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(54) Cast, light-metal, substantially cylindrical heat exchanger

Aus Leichtmetall gegossener, im wesentlichen zylindrischer Wärmetauscher

Echangeur de chaleur coulé de métal léger, essentiellement cylindrique

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Description

[0001] The invention relates to a heat exchanger. Such a heat exchanger is known from French patent specification 854.120.

[0002] FR 854.120 discloses a heat exchanger comprising a closed cylindrical inner wall, enclosing a burner space, whereby a water duct is formed around said inner wall, between said inner wall and an outer wall. On one side the water duct is provided with an inlet and on the other side with an outlet. The inlet and outlet are set diametrically. The water duct is manufactured with an open top side, which is closed after removal of the relevant mold part. The water duct is formed by a single chamber completely surrounding said burner chamber. From said inner wall a number of ribs extends radially for enlarging the heat exchanging surface.

[0003] This known heat exchanger is simple in construction but has the disadvantage that the flow of water between the inlet and outlet is substantially free. The effective length of the water duct between the inlet and outlet is approximately half the circumferential length of the inner or outer wall. This results during use in pour heat transfer between heated gases and water in said water duct.

[0004] A further heat exchanger is known from European patent specification EP-A-0 547 641.

[0005] This known heat exchanger comprises two box-shaped parts attached to each other with the open sides facing each other, with the inclusion of a burner space. Each part comprises, at the side thereof facing the burner space, a number of series and columns of projections that increase the heat-transferring area, which projections always extend in the same direction towards each other in the mounted condition of the heat exchanger, and have their free ends approximately abutting against each other. At the outside remote from the projections, each part comprises a water duct extending zig-zag from the bottom upwards. The lateral sides of the heat exchanger are formed by substantially closed, flat walls. During use, flue gases heated by means of a burner are passed from the top side of the heat exchanger through the burner space along the projections, while heat is transmitted to the projections. The projections transfer the heat to water flowing through the water ducts. This known heat exchanger is easy to manufacture, compact and practical in use, and has a favorable efficiency.

[0006] This known heat exchanger has as a drawback that the heat-transferring area is relatively small compared with the dimensions of the heat exchanger. As a consequence, the efficiency is not optimal. A water duct extends on two sides of the heat exchanger only, the other sides are clear and act as radiation surface to the environment, so that heat is lost, particularly when no or insufficient insulation measures are taken. The projections are arranged so that they transfer the heat in a favorable manner to the or each water duct, which means that they all connect to the parts of each heat exchanger part that face the water duct. During use, as a consequence of the difference in heat transfer of the different parts of the heat exchanger, stresses may occur in the material which may cause damages or even breakage.

[0007] The object of the invention is to provide a heat exchanger of the type described in the preamble of the main claim, wherein the drawbacks mentioned are avoided, while the advantages thereof are retained. To that end, a heat exchanger and burner according to the invention is characterized by the features of claim 1.

[0008] The substantially cylindrical form of the heat exchanger provides a favorable ratio between the contents and the wall surface of a heat exchanger. Moreover, the water duct extends along at least almost the entire outside of the heat exchanger, so that the heat of the flue gases is optimally used and heat radiation to the environment is minimized. During use, the heat exchanger is as it were insulated by a water jacket. Moreover, as the elements increasing the heat-transferring area extend inwardly from the inner wall while they are distributed along the entire inner circumference of the section at least in a portion of the heat exchanger, the heat of the flue gases is optimally taken up and distributed over the entire circumference of the inner wall and thus transferred to the water duct. Consequently, substantial temperature differences over the inner wall are prevented in a simple manner. A heat exchanger according to the invention can be manufactured and employed in a simple manner and is economical in production, use and maintenance.

[0009] During production of the heat exchanger, the water duct, wound spiral-wise around the inner wall, has the advantage that the casting core or casting core parts can readily be removed therefrom, because no or at least few bends occur therein. The water duct extends in a flowing manner, like a snake around the cylindrical inner wall. This prevents core material, for instance sand, wax or plastic, from staying behind in parts of the water duct and fouling and damaging the apparatus. During use, such a spirally wound water duct has the advantage that the water resistance of the heat exchanger is low, at least lower than in the case of a water duct that extends zigzag. Thus, the advantage is for instance achieved that a water pump of a lower capacity can be used, that there can be a more accurate control, that a longer water duct or greater powers can be used and like advantages. Moreover, the water duct can be cleaned more properly and foulings are more simply prevented from adhering in the water duct during use.

[0010] A further advantage of arranging a spirally wound water duct is that a casting core required therefor can be fitted and supported in a mold in a simpler manner, so that the manufacture of such a heat exchanger is simpler, all the more because the number of core holes in the water duct that are to be finished and sealed after casting is smaller than in the case of the known heat exchangers. For instance, with one core support, two windings of the water duct that lie side by side can in each case be supported.

[0011] In a preferred embodiment, a heat exchanger and burner according to the invention is further characterized by the features of claim 2.

[0012] A heat exchanger constructed in one piece has the advantage that this requires fewer assembling operations during the production of a heating apparatus designed therewith, and that, moreover, sealing problems of parts of a heat exchanger are avoided. Accordingly, such a heat exchanger is cheaper and more reliable in production and use.

[0013] In an advantageous embodiment, a heat exchanger and burner according to the invention is further characterized by the features of claim 3.

[0014] Such a heat exchanger can be manufactured as follows. By means of a mold, a casting core for the water duct is formed by forming a cast of the water duct in, for instance, molding sand or wax. This casting core is then removed in for instance two parts from the or each mold, and, next, the parts are interconnected to form a complete first casting core. If the walls of the water duct extended completely spiral-wise and without the abovementioned clearing spaces therebetween around the inner wall, the core parts would be damaged during removing, because a part thereof would be stuck behind a nonclearing part of each winding of this wall. By providing the clearing spaces on the division seam of the first casting core, i.e. at the level of the or each face that constitutes the contact face between the casting core parts after the removal of the or each mold and the joining of the casting core parts to form the first casting core, so that each casting core part is withdrawable in an approximately radial direction, each casting core part can be removed without damage. Thus, the advantage is achieved that an undamaged first casting core can be obtained in a simple manner without this requiring, for instance, sliding parts or parts that can be moved otherwise in the or each mold.

[0015] In a first further embodiment, such a heat exchanger and burner according to the invention is characterized by the features of claim 4.

[0016] In this embodiment, the water duct wall is actually wound substantially entirely spiral-wise, and the clearing spaces are formed by profiles on the water duct wall. As a matter of fact, it is of course also possible to provide the water duct so as to be alternately inclined and right-angled relative to the longitudinal axis of the heat exchanger, so that the right-angled part in each case forms a space that can be cleared in tangential direction. This does create a slightly larger number of bends in the water duct, but these bends can be relatively faint.

[0017] In a further advantageous embodiment, a heat exchanger and burner according to the invention is characterized by the features of claim 5.

[0018] In such an embodiment, a casting core for at least the burner space, the elements increasing the heat-transferring area, and the inner wall can be formed in a particularly simple manner without this requiring moving parts in the mold. Moreover, the elements increasing the heat-transferring area can thus be readily and optimally distributed over the surface of the inner wall.

[0019] Further advantageous elaborations of a heat exchanger and burner according to the invention are described in the subclaims.

[0020] The invention further relates to a casting core apparatus for manufacturing a heat exchanger according to the invention, characterized by the features of claim 9 or 10.

