A spiral heat exchanger mounted in a housing has at least one group of at least two media-conducting spiral elements which are nested into one another, wherein the spiral elements are composed of a plurality of extruded profiles which are cut to length and are arranged next to one another. Spaced-apart spacer ribs are mounted on the outer flat sides of the extruded profiles. Transverse channels connected in a media-conducting manner to the spiral channels are provided at the radially inner and radially outer ends of the extruded profiles. The transverse channels can be coupled to lines which supply and/or discharge media.
SPIRAL HEAT EXCHANGER

CROSS-REFERENCE TO RELATED APPLICATIONS


BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention relates to spiral heat exchangers. Spiral heat exchangers are technical devices which, with a relatively small apparatus volume, allow a highly effective heat exchange between same or different media.

[0004] 2. Description of the Related Art

[0005] In the context of U.S. Pat. No. 5,242,015, it is known in the art to form extruded multichannel profiles by spirally winding them into a spiral heat exchanger. The multichannel profiles are stacked into one another and rest directly against each other with their flat sides. For improving the heat transfer, the flat sides are soldered to each other. A housing circumferentially surrounding the multichannel profiles is not provided. Such a spiral heat exchanger does not have a variable field of use.

SUMMARY OF THE INVENTION

[0006] Starting from the prior art, it is the primary object of the present invention to provide a spiral heat exchanger which is of simple construction, has a variable use and, for the purpose of integration into automobiles with fuel cells, can be manufactured in an economical and inexpensive way, in particular, by mass production.

[0007] In accordance with the present invention, this object is met by a spiral heat exchanger which includes at least one group of at least two media-conducting spiral elements which are nested into one another and are arranged within a housing. The spiral elements are composed of a plurality of extruded profiles which are cut to length and define spiral channels extending next to each other, wherein the extruded profiles have outer flat sides thereof spacer ribs which extend at a distance next to each other. The spiral elements further include transverse channels arranged at the radially inner and outer ends of the extruded profiles and connected to the spiral channels for communicating media. The transverse channels can be coupled to lines which supply and/or discharge media.

[0008] Thus, the spiral heat exchanger according to the invention includes a housing, particularly a cylindrical housing, in which at least one group of at least two spiral elements are integrated which are nested into one another. Each spiral element is composed of an extruded profile which is cut to length and includes spiral channels which are arranged next to each other, wherein spacer ribs extending at a distance from each other and next to each other are arranged on the outer flat sides of the extruded profile. Also provided are transverse channels which are provided at the radially inner and outer ends of the extruded profiles.

[0009] Due to the fact that the spacer ribs are provided on the flat sides of the extruded profiles, the spiral elements which are nested into each other are not fully in contact with each other. Rather, a gap is formed between the two spiral elements to which a suitable medium can be supplied depending on the type of operation of the spiral heat exchanger. As a result, the invention makes possible a universal use of the spiral heat exchanger.

[0010] When the spiral heat exchanger is used as a compressor, it is of significant practical interest that air is conducted in the gap between the two spiral elements, wherein a cooling agent can flow in the spiral elements.

[0011] In addition, it is within the scope of the invention possible by providing the gap to provide a safety zone between two circumferentially adjacent spiral elements, wherein this safety zone is a particular advantage in safety spiral heat exchangers. Consequently, the spacer ribs on the flat sides form together with the flat sides the safety zone to which also a neutral medium can be supplied.

[0012] The transverse channels provided at the ends of the extruded profiles ensure a problem-free transfer of the media from the spiral channels into the transverse channels and to the supply lines and/or discharge lines, and vice versa.

[0013] The invention results in a configuration which is extremely compact and has a comparatively small volume, while providing a high exchange output. This renders the use of the heat exchanger particularly advantageous in automobiles with fuel cells.

[0014] The media can be conducted in such a way that they are supplied through appropriate lines to the radially inner transverse channels, from where the media flow through the spiral channels in the extruded profiles to the radially outer transverse channels, and from there are discharged through lines coupled to the outer transverse channels. It is usually useful if the media are supplied to the radially inner transverse channels from an axial direction, while in the case of the radially outer transverse channels an axial discharge as well as a radial discharge in the longitudinal direction of the transverse channels are conceivable.

