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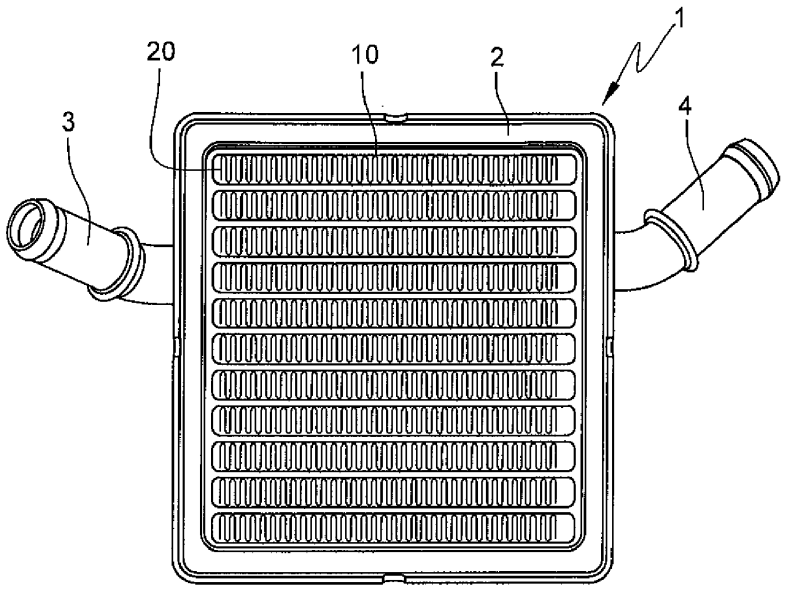
(54) HEAT EXCHANGER FOR MOTOR VEHICLE

(57) A tube for a heat exchanger, in particular for a charge air cooler installed in a motor vehicle, the tube being formed by folded sheet and the folded sheet comprising: a longitudinal direction; a sealing region extending along the longitudinal direction of the tube; an inner space closed by the sealing region; a folded portion extending from the sealing region and forming, in the inner space of the tube, a deflector portion for air flowing in the inner space of the tube.

Fig. 1



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Description

FIELD OF THE INVENTION

[0001] The invention relates to a heat exchanger for motor vehicle, in particular for a charge air cooler.

BACKGROUND OF THE INVENTION

[0002] In turbocharged engine applications, the air used for the engine combustion is compressed in order to increase its density. The thermodynamic effect of this compression is an increase in the temperature of the compressed air. If the compressed air is not cooled to a sufficient level, the engine combustion may not be efficient, or the combustion engine may not operate at all. Therefore, prior to entering the combustion chamber, the compressed air is cooled by means of a Charge Air Cooler (CAC). In the prior art Charge Air Coolers are disclosed which comprise heat exchangers comprising tubes for guiding air through the heat exchangers, wherein the tubes are internally provided with turbulator fins.

[0003] The tubes of a Charge Air Cooler have a rectangular cross section. The turbulator fin has dimensions that fill the inside of the tube as much as possible. Tubes for Charge Air Coolers are produced by means of electric welding or folding. The result of such production processes is that the resulting tube height in the corners of the tube is reduced when compared to the remaining part of the tubes.

[0004] In practice, it is difficult to fill the interior of the tubes near the corners with the turbulator fins. The areas of the tube which are not properly filled by means of the turbulator fin will create air bypasses which reduce the heat exchange efficiency of known Charge Air Coolers.

[0005] In view of the present emission standards which apply to the automotive industry, with even more stringent legislation underway, the current trend is to move towards combustion engines with higher inlet pressures and temperatures to improve fuel efficiency. In order to allow this, the compressed air needs to be cooled to even lower temperatures prior to entering the combustion chamber to ensure operation of the combustion engines. Therefore, there appears to be a need for efficient and effective heat exchangers which are adapted to be used as Charge Air Coolers and allow cost and space efficient heat exchange.