[0021] The invention moreover relates to a heating apparatus comprising a heat exchanger and burner according to the invention.

[0022] To explain the invention, exemplary embodiments of a heat exchanger and a heating apparatus will hereinafter be described, with reference to the accompanying drawings. In these drawings:

Fig. 1 shows, in sectional side elevation, an embodiment of a heat exchanger according to the invention;
Fig. 2 shows, in sectional top plan view, a heat exchanger taken on the line II-II in Fig. 1;
Fig. 3 shows, in sectional top plan view, a casting core apparatus according to the invention;
Fig. 4 shows, in side elevation, a casting core part for a water duct according to Figs. 1 and 2;
Fig. 4A shows a detail of a clearing space in a water duct in a first embodiment;
Fig. 4B shows a detail of a clearing space in a water duct in a second embodiment; and
Fig. 5 shows, in sectional side elevation, a portion of a heating apparatus according to the invention.

[0023] Figs. 1 and 2 show, in sectional views, a heat exchanger 1 according to the invention. The heat exchanger 1 comprises a cylindrical inner wall 2 and an outer wall 3 concentrically arranged around the inner wall 2. Included between the inner wall 2 and the outer wall 3 is a spiral-shaped water duct wall 4, whereby a spiral-shaped water duct 5 is formed on the outside of the inner wall 2. From the inside of the inner wall 2, projections 6 increasing the heat-transferring area extend inwardly in staggered rows and/or columns and approximately at right angles to the longitudinal direction of the heat exchanger 1. The shape and positions of the projections 6 will be further discussed hereinafter. The heat exchanger 1 is formed in one piece through casting and is manufactured from light metal. Light metal should be understood to mean, at least, aluminum and aluminum alloys, brass and brass alloys.

[0024] The heat exchanger 1 has a substantially cylindrical shape, which means that an optimum ratio is obtained between contents and heat-transferring area. The heat exchanger 1 is formed by means of a casting core assembly 7 as shown in Fig. 3. In Fig. 3, a quarter of the casting core assembly 7 has been left out. For clarity's sake, this quarter is schematically shown (in contour) in broken lines. The casting core assembly 7 is of the type that is lost during or after the casting of the heat exchanger 1 and is for instance formed from sand, wax or synthetic material, such as polystyrene, or from combinations thereof. Moreover, parts such as slides can of course be included, which can in fact be reused, if necessary.

[0025] The casting core assembly 7 comprises an outer box B wherein the shape of the outside of the heat exchanger 1 is substantially fixed. The casting core assembly 7 further comprises an inner core 8 and a water duct core 9. These cores are successively described.

[0026] The inner core 8 can be manufactured in portions and then be assembled from parts, or can be of a one-piece construction. Manufacturing the inner core 8 in portions has the advantage that the equipment required therefor is relatively cheap, yet the processing costs involved are relatively high. For manufacturing the inner core in one part, relatively costly equipment is necessary, yet an inner core 8 thus manufactured requires relatively little finishing.

[0027] In the embodiment shown in the drawing, the inner core 8 is composed of four sectors I-IV, to be referred to as segments 10. Each segment 10 comprises about a quarter of the section of the space 11 enclosed within the inner wall 2, the opposite sectors I and III being substantially mirror-symmetrical, just as the opposite sectors II and IV. As a matter of fact, the four sectors I-IV can also be equal to each other, in which case, for manufacturing the sectors, only one mold may suffice and, moreover, errors during the assembly of the inner core 8 are avoided. Each sector I-IV comprises a large number of projections 6 which extend substantially parallel to each other, at right angles to the longitudinal direction of the sector I-IV in question. The projections 6 extend so that they can be withdrawn, in such a manner that the sector in question, after the formation thereof, can be drawn from a mold used for the formation in the direction of the longitudinal edge C which, in a compound inner core 8, is directed towards the other sectors. Hence, a thus formed segment 10 approximately has the shape of a quarter of a circle and has, in the convex outer face 12, a large number of parallel recesses 13, each having the shape of the projections 6 to be formed.

[0028] The side faces 14 of the sectors I-IV, i.e. the faces which, in the compound inner core 8, abut against each other, are irregularly shaped. A number of recesses 13' extend beyond the (fictitious) boundary line 15 of the quarter circle enclosed by the relevant sector 10. These recesses 13' extending therebeyond are provided so that in a compound inner core 8, they lie between recesses 13 in the adjoining side face 14 of the adjacent sector. This means that in the cast heat exchanger 1, a number of projections 6 cross each other at the location where two sectors of the compound inner core 8 abutted against each other during casting. Thus, a suitable density of projections 6 on the different parts of the inner wall 2 is obtained, as a result of which, during use, no substantial differences in heat transfer are created, which is advantageous in terms of heat engineering and construction.

[0029] The sectors I-IV are glued together or joined otherwise with the side faces 14 against one another, to obtain the compound inner core 8 shown in Fig. 3. In the embodiment shown, four sectors I-IV are opted for, but of course, a different number can be chosen as well, for instance two semicircular sectors or more than four, which may be advantageous, in particular in the case of relatively large dimensions of the heat exchanger. The direction of the projections 6 will always have to be chosen depending on the number of sectors.

[0030] When an inner core 8 is manufactured in one piece, a tool having different movable parts (four in the embodiment shown) is used. In the starting situation, a cylinder, wherein projections extend inwardly in the desired pattern, is filled with, for instance, molding sand, which is allowed to harden. Then, the projections are withdrawn outwards in segments until they extend entirely outside the molding sand. For this purpose, the cylinder can be divided into four quadrants, each comprising projections 6 fixedly connected thereto, in accordance with the segments I-IV of the segmented inner core 8. When these four quadrants are being drawn away, the entire inner core 8 is then directly clear. However, the projections 6 can also be withdrawable through the wall of the cylinder, after which the inner core 8 should subsequently be removed from the cylinder, which cylinder can, of course, also be divisible for that purpose. This also permits the use of projections that have such a position relative to each other that they are not jointly withdrawable, for instance radial projections. They can then be withdrawn simultaneously or individually in the suitable direction if they are moveable independently of each other. As a result, similar projections can be used, which is advantageous for the heat transfer and minimizes stresses in the cast heat exchanger. In fact, the heat exchanger shown in the drawing can of course also be manufactured in this manner.

[0031] In the embodiment shown, the water duct core 9 is manufactured in two parts in one or more molds 16 and is schematically partly shown in Fig. 4. In the embodiment shown, the water duct core 9 is formed in two parts 9', 9", but a different number of parts can of course be used as well. Two parts has the advantage that relatively few joints are necessary, while the core parts 9', 9" can still be manufactured relatively simply. Moreover, these core parts 9', 9" can readily be provided around the inner core 8. Further, it is possible to construct the water duct core 9 in one piece, in particular in the case of relatively short heat exchangers, wherein the mold 16 can for instance be screwed from the formed water duct core 9.

[0032] As described, the water duct 5 is substantially spiral-shaped, wound around the outside of the inner wall 2 of the heat exchanger 1. The water duct 5 being spiral-shaped, the water duct core 9 can readily be removed after casting, because no bends of about 90° or even of 180° are included, as in the known heat exchangers. This means that fewer or even no openings for cleaning the water duct need to be included, which means that fewer finishing operations of the cast heat exchanger 1 are necessary. Further advantages will be further discussed hereinafter.

