting insert portion between the rows of cutouts. In a
further form, the corrugated internal insert has wave flanks
extending between opposite broad sides of the tube, and the
connecting insert portion is primarily in the wave flanks. In
another further form, the rows of cutouts extend over no
more than one third (1/3) of the total length of the internal
insert.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] FIG. 1 is a face view of one embodiment of a heat
exchanger incorporating the present invention;

[0022] FIG. 2 is a perspective view of a collecting tank of
the FIG. 1 embodiment;

[0023] FIG. 3 is a perspective view on one end of one
embodiment of a heat exchanger tube incorporating the
present invention;

[0024] FIG. 4 is a perspective view on one end of a second
embodiment of a heat exchanger tube incorporating the
present invention;

[0025] FIG. 5 is a perspective view of an intermediate
plate usable with the present invention;

[0026] FIG. 6 is a partially exploded perspective view of
one end of a heat exchanger including the FIG. 5 inter-
mediate plate;

[0027] FIG. 7 is a perspective view of the FIG. 6 heat
exchanger, with portions broken away to show the internal
inserts of the heat exchanger tubes;

[0028] FIGS. 8 to 14 are perspective views illustrating the
ends of different embodiments of tube internal inserts incor-
porating the present invention;

[0029] FIG. 15 is a cutout of a part of the core of the
charge air cooler of FIG. 16; and

[0030] FIG. 16 is a partially exploded view of an air-
cooled charge air cooler incorporating the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0031] The practical examples illustrated in FIGS. 1-7
involve exhaust heat exchangers, such as may be advantage-
ously incorporated in the exhaust gas recirculation system
of a vehicle in a manner not shown, and which use the
coolant of the vehicle engine as the cooling medium. The
heat exchanger can be used with the same advantages, for
example, as a charge air cooler cooled with coolant or for
other purposes, especially where high alternating tempera-
ture loads occur.

[0032] It should also be appreciated that the present inven-
tion may also be advantageously used, for example, with
heat exchangers which are U-shaped, in which the inlet
20 and the outlet 21 are situated on the same collecting tank
24a.

[0033] In the Figures showing the practical examples,
however, heat exchangers having collecting tanks on both
ends of the stack of heat exchanger tubes 26 are depicted. As
a result, in the heat exchanger depicted in FIG. 1, the
exhaust flows into the left collecting tank 24b, is distributed
to and flows through the paths 28 in the heat exchanger tubes
26, and then leaves the heat exchanger via the other (right)
collecting tank 24a. The coolant, on the other hand, enters
the inlet 20 on the right collecting tank 24a, is distributed to
the flow channels 30 which are arranged between the heat
exchanger tubes 26 (FIG. 6 or 7) and leaves the heat
exchanger via the outlet 21 provided in the left collecting
tank 24a.

[0034] The inlet 20 and the outlet 21, in this practical
example, have a roughly rectangular cross-section. Advan-
tageously, a mount 36, produced by deformation from sheet
metal, was provided in each case on the collecting tank 24a,
which extends around three sides of the collecting tank 24a
and is firmly soldered to it. The mount 36 has the inlet 20 or
the outlet 21 and an appropriate sealing groove 38, so that
the heat exchanger can be flanged directly to a connection
plane of a unit (not shown) and therefore fastened to it and
simultaneously “supplied” with coolant.

[0035] The stack of heat exchanger tubes 26 may advan-
tageously be covered by an upper and lower reinforcement
plate 76 (FIG. 7) because the sheet thickness of the heat
exchanger tubes 26 is relatively small. Both protection
against the mechanical effect on tubes 26 and higher stability
of the entire heat exchanger can be achieved by this.

[0036] FIG. 2 shows the collecting tank 24a in a first
variant in a perspective view, as present twofold in the
practical example from FIG. 1, apart from the cross-sectional
shape of the inlet 20 and outlet 21 (which are roughly
rectangular in FIG. 1 and round in FIG. 2).

