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(54) Cast, light-metal, polygonal heat exchanger having a spiral-shaped water duct

(57) A heat exchanger, manufactured from light metal by means of casting technique, comprising at least a water duct, a burner space and elements increasing the heat-transferring area, wherein the heat exchanger (1) comprises a closed, polygonal or bent inner wall (2), wherein the water duct (5) extends spiralwise along the outside of the inner wall (2) and the burner space (11) extends inside the inner wall (2), wherein at least in a portion of the heat exchanger on the inside, the elements (6) increasing the heat-transferring area such as projections and/or partitions extend from the inner wall (2), preferably in at least two directions that include an angle relative to each other.

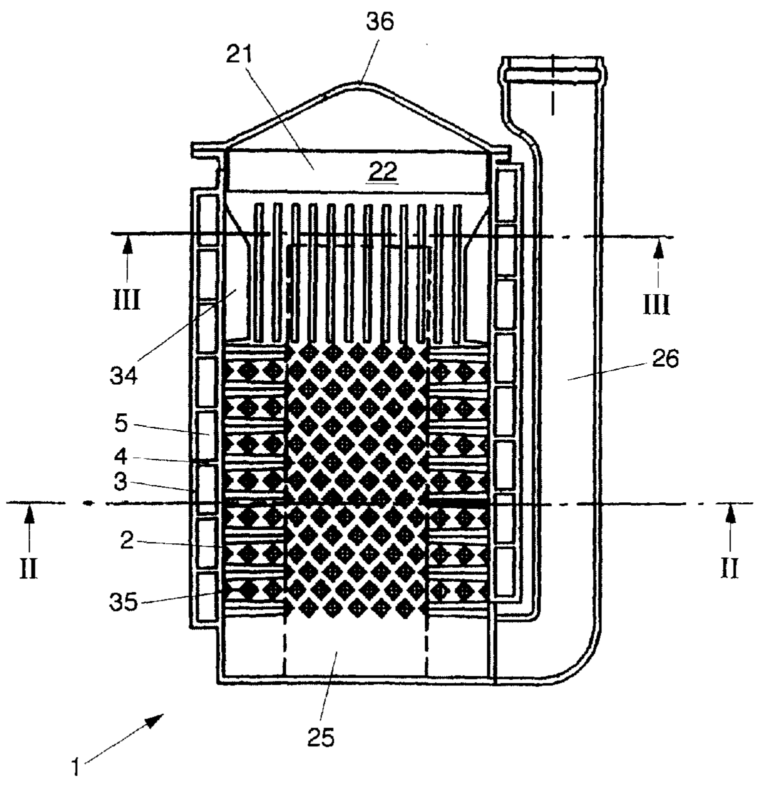

Fig. 1

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Description

The invention relates to a heat exchanger, manufactured from light metal by means of casting technique, comprising at least a water duct, a burner space and elements increasing the heat-transferring area. Such a heat exchanger is known from European patent specification 0 547 641.

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.

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.

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 according to the invention is characterized by the features of the characterizing part of claim 1.

The substantially polygonal form of the heat exchanger provides a favorable ratio between the contents and the wall surface of a heat exchanger. In this connection, a polygonal section should be understood to mean a section which comprises as least two, and in particular four or more angles and/or is partly built up of bent lines. The angles can be sharp but can also have a bend radius. 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 from the inner wall at least in a portion of the heat exchanger, distributed over the circumference of the section thereof, the heat of the flue gases is optimally taken up and distributed over the 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.

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, which bends, if present, are moreover only faint. The water duct extends in a flowing manner, like a snake around the 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.

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.

In this connection, spiral-wise should be understood to mean substantially continuous, so that during use, water can flow, in a movement extending around the inner space, from a position adjacent one end of the heat exchanger in the direction of the opposite end without this involving the flow direction being strongly deflected. Any bends in the water duct are faint, certainly less than 180°, and preferably less than 90°. Particularly advantageous is an embodiment wherein no bends are included other than those having a bend radius that is not smaller than the section of the water duct at that location, or that are about 45° or less.

In a preferred embodiment, a heat exchanger according to the invention is further characterized by the features of claim 4.

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.

In a first advantageous embodiment, a heat exchanger according to the invention is further characterized by the features of claim 5.

An at least partly symmetrical embodiment of a heat exchanger according to the invention inter alia offers the advantage that during the use thereof, a uniform heat distribution is obtained, which is advantageous in terms of heat engineering and material. Moreover, a casting core assembly for the manufacture thereof can be built up from equal parts, which is advantageous in terms of manufacturing. This involves a reduction or even an elimination of the chance of composition errors of the casting core assembly.