[0033] To be able to remove the water duct core parts 9', 9" from or out of the or each mold 16, these parts should be of a withdrawable construction. Figs. 4A and 4B give two possibilities for achieving such withdrawal.

[0034] Fig. 4A is an enlarged view of a clearing space 17 between two wall parts 4 of the water duct 5, in a first embodiment. The clearing direction of the core parts 9', 9" of the mold 16 is at right angles to the plane of the drawing. The wall parts 4 are thickened so that the space therebetween has, in each case, no undercuts in at least the clearing direction, i.e. when the heat exchanger 1 is held vertically and, accordingly, the water duct 5 extends upwards/downwards spiral-wise, the relevant wall parts are approximately parallel or receding in the clearing direction. This permits the portion of the core parts 9 therebetween to be drawn away without parts being left behind undercuts. This means that the core parts 9', 9" can be removed and joined together to form the desired water duct core 9 without damage.

[0035] Fig. 4B shows an alternative embodiment of the wall parts 4 of the water duct 5, wherein, at the location where the two parts 9', 9" of the casting core 9 come together, the wall parts 4 are bent to enclose the desired clearing space 17. For that purpose, the wall parts 4 are slightly bent relative to the longitudinal axis of the heat exchanger, to obtain a slightly stepped water duct 5 extending spiral-wise around the inner wall 2 of the heat exchanger 1.

[0036] Each water duct core part 9, 9" comprises a series of parallel, approximately semicircular parts 31. These parts are interconnected by a transverse beam 18 on which the parts 31 are arranged, via support pins 19. The parts 31 are slightly oblique relative to the longitudinal direction of the beam 18 and together form, when the core parts 9', 9" are joined together, a representation in, for instance, molding sand of the water duct 5.

[0037] In fact, it is also possible to form the casting core 9 by means of a mold 16 provided with slides or the like, or by means of a mold 16 of the lost type, which means that it is lost during or after the formation of the casting core 9.

[0038] The casting core assembly 7 is rendered ready for use through the following steps. In a first outer box part B', a cast is provided of a first half of the outside contour of the heat exchanger, i.e. it is substantially determined by the outer wall 3. In the hollow thus formed, a first part 9' of the water duct core 9 is placed, with the beam 18 being received in the first outer box part so that only the support pins 19 and the parts 31 extend inside the hollow. The support pins 19 have such a length that the parts are spaced from the inside of the hollow at a distance corresponding to the desired wall thickness of the outer wall 3, for instance some millimeters. Next, the inner core 8 is placed in the parts 31 and spaced therefrom at a distance corresponding to the desired thickness of the inner wall 2. Then, the second part 9" of the water duct core 9 and the second outer box B" containing a cast of the second half of the outside contour of the heat exchanger are provided over the inner core in a similar manner, to obtain a substantially closed casting box B. Provided in one or each outer box B', B" are a number of gates and risers (not shown in the drawing) for feeding therein the casting melt, for instance aluminum or brass or alloys of one or both metals.

[0039] After the heat exchanger has cooled down and hardened, the casting box is opened and the casting cores are removed, i.e. in so far as they have not disappeared already during casting. Because the water duct 5 is formed so as to be continuous, the removal of at least the water duct core 9 is simple, while for removing the inner core, sufficient space is present within the heat exchanger. After the removal of the casting cores, the openings in the walls of the heat exchanger are closed, wherever this is necessary, and the heat exchanger can be finished and incorporated into, for instance, a heating apparatus.

[0040] Fig. 5 is a sectional view of a portion of a heating apparatus 20 comprising a heat exchanger 1 according to the invention. In this heating apparatus 20, the heat exchanger 1 is vertically arranged, i.e. the longitudinal axis thereof extends in a vertical plane. However, it is also possible to arrange the heat exchanger 1 differently, for instance in a horizontal or inclined position. At the top end thereof, a cylindrical burner 21 is inserted into the heat exchanger 1, which has for instance a jacket-shaped burner deck 22. The burner has a relatively slight length compared with the heat exchanger 1. Connected to the burner 21 is a feed pipe 23 which, at the opposite end thereof, is connected to a fan 24. By means of the fan 24, a combustible gas or gas-air mixture is fed under pressure to the burner 21, wherein it is combusted. The hot flue gases are then forced between the projections 6.

[0041] From the lower end, an impeller 25 is inserted between the projections 6 in the inner space of the heat exchanger, to a position adjacent the burner 1. This impeller 25 fills up the space 11 below the burner 21 between the projections 6, whereby the flue gases are forced to flow between the staggered projections 6 while transferring the heat to the projections 6 and, directly or indirectly, to the inner wall 2. Because the projections are disposed in staggered rows and/or columns, a labyrinth-shaped flow path for the flue gases is formed, so that the heat transfer during use is improved. The impeller 25 is for instance a cylinder filled with fire-proof, heat-resistant fibers, or a ceramic bush. At least a number of the projections 6 almost abut against the outside of the impeller 25. At its lower end, a flue gas discharge 26 connects to the inner space of the heat exchanger 1. The flue gases can condense in the heat exchanger 1 and are discharged via the flue gas discharge 26. Included in the flue gas discharge 26, which is U-shaped in the embodiment shown, is a condensate discharge opening 27, which is for instance closable by means of a cap 28.

Because the heat exchanger is substantially cylindrical, it is at least largely symmetrical. This means that both the feed pipe 23 and the flue gas discharge 26 can be arranged in almost any direction, which enables a flexible use. Moreover, sealings can readily be provided.

[0042] Adjacent the lower end, the water duct 5 is connected to a return pipe 29 and adjacent the upper end, it is connected to a feed pipe 30 of, for instance, a heating circuit (not shown). During use, water is passed through the water duct 5 and heated by means of the heat emitted by the flue gases. As the water duct 5 encompasses almost the entire heat exchanger 1, little heat is lost to the environment, while no specific insulating measures are necessary. As the water duct 5 extends spiral-wise and has no sharp angles, the water duct has a low water resistance, so that a pump of a relatively small capacity and/or a relatively long water duct 5 can be used, which means that relatively substantial powers are possible with a heating apparatus according to the invention. This also enables the cleaning of the water duct 5 to be carried out in a relatively simple manner.

[0043] To ensure that the flue gases do not cool down too fast, which would cause problems in terms of construction and heat engineering, the length of the projections 6 in the top part of the heat exchanger 1 is adjusted. Around the burner 21, the projections are relatively short, so that the ends thereof are spaced from the burner deck 22. At the level of the end of the burner 21 facing the impeller 25, the length of the projections 6 gradually increases, in downward direction, to a maximum, which means that at that location, the projections 6 have a staggered configuration. This enables the flue gases to reach the projections 6 around the impeller 25 almost without any resistance, so that the flue gases are not directly cooled down quickly. Moreover, the projections can be of alternately different lengths, which reduces the flow resistance for the flue gases.

[0044] The heating apparatus can further be designed in a known manner with, for instance, radiators, a thermostat and a control device and like known attributes. A heating apparatus according to the invention, in particular a heating boiler suitable therefor, is compact and has a high efficiency, while it can be manufactured and employed in a simple and relatively advantageous manner. The convenience time, i.e. the time between the occurrence and the fulfilment of an established heat requirement, is relatively short, which has a comfort-increasing effect.