[0037] FIG. 3 shows one of the seven heat exchanger
tubes 26 present there. The wall 40 of collecting tank 24a
has deformations 44, which, by the way, can also be pro-
vided in the wall 40 of collecting tank 24b (FIG. 1). In
addition, there are two connection planes 50 and 54 between
the wall 40 and the stack of heat exchanger tubes 26. In one connection plane 54, direct connection of the wall 40 to the tube stack is provided at an opening 60, which represents the peripheral contour of the stack, which includes slits 64 and protrusions 66. Each slit 64 accommodates a tube edge flange 70 (see FIG. 3), and upper and lower graduations 74 accommodate the reinforcement plates 76.

[0038] In the other connection plane 50, on the other hand, an indirect connection to the wall 40 is present, since, in this practical example, an intermediate tube plate 78 is provided. For this purpose, the edge of wall 40 has a gradation at 80 (see FIGS. 2 and 6), so that the tube plate 78 has a seat with a stop in the wall 40. The already mentioned slits 64 are also situated in the contour of tube plate 78 and serve the same purpose there.

[0039] The edge of the opening 60 in the wall 40 and the edge of perforations of the tube plate 78 are formed with only a slight passage 82 (see FIG. 2) pointing toward the center of the heat exchanger, which contributes to achievement of a perfect soldered connection with the tubes 26 even with a relatively limited thickness of the wall 40, a perfect soldered connection with tubes 26 can be achieved. The passage 82 may be formed via corresponding design of the punching tool for production of the opening 60 and is therefore feasible without additional expense. Openings 60 according to this design are advantageously present in all practical examples of the exhaust heat exchanger, even if the other figures do not show it in detail.

[0040] As also shown in FIG. 3, a longitudinal section or region 86 of the heat exchanger tubes 26 lies between the two connection plates 50 and 54. The heat exchanger tubes 26 are combined in the stack direction 88 (FIG. 6) into a stack of heat exchanger tubes 26. The reinforcement plates 76 (FIG. 7) are added on opposite sides of the stack. As further described below, internal inserts 90 are inserted in each case into heat exchanger tubes 26, which consist of two identical flat tube halves 26a, 26b joined by bent brackets 92 on the edge flange 70. Such tube structure is particularly cost-effective and is characterized by high process reliability, especially during soldering. The stack is combined via the longitudinal section 86 of the heat exchanger tubes to the collecting tank 24a, in which each edge flange 70 of each heat exchanger tube 26 comes to lie in the connection plane 54 in a slit 64 present there and, in the other connection plane 50, sits in a slit 64 of tube plate 78 present there (see above).

[0041] It should be appreciated that flat heat exchanger tubes as described herein are tubes which have a smaller and a larger inside dimension, and therefore include not only those with parallel broad sides but also include, for example, heat exchanger tubes with an oval cross-section. Moreover, it should be appreciated that flat heat exchanger tubes according to the present invention also include those formed by two plates forming the two broad sides in which the two narrow sides of the tubes are represented by a rod or the like inserted between the plates. Such designs are found in many applications of heat exchangers, and are also encountered, for example, in fuel cell systems.

[0042] FIGS. 6 and 7 show one end 94 of the heat exchanger, where it is apparent that a flow channel 30 is formed in each case between the heat exchanger tubes 26 through which the coolant can flow. Specifically, as shown in FIGS. 3-4, the identical flat tube halves 26a, 26b have longitudinal projections or embossings 100 along their edges which close off a flow channel 30 between two assembled heat exchanger tubes 26. The embossings 100 seal off the flow channels so that an essentially housingless design may be achieved, which design is characterized by economic use of material with the highest efficiency of heat transfer. On the broad sides 102 of heat exchanger tubes 26, additional spaced projections 104 are also present and, in the vicinity of the connection plane 54, a row of projections 106 may be advantageously provided to make flow of the coolant which enters or emerges in that vicinity (see the arrows in FIG. 4) uniform.