SUMMARY OF THE INVENTION

[0006] The object of the invention is, among others, a tube for a heat exchanger, in particular for a charge air cooler installed in a motor vehicle, the tube being formed by a folded sheet and the folded sheet comprising:

- a longitudinal direction
- a sealing region extending along the longitudinal direction of the tube,
- an inner space closed by the sealing region,
- a folded portion extending from the sealing region and forming, in the inner space of the tube, a deflector portion for air flowing in the inner space of the tube.

[0007] The object of the invention provides an effective solution for reducing the free space on the tube ends that are not filled by the air turbulator fins which causes bypass for air flow. The invention is performed using existing material, so assembling new elements is not necessary. The deflector portion forms an additional air channel that improves heat transfer between media. Thanks to the deflector portion the overall thermal performance of the heat exchanger increases.

[0008] Preferably, the deflector forming portion is essentially U-shaped in a cross-section perpendicular to the longitudinal direction of the tube.

[0009] Preferably, the deflector forming portion is essentially V-shaped in a cross-section perpendicular to the longitudinal direction of the tube.

[0010] Preferably, the deflector forming portion is rounded in a cross-section perpendicular to the longitudinal direction of the tube.

[0011] Preferably, the tube comprises only one deflector forming portion.

[0012] Preferably, the tube comprises deflector forming portions on the both sides of the tube.

[0013] Preferably, a lock curb is protruding from the assembling portion.

[0014] Preferably, the tube has a width (W) and a thickness (T), measured in two perpendicular directions, both perpendicular to the longitudinal axis of the tube, wherein the width is greater than the thickness.

[0015] Preferably, width of a folded portion is smaller than 50%, in particular smaller than 25%, in particular smaller than 15%, of the width of the tube.

[0016] Preferably, the deflector forming portion forms an perpendicular angle with the wall that defines the width of the tube.

[0017] Preferably, the deflector forming portion is slanted towards the closest wall that defines the thickness of the tube.

[0018] Preferably, the sealing region is fixed (e.g. brazed) to a wall of the tube, along the longitudinal direction of the tube.

[0019] Preferably, at least one deflector forming portion has an end at a distance from the inner side of the tube.

[0020] Preferably, a turbulator fin is leaning against the deflector forming portion.

[0021] Preferably, the turbulator fin is introduced into the inner vicinity of the essentially U-shaped deflector forming portion.

[0022] Preferably, the turbulator fin is introduced into

the inner vicinity of the essentially V-shaped deflector forming portion.

[0023] Preferably, the turbulator fin is introduced into the inner vicinity of the rounded deflector forming portion.

[0024] Preferably, the turbulator fin comprises a corrugated sheet with a plurality of adjacent folds between a first transverse side of the sheet and a second transverse side of the sheet

[0025] Preferably, the end fold forming the edge of the sheet of at least one transverse side of the sheet has a reduced fold height compared to the fixed fold height.

[0026] Preferably, the turbulator fin is made out of the lightweight metal alloy.

[0027] Preferably, wherein the deflector forming portion is forming an additional air channel along the longitudinal direction of the tube.

[0028] Preferably, the deflector forming portion forms an additional air channel which is of the same surface area in reference to a cross-section perpendicular to the longitudinal direction of the tube.

[0029] Preferably, the outer periphery is limited by two parallel, rectilinear sides.

[0030] Preferably, the outer periphery is substantially rectangular in reference to the cross-section perpendicular to the longitudinal direction of the tube.

[0031] Preferably, the edges of rectangle are of the folded lightweight metal, in particular an aluminum.

[0032] Preferably, a heat exchanger comprises a plurality of tubes.

[0033] Preferably, the heat exchanger is configured as a charge air cooler.

BRIEF DESCRITPTION OF DRAWINGS

[0034] Examples of the invention will be apparent from and described in detail with reference to the accompanying drawings, in which:

Fig. 1 shows the cross-section of a heat exchanger according to prior art.

Fig. 2 shows the perspective view of a single tube according to the invention.

Fig. 3 shows an exemplary cross-section of a folded sheet comprising single folded portion.