[0045] The water duct around the inner wall may rise stepwise, wherein for instance in each case, half a winding extends approximately horizontally and two successive half-windings are connected by an inclined passage part. Moreover, the water duct may for instance be double-wound, i.e. consist of two water ducts wound side by side or one over the other. Further, the projections may be formed differently or be designed as, for instance, partitions or ribs. The projections may have identical lengths everywhere, or may differ in length more substantially. The length and diameter of the heat exchanger and the passage area, and the pitch of the water duct may be chosen differently, in accordance with the desired capacities, while, also, a different type of burner may be used. Instead of the impeller, other means may be included for the same purpose, for instance a water-filled vessel that can act as boiler or a water duct that can act as tapping spiral. The feed pipe for the fuel and the flue gas discharge may be of a different construction.

Claims

1. A heat exchanger, manufactured from light metal by means of casting technique and a burner (21), comprising at least a water duct, a burner space and elements increasing the heat-transferring area, wherein the heat exchanger (1) comprises a closed, substantially cylindrical inner wall (2), wherein the water duct (5) extends along the outside of the inner wall (2) and the burner space (11) extends inside the inner wall (2), the burner (21) having been inserted into an accomodation space adjacent one end of the heat exchanger (1) within the inner wall (2), wherein, on the inside, the elements (6) increasing the heat-transferring area such as projections and/or partitions extend from the inner wall (2) in at least two directions which include an angle relative to each other, wherein the heat exchanger (1) has a substantially circular cross section and the elements (6) increasing the heat-transferring area are distributed over almost the entire inner circumference of the inner wall (2) in at least a part of the heat exchanger (1), and the water duct (5) extends spiral-wise around the inner wall (2).

2. A heat exchanger and burner according to claim 1, **characterized in that** the heat exchanger (1) is of one piece.

3. A heat exchanger and burner according to any one of claims 1-2, **characterized in that** the water duct (5) comprises at least two windings, wherein each winding is at a number of positions provided with a portion enclosed by two wall parts (4) extending radially relative to the longitudinal direction of the heat exchanger, wherein the space (17) between said wall parts (4) is designed so that it can be cleared in tangential direction, the arrangement being such that at least one mold (16) can be used for at least the formation of a segmented first casting core (9) for the water duct (5), wherein, after formation, the parts (9', 9") of the first casting core (9) can be taken from the or each mold (16) and can be joined together to form a one-piece first casting core (9), which first casting core (9) is lost during or after the casting of the heat exchanger (1).

4. A heat exchanger and burner according to claim 3, **characterized in that** the water duct (5) is enclosed by the inner wall (2), an outer wall (3) and a water duct wall (4) extending between the inner and outer walls, which water duct wall (4) extends spiral-wise around the inner wall (2) and is in each winding, at at least two positions, provided with such a thickening and/or profiling that, as a result, two opposite water duct wall parts are formed that are at least parallel and preferably slightly diverging in two opposite directions tangential relative to a section that is at right angles to the longitudinal direction of the heat exchanger (1).

5. A heat exchanger and burner according to any one of the preceding claims, **characterized in that** the elements (6) increasing the heat-transferring area are accommodated in sectors (I-IV), wherein the elements (6) in each sector (I-IV) extend substantially parallel to each other, the arrangement being such that each sector (I-IV) can be manufactured by means of a withdrawable second casting core part (8), which second casting core parts can be joined together to form a one-piece second casting core (8) which is lost during or after the casting of the heat exchanger (1).

6. A heat exchanger and burner according to any one of the preceding claims, **characterized in that** the elements (6) increasing the heat-transferring area are projection-shaped and are provided in staggered rows and/or columns, wherein between the free ends of at least a part of the projections (6) a slightly cylindrical free space (11) is defined.

7. A heat exchanger and burner according to claims 5 and 6, **characterized in that** the projections (6) of any two adjoining sectors (I-IV) lie at least partly between each other and cross each other.

8. A heat exchanger and burner according to any one of the preceding claims, **characterized in that** the burner is a preferably cylindrical burner (21) of the premix type, wherein in at least a part of the heat exchanger (1), the elements (6) increasing the heat-transferring area have, in the direction away from the accommodation space, an increasing surface and/or density, the arrangement being such that during use, combustion gases flowing along the elements (6) cool down relatively calmly.

9. A casting core apparatus for the manufacture of a heat exchanger according to any one of the preceding claims, comprising at least a first casting core assembly (9) having the form of at least a spiral-shaped water duct (5) and a second casting core assembly (8) having at least the form of a burner space (11) with elements (6) increasing the heat-transferring area, wherein the second casting core assembly (8) is included within the first casting core assembly (9), wherein between the first (9) and the second casting core assembly (8) a space is included for forming at least the inner wall (2), wherein at least one of the casting core assemblies (8, 9) is built up from parts and wherein the casting core apparatus (B, 8, 9) is at least substantially of a type that is lost during or after the casting of the heat exchanger (1).

10. A casting core apparatus for the manufacture of a heat exchanger according to any one of claims 1-8, comprising at least a first casting core assembly (9) having the form of at least a spiral-shaped water duct (5) and a second casting core assembly (8) having at least the form of a burner space (11) with elements (6) increasing the heat-transferring area, wherein the second casting core assembly (8) is included within the first casting core assembly (9), wherein between the first (9) and the second casting core assembly (8) a space is included for forming at least the inner wall (2), wherein the casting core assemblies (8, 9) are of a one-piece construction and wherein the casting core apparatus (B, 8, 9) is at least substantially of a type that is lost during or after the casting of the heat exchanger (1).

11. A method for manufacturing a heat exchanger according to any one of claims 1-8, comprising the following steps:

- manufacturing a first casting core assembly (9) of the lost type, in the form of a spiral-shaped water duct (5) ;
- manufacturing a second casting core assembly (8) of the lost type, in the form of a central burner space (11) with elements (6) increasing the heat-transferring area;
- positioning the two casting core assemblies (8, 9) within a casting box (B) so that the first casting core assembly (9) substantially surrounds the second casting core assembly (8) and is spaced therefrom;
- casting the heat exchanger (1) in the casting box (B) while substantially the first (9) and the second casting core assembly (8) are simultaneously or contiguously lost; and
- removing the one-piece heat exchanger (1) having a continuous, spiral-shaped water duct (5).

12. A method according to claim 11, **characterized in that** the first (9) and/or the second casting core assembly (8) is manufactured in parts, which parts are joined together.

13. A method according to claim 11 or 12, **characterized**

in that the second casting core assembly (8) is manufactured in one piece by means of a mold having moving parts, which, after formation of the casting core assembly (8) in the mold, are pulled away in substantially radial, outward direction.

14. A method according to any one of claims 11-13, **characterized in that** the first casting core assembly (9) is manufactured in one piece by means of a mold.