[0043] As is further clearly shown in FIG. 7, corrugated internal inserts 90 are situated in the heat exchanger tubes 26. The internal inserts 90 may have wave flanks 110 corrugated in the longitudinal direction and transverse direction (see the longitudinal section on the right of FIG. 7).

[0044] In addition, the wave flanks 110 have cutouts 120 and intermediate connectors 130. In the FIG. 7 embodiment, seven rows 134 of round cutouts 120 are apparent, which are separated from each other by an intermediate connector 130. It should be appreciated that length changes in the stack direction 88 of heat exchanger tubes 26, occurring because of temperature changes, are permitted or compensated by this. In particular, the distinctness of the improvement in resistance to alternating temperature loads is surprising.

[0045] Since the loads in exhaust heat exchangers reach the limit of what can be accomplished with ordinary materials (stainless steel, aluminum) and joining techniques (particularly considering cost-effective manufacturing methods of mass production) due to the level of the temperature differences and the frequency of the temperature alternations, the inventors hereof concerned themselves with demonstrating the advantages of the present invention with additional variations thereof.

[0046] In that regard, in one variation the protrusions 106 and the flat tube halves 26a, 26b were modified so that, in the region of the connection plane 50, groups of protrusions 106 were concentrated (see FIG. 4) to divert the incoming coolant so that a significant part of it is initially directed to the connection plane 54 before it can flow further into flow channels 30. Better temperature equalization is achieved by this and therefore the objective of improving the capability, relative to alternating temperature loads, is also served.

[0047] In an alternative embodiment, the tube plate 78 (see FIG. 2) is replaced by an intermediate plate 140 (see FIGS. 5 and 6), with the flat tube halves 26a, 26b modified for this purpose (see FIG. 4). Specifically, additional projections 144 extend across the broad sides 102 of the ends 94 of the flat tube halves 26a, 26b, which projections 144 whose a height coinciding with the height of the embossings 100 running along the longitudinal sides. The additional projections 144 of adjacent heat exchanger tubes 26 lie against each other and each closes off a flow channel 30. A traditional tube plate 78 with connectors 150 can therefore be dispensed with. As shown in the mentioned figures, the intermediate plate 140, in similar fashion to the wall 40 in the other connection plane, is equipped with slits 64 and protrusions 66, in order to correspond to the peripheral contour of the stack of heat exchanger tubes 26. The protrusions 66 extend into furrows 154 (see FIG. 6). Con-
nection of the intermediate plate 140 to the wall 40 occurs via a gradation 80 of wall 40, which provides a stop and seat for the intermediate plate 140, as in the tube plate 78 that was described in conjunction with FIG. 2. The peripheral contour in the intermediate plate 140 also has shoulders 74 to accommodate the reinforcement plates 76 (FIG. 7). By providing an intermediate plate 140, an additional weight and cost reduction is achieved.

[0048] FIG. 8 shows the end of a flat heat exchanger tube 26 with a further modified internal insert 90, with the wave flanks 110 running between the broad sides 102 of the heat exchanger tube 26 having a bent contour making them also flexible in the direction between the broad sides 102. Such heat exchanger tubes 26, shaped and welded from a sheet strip, can be provided in the entire heat exchanger. It is particularly apparent from this depiction that the rows 134 of cutouts 120 and intermediate connecters 130 extend over the entire width of internal insert 90 and heat exchanger tube 26, which is the preferred design.

[0049] However, according to the present proposal, rows 134 are also spoken of, if the cutouts 120 and intermediate connecters 130 are not situated in all wave flanks 110. The same applies for the design of the rows 134 themselves. Moreover, while only straight rows 134 are shown, zig-zag rows 134, for example, are equally expedient and may be used within the scope of the present invention.