Fig. 4 shows an exemplary cross-section of two folded sheets, each comprising a single folded portion.

Fig. 5 shows an exemplary partial cross-section of a folded sheet comprising distanced folded portion.

Fig. 6 shows an exemplary partial cross-section of a folded sheet comprising slanted folded portion.

Fig. 7 shows an exemplary partial cross-section of a folded sheet comprising open air channel.

Fig. 8 shows an exemplary partial cross-section of a folded sheet comprising closed air channel.

DETAILED DESCRIPTION OF EMBODIMENTS

[0035] The subject of an invention is a tube 10 which is designed for a heat exchanger 1 in particular for a charge air cooler. The heat exchanger 1 can be installed in a motor vehicle. The heat exchanger 1 comprises a plurality of tubes 10, a housing 2 and at least one inlet 3 and outlet 4. The state of the art is presented in the Fig. 1, wherein the heat exchanger 1 is configured as a charge air cooler and there is a significant free space between the fin 21 and the wall of the tube 11.

[0036] The tube 10 is formed by a folded sheet. Preferably, the sheet is made of a lightweight metal alloy, for example an aluminum. The folded sheet comprises a longitudinal direction i.e. its length is determined by the central axis of created air channel. The tube 10 is sealed by a sealing region 14 extending along the longitudinal direction of the tube 10, so that the inner space of the tube is air-tight. Sealing is performed for example by the means of brazing the material in the brazing furnace. In the basic embodiment of the invention, a folded portion extends from an assembling portion 29. The folded portion is forming, among others, the inner space of the tube 10 and comprises a deflector portion 13 for air flowing in the inner space of the tube 10. The outer periphery of the tube 10 is substantially rectangular in reference to the cross-section perpendicular to the longitudinal direction of the tube 10. The outer periphery is limited by two parallel rectilinear sides, so that the outer periphery is substantially rectangular in reference to a cross-section perpendicular to the longitudinal direction of the tube 10.

[0037] The deflector portion 13 is rounded on the side of the assembling portion 29. In one of the embodiments, the deflector portion 13 and the assembling portion 29 form essentially U-shaped composition in the cross-section perpendicularto the longitudinal direction of the tube 10. U-shape form can be defined as an object having a cross section in the form of letter U. In the other embodiment the deflector portion 13 and the assembling portion 29 form essentially V-shaped composition in the cross-section perpendicular to the longitudinal direction of the tube 10. V-shape form can be defined as an object having a cross section in the form of letter V.

[0038] Fig. 2 presents a perspective view of the tube 10. The tube 10 has a width (W). According to the Fig. 2, width (W) can be defined as the horizontal measurement taken at right angle to the length (L).

[0039] The tube 10 has a thickness (T). According to the Fig. 2, thickness (T) can be defined as the smallest of three dimensions of the tube 10.

[0040] The width (W) and the thickness (T) are measured in two perpendicular directions, both perpendicular to the longitudinal axis of the tube. The width (W) is greater than the thickness (T).

[0041] In the basic embodiment on an invention, the

tube 10 comprises only one deflector portion 13. In reference to the width (W) of the tube 10, the deflector portion 13 is located on one or the other side of the tube 10. However, in the other embodiment of an invention, it is executable to form a second deflector portion 23 out of two different sheets of material forming the tube 10. Consequently, a second sealing region 24 and a second curb 25 are also created. The example of this embodiment is presented in the Fig 4.

[0042] The assembling portion 29 is assembled (e.g. brazed) on the wall 19 in the sealing region 14.

[0043] The tube 10 comprises a curb 15 protruding from the assembling portion 29. The curb 15 is carried out of the overlapped material that is bended inwardly along the longitudinal axis during the production process of the tube 10. The curb 15 can support a turbulator fin 20.

[0044] In spite of the amount of overlapped material, the width of the deflector portion 13 should not be greater than 50% of the width (W) of the tube 10. In the other embodiment of an invention, the width of the deflector portion 13 should be smaller than 25% of the width (W) of the tube 10. In the other embodiment of an invention, the width of the deflector portion 13 should be smaller than 15% of the width (W) of the tube 10.