15. A heating apparatus (20) comprising a heat exchanger (1) and a burner according to any one of claims 1-8.

Patentansprüche

1. Wärmetauscher, hergestellt aus Leichtmetall mittels Gießtechnik, und ein Brenner (21) mit mindestens einer Wasserleitung, einem Brennerraum und Elementen, die die Wärmeübertragungszone erweitern, wobei der Wärmetauscher (1) eine geschlossene, im wesentlichen zylindrische Innenwand (2) umfasst und sich die Wasserleitung (5) entlang der Außenseite der Innenwand (2) erstreckt und sich der Brennerraum (11) innerhalb der Innenwand (2) erstreckt, wobei der Brenner (21) in einen dem Ende des Wärmetauscher (1) benachbarten Aufnahmeraum innerhalb der Innenwand (2) eingeführt worden ist, wobei innen die Elemente (6) die Wärmeübertragungszone erweitern, wie zum Beispiel Vorsprünge und/oder Trennwände, die von der Innenwand (2) aus in mindestens zwei Richtungen verlaufen, welche einen Winkel zueinander einschließen, wobei der Wärmetauscher (1) einen im wesentlichen runden Querschnitt aufweist und die Elemente (6), die die Wärmeübertragungszone erweitern, werden über fast den gesamten inneren Umkreis der Innenwand (2) in mindestens einem Teil des Wärmetauschers (1) verteilt, und die Wasserleitung (5) erstreckt sich spiralförmig um die Innenwand (2) herum.

2. Wärmetauscher und Brenner nach Anspruch 1,
dadurch gekennzeichnet, dass
der Wärmetauscher (1) einstückig ausgebildet ist.

3. Wärmetauscher und Brenner nach einem der Ansprüche 1-2,
dadurch gekennzeichnet, dass
der Wasserkanal (5) mindestens zwei Wicklungen aufweist, wobei jede Wicklung an mehreren Positionen mit einem von zwei Wandteilen (4), die radial relativ zur Längsrichtung des Wärmetauschers verlaufen, umschlossenen Gebiet versehen ist, wobei der Raum (17) zwischen den Wandteilen (4) derart konfiguriert ist, dass er in tangentialer Richtung geräumt werden kann, wobei die Anordnung derart ausgeführt ist, dass mindestens ein Formteil (16) für mindestens die Ausbildung eines segmentierten ersten Gießkerns (9) für den Wasserkanal (5) verwendet werden kann, wobei nach der Ausbildung die Teile (9', 9") des ersten Gießkerns (9) aus dem oder jedem Formteil (16) entnommen und zwecks Ausbildung eines einstückigen ersten Gießkerns (9) miteinander verbunden werden können, wobei der erste Gießkern (9) während oder nach dem Gießen des Wärmetauschers (1) verloren ist.

4. Wärmetauscher und Brenner nach Anspruch 3,
dadurch gekennzeichnet, dass
der Wasserkanal (5) von der Innenwand (2), einer Außenwand (3) und einer Wasserkanalwand (4), die zwischen den Innen- und Außenwände verläuft, umschlossen ist, wobei die Wasserkanalwand (4) spiralförmig um die Innenwand (2) verläuft und an jeder Wicklung an mindestens zwei Positionen mit einer solchen Verdickung und/oder einem solchen Profil versehen ist, dass dadurch zwei gegenüberliegende Wasserkanalwände gebildet werden, die mindestens parallel verlaufen und vorzugsweise leicht in zwei entgegengesetzte Richtungen tangential relativ zu einem Abschnitt, der rechtwinklig zur Längsrichtung des Wärmetauschers (1) ausgerichtet ist, divergieren.

5. Wärmetauscher und Brenner nach einem der vorhergehenden Ansprüche,
dadurch gekennzeichnet, dass
die den Wärmeübertragungsbereich vergrößernden Elemente (6) in Sektoren (I-IV) aufgenommen sind, wobei die Elemente (6) in jedem Sektor (I-IV) im wesentlichen parallel zueinander verlaufen, wobei die Anordnung derart ausgeführt ist, dass jeder Sektor (I-IV) mittels eines entfernbaren zweiten Gießkernteils (8) hergestellt werden kann, wobei zweite Gießkernteile zwecks Bildung eines einstückigen zweiten Gießkerns (8), der während oder nach dem Gießen des Wärmetauschers (1) verloren ist, miteinander verbunden werden können.

6. Wärmetauscher und Brenner nach einem der vorhergehenden Ansprüche,
dadurch gekennzeichnet, dass
die den Wärmeübertragungsbereich vergrößernden Elemente (6) als Vorsprünge ausgebildet sind und in versetzten Reihen und/oder Spalten angeordnet sind, wobei zwischen den freien Enden von mindestens einem Teil der Vorsprünge (6) ein leicht zylindrisch ausgebildeter freier Raum (11) gebildet wird.

7. Wärmetauscher und Brenner nach Anspruch 5 und 6,
dadurch gekennzeichnet, dass
die Vorsprünge (6) zweier benachbarter Sektoren (I-IV) mindestens teilweise einander zwischenge-

schaltet sind und einander kreuzen.

8. Wärmetauscher und Brenner nach einem der vorhergehenden Ansprüche,
dadurch gekennzeichnet, dass
der Brenner ein vorzugsweise zylindrischer Brenner (21) vom Typ Brenner mit Vormischung ist, wobei in mindestens einem Teil des Wärmetauschers (1) die den Wärmeübertragungsbereich vergrößernden Elemente (6) in der vom Aufnahmeraum abgewandten Richtung eine sich vergrößernde Fläche und/oder Dichte aufweisen, wobei die Anordnung derart ausgeführt ist, dass während des Betriebs die Verbrennungsgase, die die Elemente (6) entlangströmen, relativ sanft abkühlen.

9. Gießkernvorrichtung zur Herstellung eines Wärmetauschers gemäß einem der vorhergehenden Ansprüche, mit mindestens einer ersten Gießkernanordnung (9) in Form mindestens eines spiralförmigen Wasserkanals (5) und einer zweiten Gießkernanordnung (8) mindestens in Form eines Brennerraums (11) mit den Wärmeübertragungsbereich vergrößernden Elementen (6), wobei sich die zweite Gießkernanordnung (8) innerhalb der ersten Gießkernanordnung (9) befindet, wobei zwischen der ersten (9) und der zweiten Gießkernanordnung (8) ein Raum zum Ausbilden mindestens der Innenwand (2) vorgesehen ist, wobei mindestens eine der Gießkernanordnungen (8, 9) aus Teilen gebildet ist und die Gießkernvorrichtung (B, 8, 9) im wesentlichen von dem Typ ist, der während oder nach dem Gießen des Wärmetauschers (1) verloren ist.

10. Gießkernvorrichtung zur Herstellung eines Wärmetauschers gemäß einem der Ansprüche 1-8 mit mindestens einer ersten Gießkernanordnung (9) in Form mindestens eines spiralförmigen Wasserkanals (5) und einer zweiten Gießkernanordnung (8) mindestens in Form eines Brennerraums (11) mit den Wärmeübertragungsbereich vergrößernden Elementen (6), wobei sich die zweite Gießkernanordnung (8) innerhalb der ersten Gießkernanordnung (9) befindet, wobei zwischen der ersten (9) und der zweiten Gießkernanordnung (8) ein Raum zum Ausbilden mindestens der Innenwand (2) vorgesehen ist, wobei die Gießkernanordnungen (8, 9) einstückig ausgebildet sind und die Gießkernvorrichtung (B, 8, 9) wenigstens überwiegend von dem Typ ist, der während oder nach dem Gießen des Wärmetauschers (1) verloren ist.