[0050] FIGS. 9-14 illustrate another embodiment incorporating the present invention in which a line-like wall thinning 158 was made in the flanks 110 of the corrugated internal inserts 90, which serve as a rupture site 159 (see FIG. 11) which passes through all intermediate connecters 130. It is drawn as a line in FIGS. 9-14, which otherwise show different internal inserts 90 in partial views and make it clear that the shape and size of the cutouts 120 and intermediate connecters 130 are subject to no special provisions and can be designed according to the application, in order to achieve the desired advantages with respect to resistance to alternating temperature loads.

[0051] As shown in FIG. 10, the cross-sectional shape of the cutouts 120 and the size of the individual cross-sections from the end of the internal insert 90 in the direction toward the center can be varied. Particularly widely protruding collars 160 are also shown in FIG. 10, which collars 160 have proven to be particularly advantageous during the soldering process which, as is known, occurs in a finely adjusted temperature range, in which the materials are already in a “doughy” state. The collars 160 prevent “falling” in the region of the connections caused by gravity in this state.

[0052] FIGS. 15 and 16 show the use of flat heat exchanger tubes 26 in conjunction with an air-cooled charge air cooler. The charge air cooler has a collecting tank 24 with a wall 40, with the ends 94 of the heat exchanger tubes 26 extending into openings of a tube plate 78 and, for example, soldered there. The tube plate 78 represents the connection plane 50. The type of indirect connection provided in this example between wall 40 and heat exchanger tube 26 (via an intermediate tube plate 78) is unimportant. The sometimes extremely hot charge air flows through the heat exchanger tubes 26, and cooling air flows through corrugated ribs 166 situated between tubes 26. The connectors 150 between the openings in the tube plate 78 are provided with a cross-section contour (see, for example, FIG. 6) in order to support the flexible behavior of the alternating temperature loads, and internal inserts 90 are situated in the tubes 26 (as illustrated by the cutout of two tubes 26 FIG. 16). The internal insert 90 has rows 134 of cutouts 120 and intermediate connecters 130 which extend, at least a bit, in the longitudinal direction of the internal insert 90. Two or three such rows 134 may be sufficient to achieve the intended effects. The heat exchanger tubes 26 of this practical example are designed as welded flat tubes and have no elevations on their broad sides 102, as an additional difference relative to the application as an exhaust heat exchanger.

[0053] The use of the described features means that ruptures in the connection heat exchanger/tube/tube plate occur much more rarely. The individual parts of the heat exchanger consisting of metal are prepared, according to known methods, as required, so that they can be metallically connected in a soldering furnace.

[0054] Because the internal insert as described has at least one row of cutouts with an intermediate connector (at least in the connection region of the flat heat exchanger tubes with the wall of the collecting tank) in order to compensate for alternating temperature loads, the resistance of the heat exchanger according to the invention to alternating temperature loads was significantly increased in comparison with the previously mentioned prior art, as demonstrated by evaluation of an extensive series of experiments. The number of achieved temperature alternations was increased to more than double, without the previous ruptures or leaks occurring. Improvements to this extent were not expected and make it clear that even apparently slight differences relative to the prior art can lead to significant advantages.

[0055] Still other aspects, objects, and advantages of the present invention can be obtained from a study of the specification, the drawings, and the appended claims. It should be understood, however, that the present invention could be used in alternate forms where less than all of the objects and advantages of the present invention and preferred embodiment as described above would be obtained.

1. A heat exchanger, comprising:

(a) a plurality of longitudinal flat tubes stacked together with space between the broad sides of adjacent tubes;

(b) an inlet collecting tank distributing a first medium into said tubes, said inlet collecting tank having a wall extending around the periphery of one end said stack of flat tubes over a selected longitudinal section, said wall having at least one of an inlet and outlet for a second medium distributed in said space between said stacked tubes;

(c) an outlet collecting tank receiving said first medium from said tubes;
longitudinal internal inserts in the flat tubes, each internal insert being metallically connected to the broad sides of the associated flat tube; and

at least one row of cutouts between the longitudinal ends of said internal inserts and in said selected longitudinal section, said row of cutouts extending substantially across the breadth width of the insert.