[0015] In accordance with another flow configuration, the media are supplied to the outer transverse channels axially or radially, are then conducted through the spiral channels in the extruded profiles to the inner transverse channels and are discharged from there preferably axially.

[0016] A combination of flow configurations is also possible in such a way that, in the case, for example, of two spiral elements which are nested into each other, in one spiral element the medium flows from the radially inner transverse channel to the radially outer channel and in the other spiral element the medium in that element flows from the radially outer transverse channel to the radially inner transverse channel.

[0017] The radially inner transverse channels as well as the radially outer transverse channels can be constructed in such a way that, depending on the flow configuration, they constitute only one overflow area. In other words, a medium can be supplied, for example, to a radially inner transverse channel which is divided into two chambers by a center separating wall. In that case, the medium flows from the inlet chamber of the radially inner transverse channel through the connected spiral channels in the extruded profiles to the radially outer transverse channel which is not divided. Through this outer transverse channel the medium then
flows into the spiral channels which are connected to the discharge chamber of the radially inner transverse channel and is again discharged from this transverse channel. Also conceivable is a reverse media flow configuration from a radially outer transverse channel provided with two separated chambers to an undivided, radially inner transverse channel which forms only one overflow area, and back again.

[0018] In accordance with the invention, the spacer ribs on the flat sides of the extruded profiles which face each other can be located in a radial plane and contact each other with their end faces. However, in accordance with another feature of the present invention, the spacer ribs of the two spiral elements may also be offset relative to each other in the transverse direction. The end faces of the spacer ribs then contact the oppositely located flat side of the adjacent spiral element. This further increases the variable use of the heat exchanger.

[0019] In accordance with another feature, the spiral elements are displaceable relative to each other in the transverse direction. This feature can be utilized for compressing a medium conducted between the two spiral elements, wherein a cooling fluid flows in the spiral elements. On the other hand, a fluid conducted between the spiral elements may be decompressed or pumped, wherein a medium having a higher temperature is then conducted in the spiral elements.

[0020] In another embodiment of the spiral heat exchanger according to the present invention, at least two groups with two media-conducting spiral elements which are nested into one another are arranged next to one another in a housing, wherein the two groups can be coupled in a media-conducting manner through the radially inner transverse channels and/or the radially outer transverse channels. This embodiment is used, for example, when a spiral heat exchanger constructed as a compressor is coupled with a spiral heat exchanger constructed as a decompressor or turbine. In the group forming the compressor, especially air is compressed on its flow path from the radially inner transverse channels to the radially outer transverse channels. The air then flows from there into the adjacent second group with nested spiral elements, wherein the compressed air flows in the second group from radially outwardly to radially inwardly. Simultaneously, in the case of a turbine, a cooling agent flows in the spiral elements, so that a turbocharger is obtained in this manner.

[0021] A reverse flow path is also conceivable.

[0022] The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of the disclosure. For a better understanding of the invention, its operating advantages, specific objects attained by its use, reference should be had to the drawing and descriptive matter in which there are illustrated and described preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWING

[0023] In the drawing:

[0024] FIG. 1 is a schematic vertical cross-sectional view of a spiral heat exchanger;

[0025] FIG. 2 is a vertical sectional view taken along sectional line II-II of FIG. 1 in the direction of arrows IIa;

[0026] FIG. 3 is an enlarged view of detail III of FIG. 2;

[0027] FIG. 4 is an enlarged view of detail IV of FIG. 2, showing a different embodiment;

[0028] FIG. 5 is a schematic vertical longitudinal sectional view of another embodiment of a spiral heat exchanger; and

[0029] FIGS. 6 through 11 schematically show the spiral heat exchangers of FIGS. 2 and 5 with various flow configurations.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0030] FIGS. 1 and 2 of the drawing show a spiral heat exchanger as it is particularly used in automobiles with fuel cells.

[0031] The spiral heat exchanger 1 has a cylindrical housing 2 with closed sides 3, 4. Arranged in the housing 2 is a group A of spiral elements 5, 6 which are nested into one another and whose structural configuration is explained in more detailed in connection with FIGS. 3 and 4. These spiral elements 5, 6 are connected at the radially inner ends and the radially outer ends with tubular transverse channels 7, 8 and 9, 10, respectively.