[0045] In the embodiments presented in the figures 7 and 8, the deflector portion 13 forms a perpendicular angle with the wall that defines the width of the tube 10. In this embodiment the deflector portion 13 is also parallel to the wall 19 that defines the thickness of the tube 10.

[0046] In one of the embodiments, the deflector portion 13 is slanted towards the closest wall that defines the thickness of the tube i.e. the assembling portion 29. Slanted means that the deflector portion 13 gives an oblique or sloping direction to the wall that defines the width of the tube 10 and to the wall that defines the thickness of the tube 10 i.e. the assembling portion 29.

[0047] In one of the embodiments, the deflector portion 13 is integrally locked along the longitudinal direction of the tube 10. The far end of the deflector portion 13 is brazed to the inner side of the tube 10. Depending on the shape of the deflector portion 13, it can be brazed to the wall that defines the width of the tube 10, to the wall that defines the thickness of the tube 10 or to the area connecting these walls.

[0048] In the basic embodiment of an invention, at least one deflector portion 13 has an end at a distance from the inner side of the tube 10. The end of deflector portion 13 is defined in the cross-section perpendicular to the longitudinal direction of the tube 10 by the margin edge of the folded sheet.

[0049] A turbulator fin 20 is a corrugated sheet made of the lightweight metal alloy comprising a plurality of adjacent folds between a first transverse side of the sheet and a second transverse side of the sheet. In the most basic embodiment, the turbulator fin 20 has the constant pitch between the adjacent walls and the edges of the folds are of the fixed height. In the other embodiment, the end fold 23 forming the edge of the sheet of at least one transverse side of the sheet has a reduced fold height compared to the fixed fold height. Reducing hold height enables assembling the turbulator fin 20 with the tube 10 comprising a deflector portion 13.

[0050] in one of the embodiments, a turbulator fin 20 is leaning against the deflector portion 13. This type of support ensures the proper fin pitch distribution and it is much more firm than, for example, leaning the turbulator fin 20 against the curb 15.

[0051] In one of the embodiments, the turbulator fin 20 is introduced into the inner vicinity of the deflector portion 13. The deflector portion 13 is essentially U-shaped or V-shaped, so entering the turbulator fin 20 into its vicinity is executable in several forms. In the basic embodiment, the pitch between adjacent walls of the turbulator fin 20 remains constant and the far end of the turublator fin 20 is leaning against the U-shape of the deflector portion 13 as shown in the Fig. 6. In the other embodiment presented in the Fig. 5, the pitch between adjacent walls of the turbulator fin 20 may be different i.e. the far end portion of the turbulator fin 20 is bent on the pitch or on the wall to enable entering the turbulator fin 20 into the inner vicinity of the deflector portion 13, so that the turbulator fin 20 is leaning against the assembling portion 29.

[0052] The deflector portion 13 is forming an additional air channel along the longitudinal direction of the tube 10. The additional air channel is of the same surface area in reference to the cross-section perpendicular to the longitudinal direction of the tube 10. In the basic embodiment of the invention presented for example in the Fig. 7, the additional air channel is at least partially connected in a fluidical manner with the adjacent channel i.e. the channels located on both sides of the deflector portion 13 are fluidically connected. In the other embodiment on an invention presented for example in the Fig. 8, the additional air channel is separated by the deflector portion 13, so that there is no fluidical connection between the channels located on both sides of the deflector portion 13.

[0053] Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of drawings, the disclosure, and the appended claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to the advantage.

Claims

1. A tube (10) for a heat exchanger (1), in particular for a charge air cooler installed in a motor vehicle, the tube (10) being formed by a folded sheet and the folded sheet comprising:

    - a longitudinal direction
    - a sealing region (14) extending along the longitudinal direction of the tube (10),

- an inner space of the tube (10) closed by the sealing region,
- a folded portion extending from the sealing region (14) and forming, in the inner space of the tube, a deflector portion (13) for air flowing in the inner space of the tube (10).