2. The heat exchanger of claim 1, wherein the internal insert is a sheet corrugated in the longitudinal and transverse directions and said at least one row of cutouts includes at least two rows of cutouts with a connecting insert portion between said rows of cutouts.

3. The heat exchanger of claim 2, wherein the corrugated sheet includes wave flanks, and said connection insert portion is in said wave flanks.

4. The heat exchanger of claim 2, wherein said rows of cutouts extend no more than one third (1/3) of the total length of the internal insert and the remaining length of the internal insert has substantially no cutouts.

5. The heat exchanger of claim 2, wherein the size and shape of the cutouts and the connecting insert portion is variable.

6. The heat exchanger of claim 2, further comprising a row of end cutouts open on the end of the internal insert in said selected longitudinal section, and an end connecting insert portion between said row of end cutouts and an adjacent row of cutouts.

7. The heat exchanger of claim 6, wherein said internal insert includes fingers in the crests and valleys of the corrugated sheet adjacent opposite sides of said end cutouts, and said fingers are soldered on the inside wall of the associated flat tube.

8. The heat exchanger of claim 1, wherein said at least one row of cutouts includes at least two rows of cutouts with a connecting insert portion between said rows of cutouts, and further comprising at least one rupture site in said connecting insert portion.

9. The heat exchanger of claim 1, wherein said tubes comprise two flat tube halves connected on their longitudinal edges.

10. The heat exchanger of claim 1, further comprising outwardly projecting embossings on the broad sides of said tubes, said embossings defining said space between the broad sides of adjacent tubes in said stack of tubes.

11. The heat exchanger of claim 1, wherein said collecting tank wall has deformations adapted to stabilize said tank while providing elasticity during alternating temperature loads.

12. The heat exchanger of claim 1, wherein said selected longitudinal section is bounded by first and second connection planes at one end of the stack of tubes, and said one inlet or outlet for the second medium is in said collecting tank wall between said two planes.

13. The heat exchanger of claim 12, further comprising a tube plate connected to said collecting tank wall at said first connection plane, said tube plate having connectors for the ends of the stack of flat tubes.

14. The heat exchanger of claim 12, further comprising an intermediate plate having the peripheral contour of the stack of flat tubes and connected to wall in the first connection plane.

15. The heat exchanger of claim 12, wherein said second connection plane is defined by a contour cut in the collecting tank wall and matching the peripheral contour of the stack of flat tubes.

16. The heat exchanger of claim 12, wherein said contour cut in the collecting tank wall has slits matching an end flange on said flat tubes, and protrusions closing furrows at the space between adjacent flat tubes.

17. The heat exchanger of claim 12, wherein the broad sides of the heat exchanger tubes include protrusions in the region of the first connection plane to divide the flow of the second medium in the space between adjacent tubes.

18. The heat exchanger of claim 1, wherein said inlet collecting tank includes a diffuser for said first medium, and one of an inlet and outlet for said second medium is in said selected longitudinal section.

19. The heat exchanger of claim 1, wherein the heat exchanger is an exhaust heat exchanger cooled with liquid in the exhaust gas recirculation system of vehicles.

20. The heat exchanger of claim 1, wherein the heat exchanger is a charge air cooler.

21. A tube for use with a heat exchanger with said tube including an end section connectable to a wall of at least one collecting tank, comprising:

a longitudinal flat tube with broad sides; and

a longitudinal internal insert metallically connected to the tube broad sides and including at least one row of cutouts between the longitudinal ends of said internal insert in said end and extending substantially across the broad width of the insert.

22. The tube of claim 21, wherein the internal insert is corrugated and said at least one row of cutouts includes at least two rows of cutouts with a connecting insert portion between said rows of cutouts.

23. The tube of claim 22, wherein the corrugated internal insert has wave flanks extending between opposite broad sides of the tube, and said connecting insert portion is primarily in said wave flanks.

24. The tube of claim 22, wherein said rows of cutouts extend over no more than one third (1/3) of the total length of the internal insert.

* * * * *