11. Verfahren zum Herstellen eines Wärmetauschers, der insbesondere als Wärmetauscher gemäß einem der Ansprüche 1-8 geeignet ist, wobei das Verfahren folgende Schritte aufweist:

- Herstellen einer ersten Gießkernanordnung (9) des verlorenen Typs in Form eines spiralförmigen Wasserkanals (5);
- Herstellen einer zweiten Gießkernanordnung (8) des verlorenen Typs in Form eines zentralen Brennerraums (11) mit den Wärmeübertragungsbereich vergrößernden Elementen (6);
- Positionieren der beiden Gießkernanordnungen (8, 9) innerhalb eines Gießkastens (B), so dass die erste Gießkernanordnung (9) im wesentlichen die zweite Gießkernanordnung (8) umgibt und von dieser beabstandet ist;
- Gießen des Wärmetauschers (1) im Gießkasten (B), wobei im wesentlichen die erste (9) und die zweite Gießkernanordnung (8) gleichzeitig oder nacheinander verloren gehen; und
- Entfernen des einstückigen Wärmetauschers (1), der einen durchgehenden spiralförmigen Wasserkanal (5) aufweist.

12. Verfahren nach Anspruch 11,
dadurch gekennzeichnet, dass
die erste (9) und/oder die zweite Gießkernanordnung (8) in Teilen, die miteinander verbunden werden, hergestellt wird.

13. Verfahren nach Anspruch 11 oder 12,
dadurch gekennzeichnet, dass
die zweite Gießkernanordnung (8) mittels eines bewegliche Teile aufweisenden Formteils einstückig ausgebildet wird, wobei die Formteile nach der Ausbildung der Gießkernanordnung (8) in dem Formteil im wesentlichen radial nach außen gezogen werden.

14. Verfahren nach einem der Ansprüche 11-13,
dadurch gekennzeichnet, dass
die erste Gießkernanordnung (9) mittels eines Formteils einstückig ausgebildet wird.

15. Heizvorrichtung (20) mit einem Wärmetauscher (1) gemäß einem der Ansprüche 1-8.

Revendications

1. Echangeur de chaleur, fabriqué en métal léger par une technique de coulée, et brûleur (21), comprenant au moins un conduit d'eau, un espace de brûleur et des éléments qui augmentent la surface de transfert de chaleur, dans lequel l'échangeur de chaleur (1) comporte une paroi interne fermée pratiquement cylindrique (2), dans lequel le conduit d'eau (5) s'étend le long de l'extérieur de la paroi interne (2) et l'espace de brûleur (11) s'étend à l'intérieur de la paroi interne (2), le brûleur (21) ayant été inséré dans un espace de logement adjacent à une extrémité de l'échangeur de chaleur (1) à l'intérieur de la paroi interne (2), dans lequel, à l'intérieur, les éléments (6) qui augmentent la surface de transfert de chaleur, tels que des saillies et/ou des cloisons, s'étendent depuis la paroi interne (2) dans au moins deux directions qui forment un angle l'une avec l'autre, dans lequel l'échangeur de chaleur (1) a une section pratiquement circulaire et les éléments (6) qui augmentent la surface de transfert de chaleur sont répartis sur presque toute la circonférence interne de la paroi interne (2) dans une partie au moins de l'échangeur de chaleur (1), et le conduit d'eau (5) s'étend en spirale autour de la paroi interne (2).

2. Echangeur de chaleur et brûleur selon la revendication 1, **caractérisé en ce que** l'échangeur de chaleur (1) est en une seule pièce.

3. Echangeur de chaleur et brûleur selon l'une des revendications 1 et 2, **caractérisé en ce que** le conduit d'eau (5) comporte au moins deux serpentins, chaque serpentin comportant un certain nombre de positions, une partie enfermée par deux parties de paroi (4) qui s'étendent radialement par rapport à la direction longitudinale de l'échangeur de chaleur, dans lequel l'espace (17) compris entre les parties de paroi (4) est tel qu'il peut être dégagé en direction tangentielle, la disposition étant telle qu'un moule au moins (16) peut être utilisé pour au moins la formation d'un premier noyau segmenté (9) de coulée du conduit d'eau (5), dans lequel, après la formation, les parties (9', 9") du premier noyau de coulée (9) peuvent être retirées du moule ou de chaque moule (16) et peuvent être raccordées pour former un premier noyau de coulée en une seule pièce (9), ce premier noyau de coulée (9) étant perdu pendant la coulée de l'échangeur de chaleur (1) ou après cette coulée.

4. Echangeur de chaleur et brûleur selon la revendication 3, **caractérisé en ce que** le conduit d'eau (5) est enfermé par la paroi interne (2), une paroi externe (3) et une paroi (4) de conduit d'eau qui s'étend entre les parois interne et externe, la paroi (4) de conduit d'eau s'étendant en spirale le long de la paroi interne (2) et comprenant, dans chaque serpentin, à deux positions au moins, un épaississement et/ou un profilage tels que deux parties opposées de paroi de conduit d'eau sont formées et sont pratiquement parallèles et de préférence légèrement divergentes dans deux sens opposés tangentiellement à un tronçon qui est perpendiculaire à la direction longitudinale de l'échangeur de chaleur (1).

5. Echangeur de chaleur et brûleur selon l'une quelconque des revendications précédentes, **caractérisé en ce que** les éléments (6) qui accroissent la surface de transfert de chaleur sont logés dans des secteurs (I-IV), dans lequel les éléments (6) de chaque secteur (I-IV) s'étendent en directions pratiquement parallèles, la disposition étant telle que chaque secteur (I-IV) peut être fabriqué à l'aide d'une seconde partie de noyau de coulée (8) qui peut être retirée, les secondes parties de noyau de coulée pouvant être raccordées pour former un second noyau de coulée en une seule pièce, (8) qui est perdu pendant la coulée de l'échangeur de chaleur (1) ou après cette coulée.

6. Echangeur de chaleur et brûleur selon l'une quelconque des revendications précédentes, **caractérisé en ce que** les éléments (6) qui augmentent la surface de transfert de chaleur ont la forme de saillies et sont disposés en lignes et/ou colonnes décalées, et un espace libre légèrement cylindrique (11) est délimité entre les extrémités libres d'une partie au moins des saillies (6).

7. Echangeur de chaleur et brûleur selon les revendications 5 et 6, **caractérisé en ce que** les saillies (6) de deux secteurs adjacents quelconques (I-IV) se trouvent au moins en partie les unes entre les autres et se recoupent.

8. Echangeur de chaleur et brûleur selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le brûleur est un brûleur cylindrique de préférence (21) du type à prémélange, dans lequel, dans une partie au moins de l'échangeur de chaleur (1), les éléments (6) qui augmentent la surface de transfert de chaleur ont, en direction opposée à celle de l'espace de logement, une surface et/ou une densité croissante, la disposition étant telle que, pendant l'utilisation, les gaz de combustion s'écoulant le long des éléments (6) se refroidissent d'une manière relativement calme.

9. Appareil à noyaux de coulée pour la fabrication d'un échangeur de chaleur selon l'une quelconque des revendications précédentes, comprenant au moins un premier ensemble (9) de noyaux de coulée ayant la forme d'au moins un conduit d'eau (5) en spirale et un second ensemble (8) de noyaux de coulée ayant au moins la forme d'un espace de brûleur (11) avec des éléments (6) qui augmentent la surface de transfert de chaleur, dans lequel le second ensemble de noyaux de coulée (8) est incorporé dans le premier ensemble de noyaux de coulée (9), dans lequel, entre le premier (9) et le second (8) ensemble de noyaux de coulée, est incorporé un espace destiné à former au moins la paroi interne (2), dans lequel l'un au moins des ensembles de noyaux de coulée (8, 9) est construit à partir d'éléments, et dans lequel l'appareil à noyaux de coulée (B, 8, 9) est au moins pratiquement du type perdu pendant la coulée de l'échangeur de chaleur (1) ou après cette coulée.