2. The tube (10) of claim 1, wherein the deflector forming portion (13) is rounded in a cross-section perpendicular to the longitudinal direction of the tube (10).

3. The tube (10) of claim 1 comprising only one deflector forming portion (13).

4. The tube (10) of claim 1 comprising deflector forming portions (13) on the both sides of the tube.

5. The tube (10) of claim 1 has a width (W) and a thickness (T), measured in two perpendicular directions, both perpendicular to the longitudinal axis of the tube, wherein the width is greater than the thickness.

6. The tube of claim 5, wherein width of a folded portion is smaller than 50%, in particular smaller than 25%, in particular smaller than 15%, of the width of the tube (10).

7. The tube (10) of claim 2, wherein the deflector forming portion (13) forms a perpendicular angle with the wall that defines the width of the tube (10).

8. The tube (10) of claim 2, wherein the deflector forming portion (13) is slanted towards the closest wall that defines the thickness of the tube.

9. The tube (10) of claim 7 or 8, wherein the deflector forming portion (13) is brazed along the longitudinal direction of the tube (10).

10. The tube (10) of claims 7 or 9, wherein at least one deflector forming portion (13) has an end at a distance from the inner side of the tube (10).

11. The tube (10) of claim 8 and 10, comprising a turbulator fin (20) leaning against the deflector forming portion (13).

12. The tube (10) of claim 10, wherein the turbulator fin (20) is introduced into the inner vicinity of the deflector forming portion (13).

13. The tube (10) of all preceding claims, wherein the deflector forming portion (13) is forming an additional air channel along the longitudinal direction of the tube (10), which is of the same surface area in reference to the cross-section perpendicular to the longitudinal direction of the tube (10).