[0032] As illustrated in FIG. 3, each spiral element 5, 6 (spiral element 5 being shown in FIG. 3) includes an extruded profile 12 of an aluminum alloy which is cut to length and forms several spiral channels 11 which are arranged next to each other. The cross-section of the extruded profiles 12 is essentially rectangular. The wall thicknesses of the extruded profiles are smaller by a multiple than the cross-section of the spiral channels 11.

[0033] Each extruded profile 12 is provided on the outer flat sides 13 thereof with longitudinally directed spacer ribs 14. These spacer ribs 14 extend in the planes of the walls 15 which separate the spiral channels 11 from each other. The spacer ribs 14 have a height above the flat sides 13 which corresponds approximately to one to two times the thickness of the walls 15.

[0034] The spiral channels 11 in the extruded profiles 12 are connected in a media-conducting manner to the radially inner transverse channels 7, 9 and the radially outer transverse channels 8, 10.

[0035] FIG. 4 shows an embodiment in which the adjacent spiral elements 5, 6 are transversely offset relative to each other in the transverse direction by about half the distance between two spacer ribs 14. As can be seen in FIG. 4, this results in an approximately meander-shaped gap 16 in the transverse plane between the spiral elements 5, 6, wherein the spacer ribs 14 rest against the flat sides 13.

[0036] Media can be supplied to the spiral elements 5, 6 of the spiral heat exchanger 1 according to FIGS. 1 and 2 in various ways. As seen in the schematic developed view of the spiral element 5 of FIG. 6, in this embodiment the radially inner transverse channel 7 is at its end connected in accordance with solid arrow 17 to a line which conducts medium. The broken arrow 18 at the other end of the transverse channel 7 indicates an embodiment in which the
The medium is supplied from this side to the transverse channel 7. The medium flows in accordance with the indicated arrows from the radially inner transverse channels 7 through the spiral ducts 11 to the radially outer transverse channel 8. The medium leaves this transverse channel 8 at an end indicated by a solid arrow 19 or at the other end in accordance with arrow 20 which is shown in broken lines. It is also conceivable that the medium leaves the radially outer transverse channel 8 radially as indicated by broken arrows 21 which represent pipe lines. The connections may be located at a suitable location of the transverse channel 8.

The medium flows in accordance with solid arrow 22 at one end into the radially outer transverse channel 8 of the spiral element 5, flows in accordance with the indicated arrows through the spiral channels 11 and leaves the radially inner transverse channel 7 at the end thereof in accordance with the solid arrow 23. However, the medium may also enter in accordance with broken arrow 24 at the other end of the radially outer transverse channel 8 or the medium may enter in accordance with broken arrows 25 radially at any chosen location in the radially outer transverse channel 8, and the medium then also leaves the transverse channel 7 in accordance with broken arrow 26 at the end of the radially inner transverse channel 7.

The embodiments described above can each be used in the two spiral elements 5, 6 of FIGS. 1 and 2. Also conceivable is a combination of these embodiments in which medium flows in the spiral element 5 in accordance with the illustration of FIG. 6 and in the other spiral element 6 in accordance with FIG. 7.

FIG. 8 shows an embodiment of a flow configuration in a spiral element 5 in which the radially inner transverse channel 7 is divided by a separating wall 27 into two chambers 28, 29. The medium flows in accordance with the solid arrow 30 into the end of the inlet chamber 28 of the radially inner transverse channel 7, flows in accordance with the indicated arrows through the spiral channels 11 connected to the inlet chamber 28, and enters the radially undivided outer transverse channel 8. The medium then flows in the transverse channel 8 to the spiral channels 11 which are connected in a media-conducting manner to the discharge chamber 28 of the radially inner transverse channels 7. The medium then leaves the spiral heat exchanger 5 in accordance with the solid arrow 31 through the spiral channels 11 and the radially inner transverse channel 7.