In a further advantageous embodiment, a heat exchanger according to the invention is further characterized by the features of claim 7.

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 one or more parts from the or each mold, and next, if more than one, 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 above-mentioned clearing spaces therebetween around the inner wall, the core parts would be damaged during removing, because a part thereof would be stuck behind a non-clearing part of each winding of this wall. By providing the clearing spaces on a division seam of the first casting core mold, i.e. at the level of the or each face that constitutes the contact face between the casting core mold parts, so that each casting core mold part is withdrawable in an approximately radial direction, the first casting core or each casting core part thereof 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.

In a first further embodiment, such a heat exchanger according to the invention is characterized by the features of claim 8.

In this embodiment, the water duct wall is 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.

In a further advantageous embodiment, a heat exchanger according to the invention is characterized by the features of claim 9.

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.

In a further advantageous embodiment, a heat exchanger according to the invention is characterized by the features of claim 12.

In this embodiment, the flow resistance of the heated gases through the heat exchanger increases in the direction away from the burner. Accordingly, the heat transfer, at least the intensity of the contact with the elements that increase the heat transfer, increases in the same direction. The rate at which the gases are cooled down is thereby reduced. This is advantageous from an energetic viewpoint.

In a further embodiment, a heat exchanger according to the invention is further characterized by the features of claim 13.

A polygonal burner offers the advantage that it can optimally be adjusted to the shape of the burner space of the heat exchanger. Moreover, such a burner may comprise a series of flat or single-curved burner surfaces, as a result of which a burner having a favorable burner pattern can be obtained in an economical manner.

Further advantageous elaborations of a heat exchanger according to the invention are described in the subclaims.

The invention further relates to a casting core apparatus for manufacturing a heat exchanger according to the invention, characterized by the features of claim 14 or 15.

The invention moreover relates to a method for manufacturing a heat exchanger according to the invention, characterized by at least the features of claim 16.

The invention moreover relates to a heating apparatus comprising a heat exchanger according to the invention.

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 heat exchanger taken on the line III-III in Fig. 1;

Fig. 4 shows, in sectional top plan view, a casting core apparatus according to the invention;

Fig. 5 shows a portion of a casting core for a water duct;

Fig. 5A shows a detail of a clearing space in a water duct in a first embodiment;

Fig. 5B shows, in cut-off perspective view, a portion of a mold for forming a casting core part for a water duct of a heat exchanger according to the invention;

Fig. 6 shows, in side elevation, a portion of a heating apparatus according to the invention; and

Figs. 7A-E show, in sectional top plan views taken on the line VII-VII in Fig. 6, a number of alternative embodiments of a heat exchanger with a burner according to the invention.

Figs. 1, 2 and 3 show, in sectional views, a heat exchanger 1 according to the invention. The heat exchanger 1 comprises an inner wall 2 and an outer wall 3 arranged around and aligned with the inner wall 2. Included between the inner wall 2 and the outer wall 3 is a 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, elements 6 increasing the heat-transferring area extend inwardly, approximately at right angles to the longitudinal direction of the heat exchanger 1. In the top range of the heat exchanger, these elements 6 are formed by partitions 34, extending parallel to each other in the longitudinal direction of the heat exchanger 1, i.e. vertically inwardly during normal use. In the bottom range of the heat exchanger 1, these elements 6 are formed by projections 35, disposed in staggered rows and/or columns. The shape and positions of the elements 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.

The heat exchanger 1 has a substantially mirror-symmetrical, blocked shape with, in the embodiment shown, an approximately rectangular top plan view, which means that a highly favorable ratio is obtained between contents, heat-transferring area and water duct contents. The heat exchanger 1 is formed by means of a casting core assembly 7 as shown in Fig. 4. In Fig. 4, 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.

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.

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, at least as far as cost price is concerned, 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.

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 elements 6 which extend substantially parallel to each other, at right angles to the longitudinal direction of the sector I-IV in question. The elements 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 square and has, in the outer face 12, a large number of parallel recesses 13, each having the shape of the elements 6 to be formed.

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 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 35 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 35 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.

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. 4. 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, three 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 partitions 34 and the projections 35 will always have to be chosen depending on the number of sectors.

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 tube with the relevant inner section corresponding to the inside of the inner wall 2, wherein elements 6 extend inwardly in the desired pattern, is filled with, for instance, molding sand, which is allowed to harden. Then, the elements 6 are withdrawn outwards in segments until they extend entirely outside the molding sand. For this purpose, the tube can be divided into four quadrants, each comprising elements 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 elements 6 can also be withdrawable through the wall of the tube, after which the inner core 8 should subsequently be removed from the tube, which tube can, of course, also be divisible for that purpose. This also permits the use of elements 6 that have such a position relative to each other that they are not jointly withdrawable, for instance oblique 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.