14. A heat exchanger (1) comprising the tube (10) of any preceding claim, in particular a plurality of tubes (10).

15. The heat exchanger (1) according to preceding claim, configured as a charge air cooler.

Fig. 1

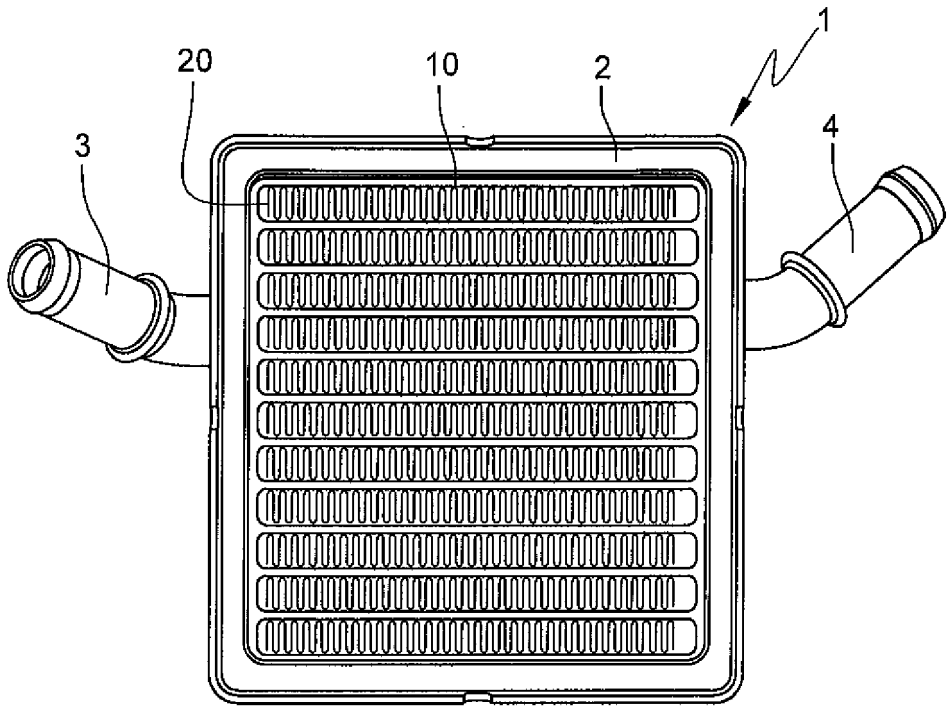


Fig. 2

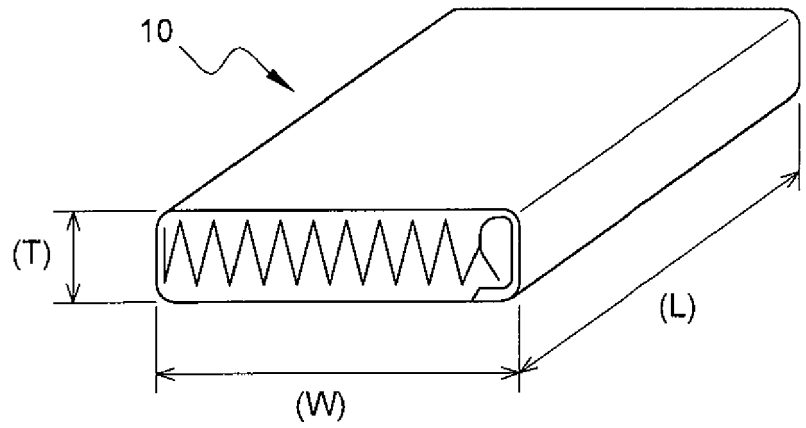


Fig. 3