10. Appareil à noyau de coulée pour la fabrication d'un échangeur de chaleur selon l'une quelconque des

revendications 1 à 8, comprenant au moins un premier ensemble de noyaux de coulée (9) ayant la forme d'au moins un conduit d'eau spiralé (5) et un second ensemble de noyaux de coulée (8) ayant au moins la forme d'un espace de brûleur (11) avec des éléments (6) qui augmentent la surface de transfert de chaleur, dans lequel le second ensemble de noyaux de coulée (8) est incorporé dans le premier ensemble de noyaux de coulée (9), dans lequel, entre le premier (9) et le second (8) ensemble de noyaux de coulée est disposé un espace destiné à former au moins la paroi interne (2), dans lequel les ensembles de noyaux de coulée (8, 9) ont une construction en une seule pièce, et dans lequel l'appareil à noyau de coulée (B, 8, 9) est au moins pratiquement du type perdu pendant la coulée de l'échangeur de chaleur (1) ou après cette coulée.

11. Procédé de fabrication d'un échangeur de chaleur, selon l'une quelconque des revendications 1 à 8, comprenant les étapes suivantes :

la fabrication d'un premier ensemble de noyaux de coulée (9) de type perdu, sous forme d'un conduit d'eau de forme spiralée (5),
la fabrication d'un second ensemble de noyaux de coulée (8) de type perdu, sous forme d'un espace de brûleur central (11) avec des éléments (6) qui augmentent la surface de transfert de chaleur,
le positionnement des deux ensembles de noyaux de coulée (8, 9) dans une caisse de coulée (B) afin que le premier ensemble de noyaux de coulée (9) entoure pratiquement le second ensemble de noyaux de coulée (8) et en soit distant,
la coulée de l'échangeur de chaleur (1) dans la caisse de coulée (B) alors que le premier (9) et le second (8) ensemble de noyaux de coulée sont pratiquement perdus simultanément ou de façon contiguë, et
l'extraction de l'échangeur de chaleur en une seule pièce (1) ayant le conduit d'eau continu de forme spiralée (5).

12. Procédé selon la revendication 11, **caractérisé en ce que** le premier (9) et/ou le second (8) ensemble de noyaux de coulée est formé en parties et ces parties sont raccordées les unes aux autres.

13. Procédé selon la revendication 11 ou 12, **caractérisé en ce que** le second ensemble de noyaux de coulée (8) est fabriqué en une seule pièce à l'aide d'un moule ayant des parties mobiles qui, après formation de l'ensemble de noyaux de coulée (8) dans le moule, sont écartées en direction externe pratiquement radiale.

14. Procédé selon l'une quelconque des revendications 11 à 13, **caractérisé en ce que** le premier ensemble de noyaux de coulée (9) est fabriqué en une seule pièce à l'aide d'un moule.

15. Appareil de chauffage (20) comprenant un échangeur de chaleur (1) et un brûleur selon l'une quelconque des revendications 1 à 8.