Depending on the form of the burner that is inserted, during use (as will be further discussed hereinafter), into the top side of the burner space 11 between the partitions 34, all elements 6 can approximately have the same length, for instance when a substantially square or polygonal burner is inserted into a heat exchanger of a section having a similar form, or changing lengths, for instance when a burner having a differently shaped section is used in a heat exchanger of an approximately square section. Inter alia the length, the section, the shape and the mutual distance and position of the elements 6 relative to each other determine the heat transfer during use between the flue gases and the water in the water duct.

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. 5B. 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 removed in portions from the water duct core 9.

As described, the water duct 5 is substantially spiral-shaped, wound around the outside of the inner wall 2 of the heat exchanger 1. In this connection, spiral-wise should be understood to mean substantially continuous, so that during use, water can flow, in a movement extending around the inner space, from a position adjacent one end of the heat exchanger in the direction of the opposite end without this involving the flow direction being strongly deflected. Any bends in the water duct are faint, certainly less than 180°, and preferably less than 90°. Particularly advantageous is an embodiment wherein no bends are included other than those having a bend radius that is not smaller than the section of the water duct at that location, or that are about 45° or less. Of course, connection parts for a feed and discharge pipe can indeed include a relatively sharp angle with the water duct, because they will be able to be cleared from the outside. However, this is not advantageous. The water duct 5 being spiral-shaped, the water duct core 9 can readily be removed after casting, if necessary, 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.

In the embodiment shown in Figs. 1-3, the corners 40 of the heat exchanger 1 are rounded, so that, in top plan view, each wall 2, 3 of the heat exchanger 1 comprises four relatively long, flat first wall parts 41, at right angles to each other and interconnected by bent second wall parts 42. The bend radius R of the second wall parts 42 is preferably not less than the section D of the water duct 5.

By virtue of these features, the core 9 is readily removable and, moreover, the resistance in the water duct 5, during use, is kept low. Further advantages will be further discussed hereinafter.

To be able to remove the water duct core parts 9', 9" (Fig. 5) from or out of the or each mold 16, these parts should be of a withdrawable construction. Figs. 5A and 5B give two possibilities for achieving such withdrawal.

Fig. 5A 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 in approximately horizontal direction 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.

Fig. 5B shows an alternative embodiment of a mold 16 for forming at least the wall parts 4 of the water duct 5 for a heat exchanger of an octagonal section. In this embodiment, the clearing direction of the water duct core part 9', 9" (not shown) from the mold 16 is indicated by the arrow P. By way of illustration, three axes X, Y and Z, at right angles to each other, are indicated by dash and dot lines. The upper and lower parts of the mold 16 are broken away.

The water duct wall 4 comprises in each winding W_{1-5} two first water duct wall parts 4A provided on opposite sides and extending in a plane parallel to the X-axis and the Y-axis, parallel to the clearing direction P. Each pair of first water duct wall parts 4A is interconnected by a second water duct wall part 4B that is inclined relative to the Z-axis and that is parallel to the Y-axis. This means that both the space 17A between two first water duct wall parts 4A lying one above the other, and the space 17B between two second wall parts 4B lying one above the other, can be cleared in the direction P.

Each water duct core part 9, 9" comprises (Fig. 5) a series of parallel 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 comprise a first part 50 that is slightly oblique relative to the longitudinal direction of the beam 18, which is a representation of the inclined portion of the water duct 5 (second space 17B). Further, each part 31 comprises two second parts 51, connecting to both ends of the first part 50 and extending at right angles to the longitudinal direction of the beam 18, which parts form a representation of parts of a flat portion of the water duct 5 (first space 17A). The first part 50 is in each case connected to a second part 51 via a third part 52 which is a representation of the portion 17C of the water duct 5 forming the bevelled or rounded corner 40. The parts 31 together form, when the core parts 9', 9" are joined together, a representation in, for instance, molding sand of the water duct 5 (Fig. 5).

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.

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.

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.

Fig. 6 shows, in side elevation, 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 such a heat exchanger 1 differently, for instance in a horizontal or inclined position. At the top end thereof, a 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. The top side of the heat exchanger is closed over the burner 21 by a cover cap 36, extending partly along the rear side of the heat exchanger and connected at that location with a fan 24. The cover cap 36 thus forms a feed pipe 23 for the burner 21. 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 elements 6.