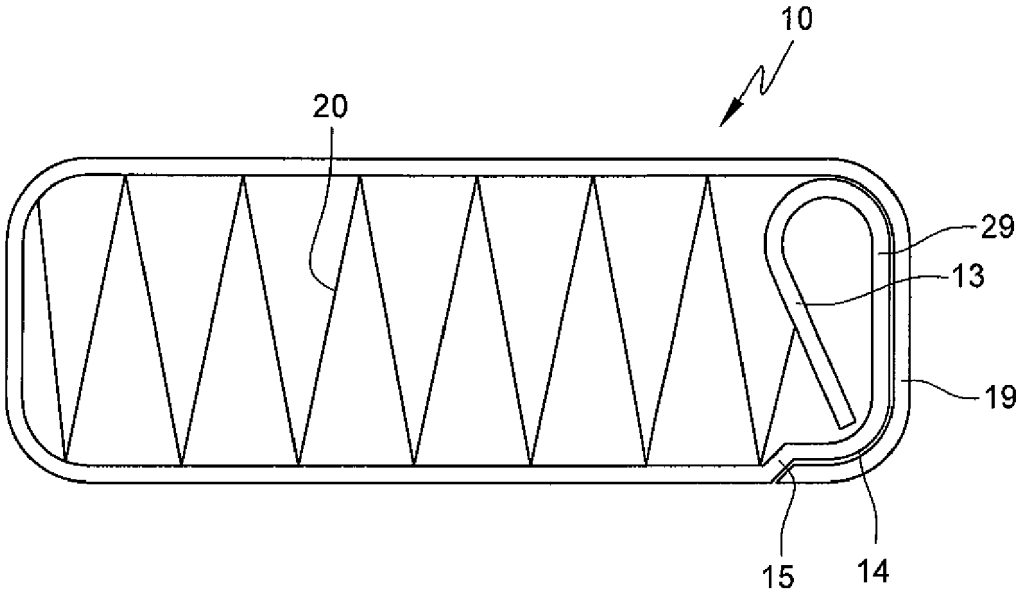


Fig. 4

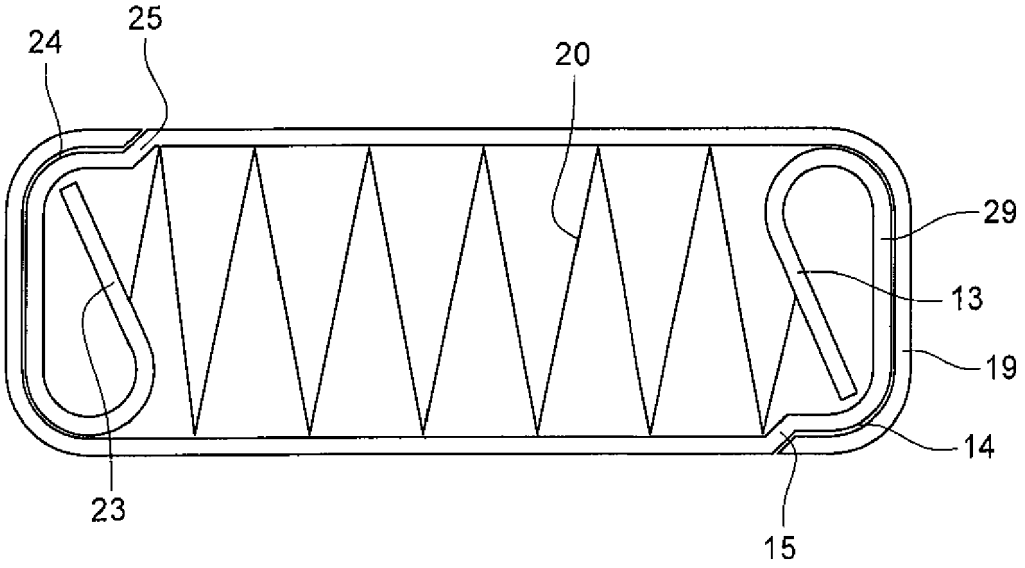


Fig. 5

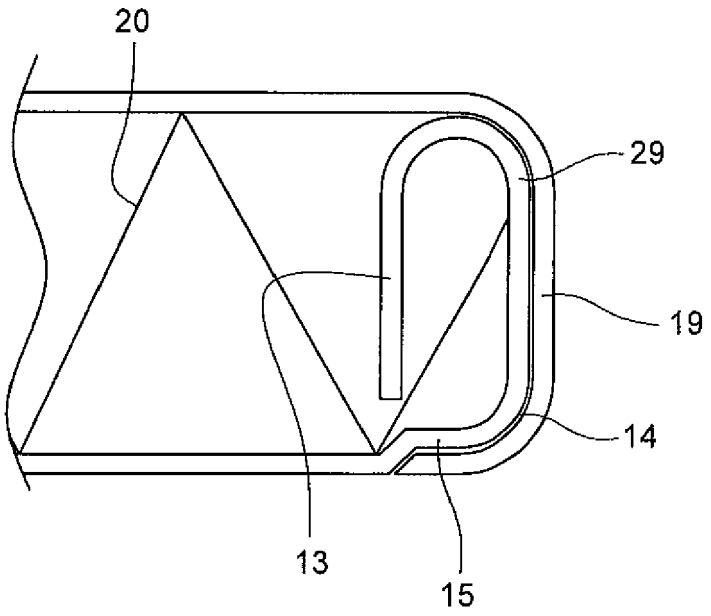


Fig. 6

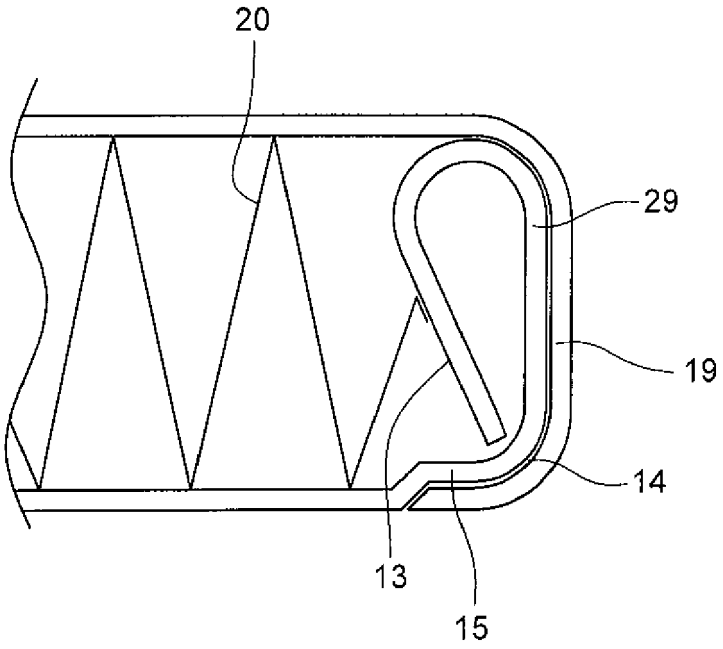


Fig. 7

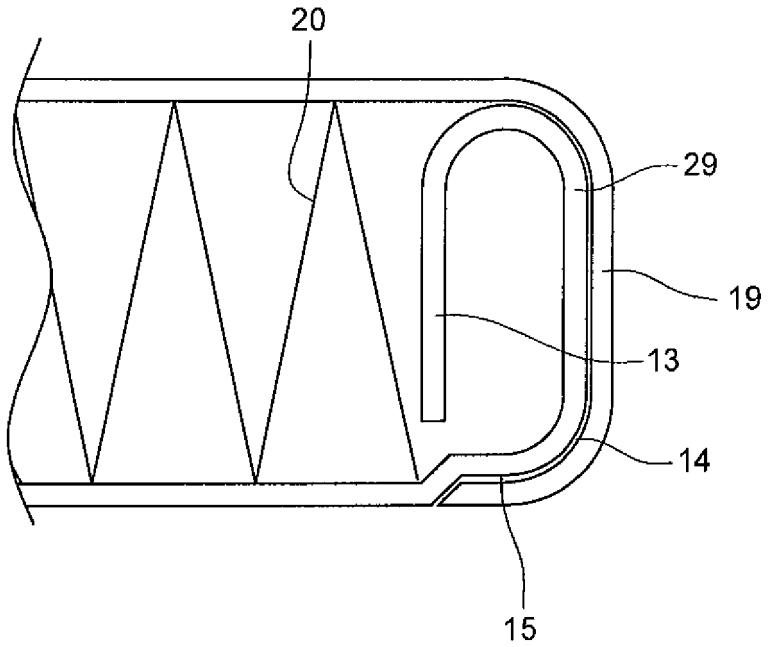
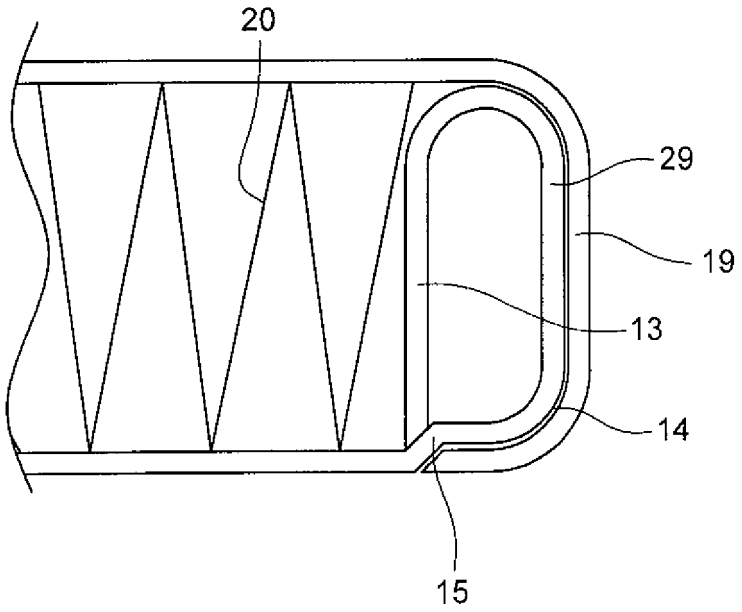


Fig. 8



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EUROPEAN SEARCH REPORT

Application Number
EP 19 46 1509

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

F28D
F28F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	9 July 2019	Martínez Rico, Celia

CATEGORY OF CITED DOCUMENTS

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