The embodiment of FIG. 9 of the spiral heat exchanger 5 corresponds essentially to that of FIG. 8, with the only difference that now the radially outer transverse channel 8 is divided into two chambers 33, 34 by a separating wall 32, while the radially inner transverse channel 7 constitutes an overflow area. Consequently, the medium can flow in accordance with solid arrow 35 into the end of the inlet chamber 33 of the radially outer transverse channel 8, the medium then flows in accordance with the indicated arrows through the spiral channels 11 connected to the inlet chamber 33, reaches the radially inner transverse channel 7 and then flows from there in the opposite direction in accordance with the arrows through the spiral channels 11 to the discharge chamber 34 of the radially outer transverse channel 8 and leaves the transverse channel 8 in accordance with solid arrow 36 at the end thereof. However, the medium can also flow in accordance with the broken arrows 37, 38 radially in the radially outer transverse channel 8 at any location of the inlet chamber 33, on the one hand, and can exit from the discharge chamber 34, on the other hand.

FIG. 5 shows a spiral heat exchanger 1a in which two groups A, B each with at least two media-conducting spiral elements 5, 6 which are nested into one another are located next to each other in a housing 2a. The structural configuration of the spiral elements 5, 6 corresponds to that of the spiral heat exchanger 1 of FIGS. 1-4. The two groups A, B of the spiral heat exchanger 1a of FIG. 5 can be coupled in a media-conducting manner through the radially inner transverse channels 7, 9 and/or the radially outer transverse channels 8, 10.

The manner in which the elements are coupled is illustrated schematically in a developed view of a spiral element 5 in FIGS. 10 and 11 which are analogous to FIGS. 6-9.

In the embodiment of FIG. 10, the medium flows in accordance with solid arrow 39 into an end of the radially inner transverse channel 7 of group A, flows through all spiral channels 11 to the radially outer transverse channel 8 and then flows from this transverse channel 8 in accordance with arrow 40 into the radially outer transverse channel 8 of the other group B. The medium flows from there in accordance with the indicated arrows through the spiral channels 11 into the radially inner transverse channel 7 of this group B and leaves at the end thereof the radially inner transverse channel 7 in accordance with solid arrow 41.

However, the flow may also be in the opposite direction, as illustrated in FIG. 10 by broken arrows 42, 43 at the ends of the two transverse channels 7 of the groups A and B.

FIG. 11 shows a flow configuration in which the medium flows in accordance with solid arrow 44 to the end of the radially outer transverse channel 8 of group B, then flows through the spiral channels 11 in the direction of the indicated arrows, and flows from the radially inner transverse channel 7 of this group B in accordance with arrow 45 into the radially inner transverse channel 7 of the other group A. The medium then flows form there in the direction of the indicated arrows through the spiral channels 11 into the radially outer transverse channel 8 of this group A and leaves this transverse channel 8 at the end thereof in accordance with solid arrow 46.

However, the medium may also flow in accordance with broken arrows 47 radially into the radially outer transverse channel 8 of group B and may radially leave the radially outer transverse channel 8 of the other group A in accordance with broken arrows 48.

An opposite flow direction is also possible in this embodiment, as illustrated by dotted arrows 49, 50, 51 and 52.

While specific embodiments of the invention have been shown and described in detail to illustrate the inventive principles, it will be understood that the invention may be embodied otherwise without departing from such principles.
We claim:

1. A spiral heat exchanger comprising a housing, and at least one group of at least two media-conducting spiral elements nested into one another and mounted in the housing, wherein the spiral elements are comprised of extruded profiles which are cut to length and form spiral channels extending next to one another, the extruded profiles having outer flat sides and spaced-apart it spacer ribs extending next to each other on the outer flat sides, further comprising transverse channels connected in a media-conducting manner to the spiral channels at radially inner and outer ends of the extruded profiles, wherein the transverse channels are adapted to be coupled to lines which supply and/or discharge media.

2. The spiral heat exchanger according to claim 1, wherein the two spiral elements and the spacer ribs thereof are offset relative to each other in a transverse direction of the heat exchanger.

3. The spiral heat exchanger according to claim 1, wherein the two spiral elements are displaceable relative to each other in a transverse direction of the heat exchanger.

4. The spiral heat exchanger according to claim 1, comprising at least two groups of at least two media-conducting spiral elements nested into one another, wherein the two groups are arranged in the housing located next to one another, and wherein the two groups are connected in a media-conducting manner through one of the radially inner transverse channels and the radially outer transverse channels.

* * * * *