An impeller 25 (shown in broken lines in Fig. 1) is inserted between the elements 6 in the inner space of the heat exchanger, to a position adjacent the burner 1. This impeller 25 largely fills up the space 11 below the burner 21 between the elements 6, whereby the flue gases are forced to flow between the partitions 34 and, next, between the staggered projections 35 while transferring the heat to the partitions 34, the projections 35 and, directly or indirectly, to the inner wall 2. The partitions 34 have a radial height such that between the longitudinal edges thereof remote from the inner wall 2 and the impeller 25, some space is left free. At the ends facing the burner 25, the partitions 34 are bevelled in the direction of the inner wall 2. The impeller 25 has a height such that the end thereof facing the burner 21 is approximately flush with the beginning of the bevelled ends of the partitions 34, so that a free space remains between the burner 21 and the impeller. As the partitions 34 are spaced from the impeller and, moreover, create little flow resistance, the flue gases can, during use, flow relatively freely along the partitions 34, with slight heat exchange. Hence, the flue gases are cooled down slowly, which is advantageous for the emission values of the heating apparatus.

Because the projections are disposed in staggered rows and/or columns, a labyrinth-shaped flow path for the flue gases is formed in the lower range, so that the heat transfer during use is improved. The impeller 25 is for instance a bush 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. Adjacent the bottom side, the flue gas discharge 26 connects to the heat exchanger in a sidewall thereof, and can be provided with a condensate discharge opening, closable by a cap. The flue gas discharge 26 can be cast together with the heat exchanger 1, as integral part thereof, but can also be provided afterwards, with the interposition of a packing. Thus, a greater freedom of choice is obtained in positioning the flue gas discharge 26 relative to the heat exchanger 1. In the embodiment shown, the flue gas discharge duct 26 is rounded on the outside, and a particularly complete heating apparatus 20 is obtained having particularly favorable operating properties.

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.

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.

In the exemplary embodiment shown, the burner has a burner deck 22 which extends substantially transversely to the longitudinal direction of the heat exchanger 1, parallel to the section II-II in Fig. 1. However, it is also possible to use a burner wherein the burner 21 extends at least partly between the partitions 34 and, possibly, the projections 35 and has its outwardly facing sides provided with burner faces 22. Different embodiments thereof are shown in Figs. 7A-7E. Such an embodiment inter alia offers the advantage that the entire burner surface 22 faces in the direction of the elements 6 increasing the heat-transferring area. In that case, the impeller extends less far and preferably has an end face thereof abutting against or lying adjacent an end face of the burner 21.

Figs. 7A-E schematically show a series of sectional top plan views of a heat exchanger 1 with a burner 21. For clarity's sake, the elements 6 increasing the heat-transferring area have been left out, the inner 3 and outer walls 3 are represented as single lines.

Fig. 7A shows an octagonal heat exchanger 101 with an octagonal burner 121. The burner 121 comprises a closed end face 129 and eight burner faces 122, arranged parallel to the longitudinal axis of the burner 121, at right angles to the end face 129. The burner faces 122 have their longitudinal edges slidably confined in link-shaped connection parts 130. This allows the burner faces 122 to deform freely in a direction parallel to their own planes, so that stresses are prevented. The burner faces 122 are flat, which renders the manufacture of the burner 122 simple, and, accordingly, relatively cheap, while the burner faces 122 are optimally positioned relative to the elements 6, which may all have an approximately equal length and heat-transfer capacity. This heat exchanger has for instance eight planes of symmetry.

Fig. 7B shows a hexagonal heat exchanger 201 having six equally large side faces, with a round, cylindrical burner. This burner 221 has a cylindrical burner face 222 and a closed end face 229. The burner face 222 is included in slide links, while behind the burner face 222, a distributor plate 231 is included for distributing the gas flow or gas-air flow over the burner plate 222, so that a better, calmer burner pattern is obtained.

Fig. 7C shows a heat exchanger 301, comparable with the heat exchanger according to Fig. 7B, but with rounder corners. Consequently, the water duct 5 exhibits an even more flowing configuration. Two opposite sides 332 have a greater length than the other sides, so that the heat exchanger is relatively flat in one direction. The burner 321 is designed as the burner 121 according to Fig. 7A, but with a hexagonal shape and six burner faces 322.

Fig. 7D shows a substantially rectangular heat exchanger 401 having a likewise rectangular burner 421. This heat exchanger and can readily be fitted against, for instance, a wall so as to be relatively flat. The burner 421 has in each case one burner face 422A on the opposite short side and two burner faces 422B on the two long sides. Hence, the burner faces 422A and B are relatively short, so that they will deform relatively slightly during use.