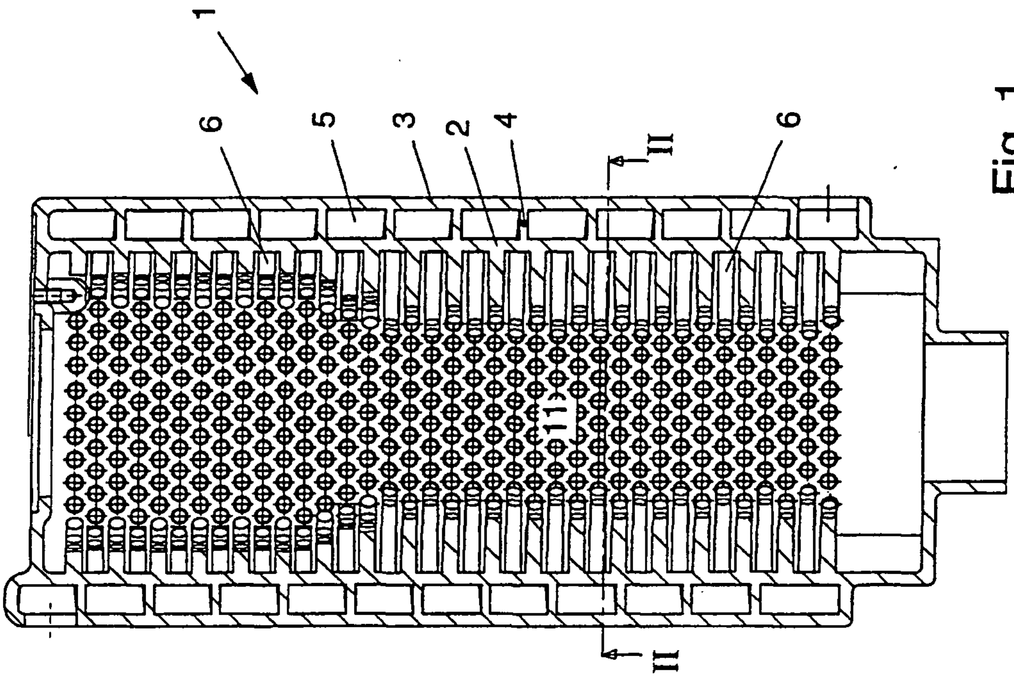

Fig. 1

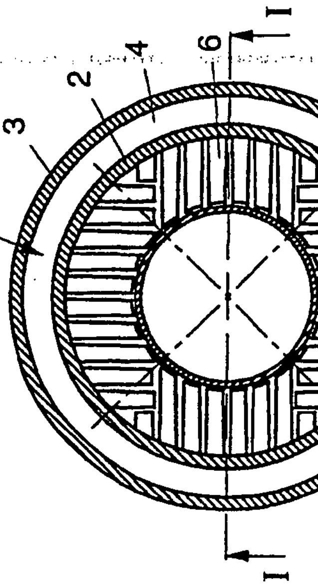

Fig. 2

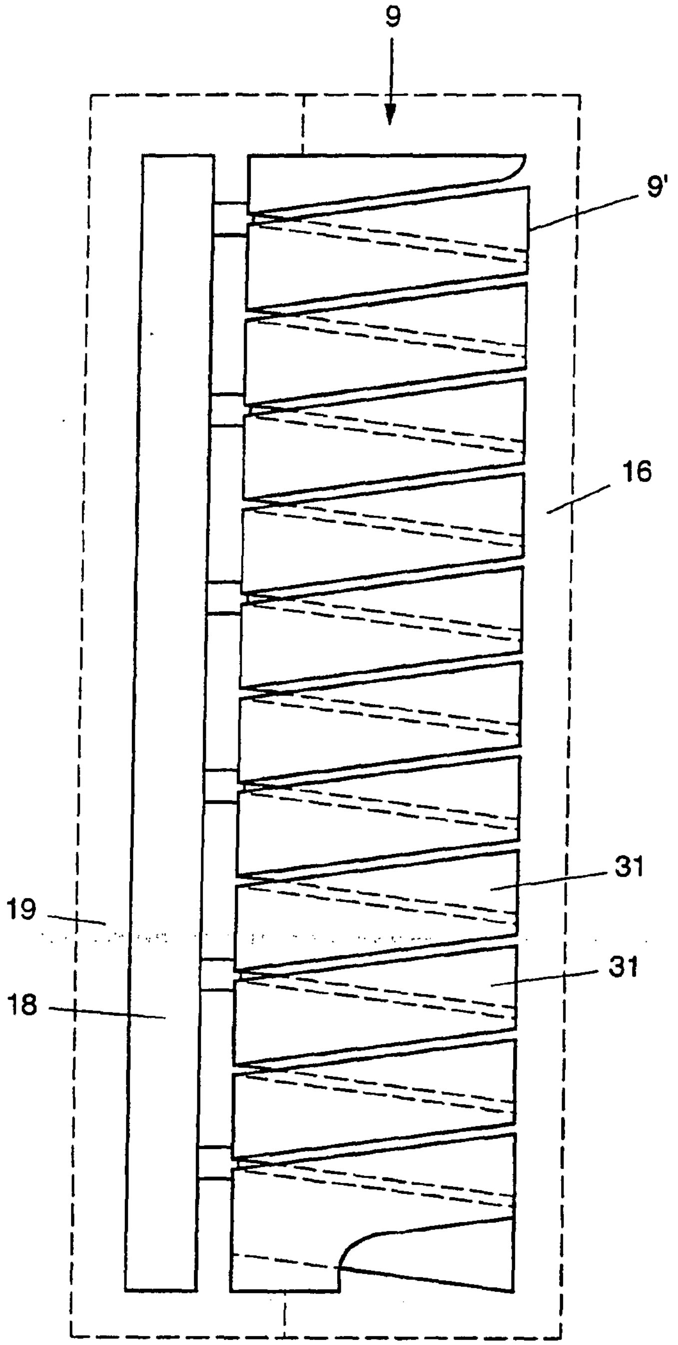

Fig. 4

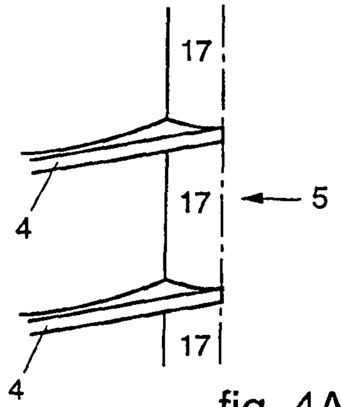

fig. 4A

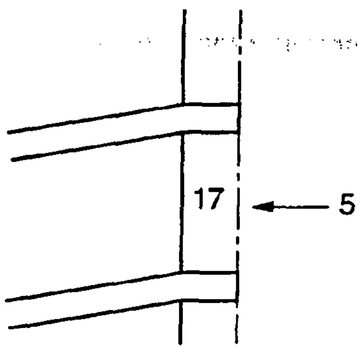

Fig. 4B

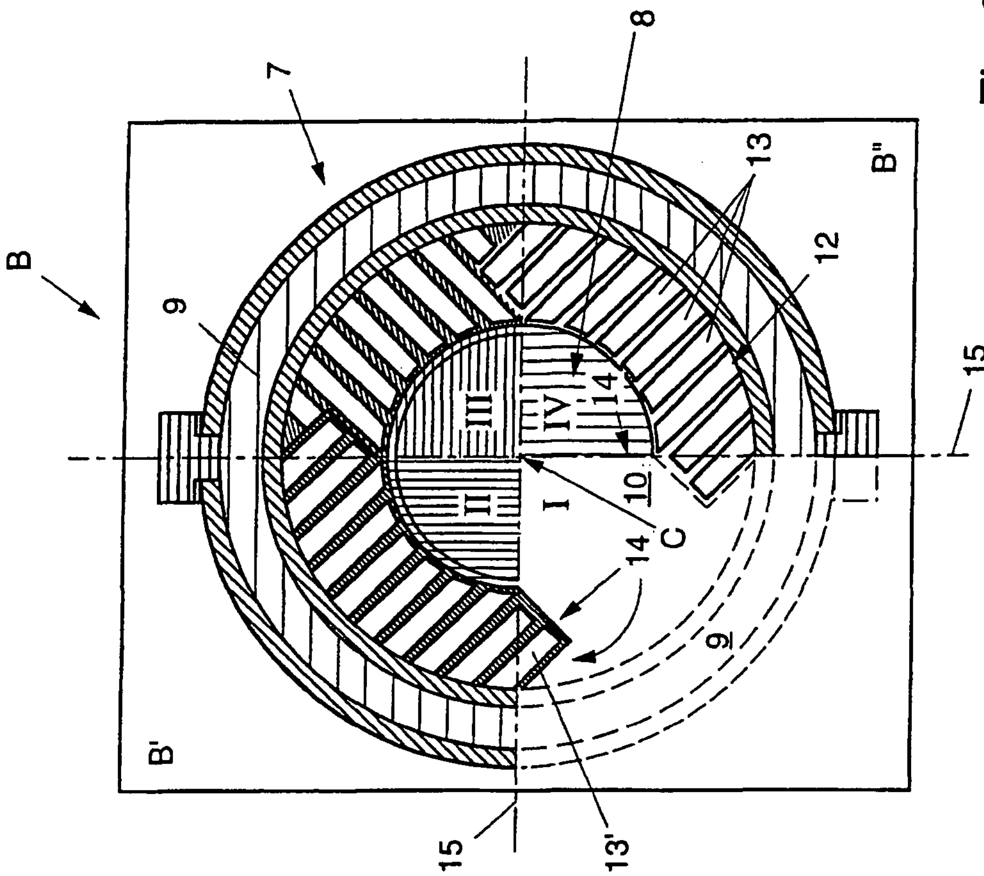
B
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Fig. 3

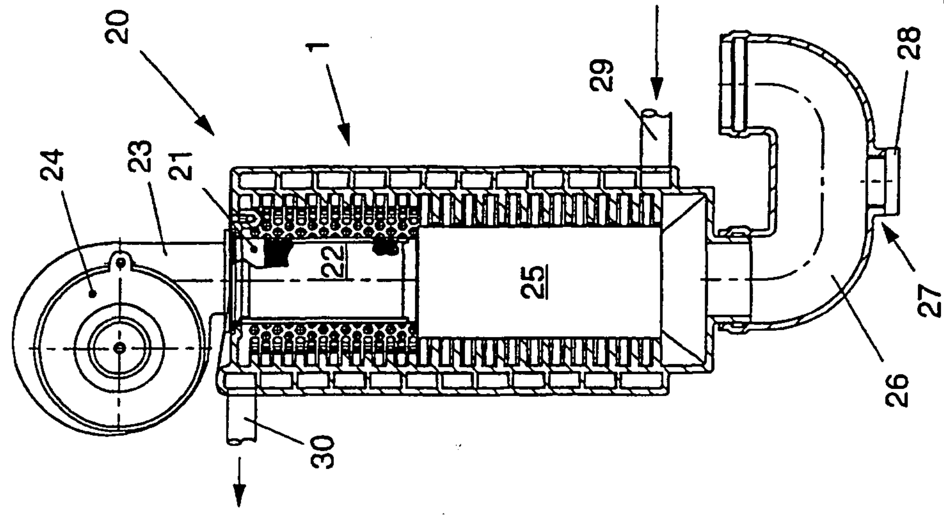
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Fig. 5

REFERENCES CITED IN THE DESCRIPTION

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- EP 0547641 A **[0004]**