Fig. 7E shows a heat exchanger 501 having one flat (rear) side 532 and a curved second (front) side 533. The burner 521 has a similarly shaped section with five burner faces 522. This heat exchanger 501 has the advantage of a flat side for simple assembly and an advantageous ratio between volume and heat-transferring area.

Of course, combinations of shapes and assemblies of heat exchangers and burners are possible, which can be selected depending on the desired applications.

A heat exchanger according to the invention can of course also be assembled from parts, but such embodiment has as a disadvantage that additional sealings, assembling operations and/or assembling means are necessary.

The invention is by no means limited to the embodiments shown and described in the drawings and specification. Many variations thereto are possible.

For instance, the water duct may be double-wound, i.e. consist of two or more water ducts wound side by side or one over the other, while each water duct can be connected to the same or to separate heating circuits. The length and the flow-through area of the water ducts may differ, as well as the position thereof relative to the burner, so that, during use, water of different temperatures can be obtained from the different water ducts. Further, the projections may be formed differently or be designed as, for instance, partitions or ribs. The projections may have the same length 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. Moreover, the heat exchanger may have different sections at different levels, for instance for constricting or widening the flow-through area for the flue gases or for creating building-in space for, for instance, control and regulating means and/or a pump within the describing circumferential face of the heat exchanger, so that it can be used in an even more compact heating apparatus. 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, the feed and discharge of water, and the flue gas discharge may be of a different construction.

These and many comparable modifications and variations are understood to fall within the framework of the invention.

Claims

1. A heat exchanger, manufactured from light metal by means of casting technique, comprising at least a water duct, a burner space and elements increasing the heat-transferring area, **characterized in that** the heat exchanger (1) comprises a closed, polygonal or partly bent inner wall (2), wherein the water duct (5) extends spiral-wise along the outside of the inner wall (2) and the burner space (11) extends inside the inner wall (2), wherein at least in a portion of the heat exchanger on the inside, the elements (6) increasing the heat-transferring area such as projections (35) and/or partitions (34) extend from the inner wall (2).

2. A heat exchanger according to claim 1, characterized in that the water duct (5) extends spiral-wise around the entire inner wall (2).

3. A heat exchanger according to claim 1 or 2, characterized in that the elements (6) increasing the heat-transferring area extend in at least two directions which include an angle relative to each other.

4. A heat exchanger according to any one of claims 1-3, characterized in that the heat exchanger (1) is of one piece.

5. A heat exchanger according to any one of claims 1-4, characterized in that the heat exchanger has at least one, and preferably a series of planes of symmetry.

6. A heat exchanger according to claim 5, characterized in that the heat exchanger has two planes of symmetry.

7. A heat exchanger according to any one of claims 1-6, 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 at right angles 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 first casting core (9) for the water duct (5), which first casting core (9) is lost during or after the casting of the heat exchanger (1).

8. A heat exchanger according to claim 7, 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 outwardly in two opposite directions substantially transverse relative to a section that is at right angles to the longitudinal direction of the heat exchanger (1).

9. A heat exchanger 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).

10. A heat exchanger according to any one of the preceding claims, characterized in that the elements increasing the heat-transferring area are projection-shaped (35) and are provided in staggered rows and/or columns, wherein between the free ends of at least a part of the projections (35) a polygonal free space (11) is defined.

11. A heat exchanger according to claims 9 and 10, characterized in that at least a number of the projections (35) of any two adjoining sectors (I-IV) lie at least partly between each other and cross each other.

12. A heat exchanger according to any one of the preceding claims, characterized in that adjacent one end within the inner wall (2), there is provided an accommodation space for a burner (21), preferably 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 and/or length, the arrangement being such that during use, combustion gases flowing along the elements (6) cool down relatively calmly.

13. A heat exchanger according to any one of the preceding claims, characterized in that an accommodation space is provided for a burner, preferably of the premix type, wherein the burner has substantially a polygonal cross section.

14. A casting core apparatus for use in 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).

15. A casting core apparatus for use in the manufacture of a heat exchanger according to any one of claims 1-13, 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).

16. A method for manufacturing a heat exchanger, in particular suitable for a heat exchanger according to any one of claims 1-13, 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).

17. A method according to claim 16, characterized in that the first (9) and/or the second casting core assembly (8) is manufactured in parts, which parts are joined together.

18. A method according to claim 16 or 17, 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.

19. A method according to any one of claims 16-18, characterized in that the first casting core assembly (9) is manufactured in one piece by means of a mold.

20. A heating apparatus (20) comprising a heat exchanger (1) according to any one of claims 1-13.

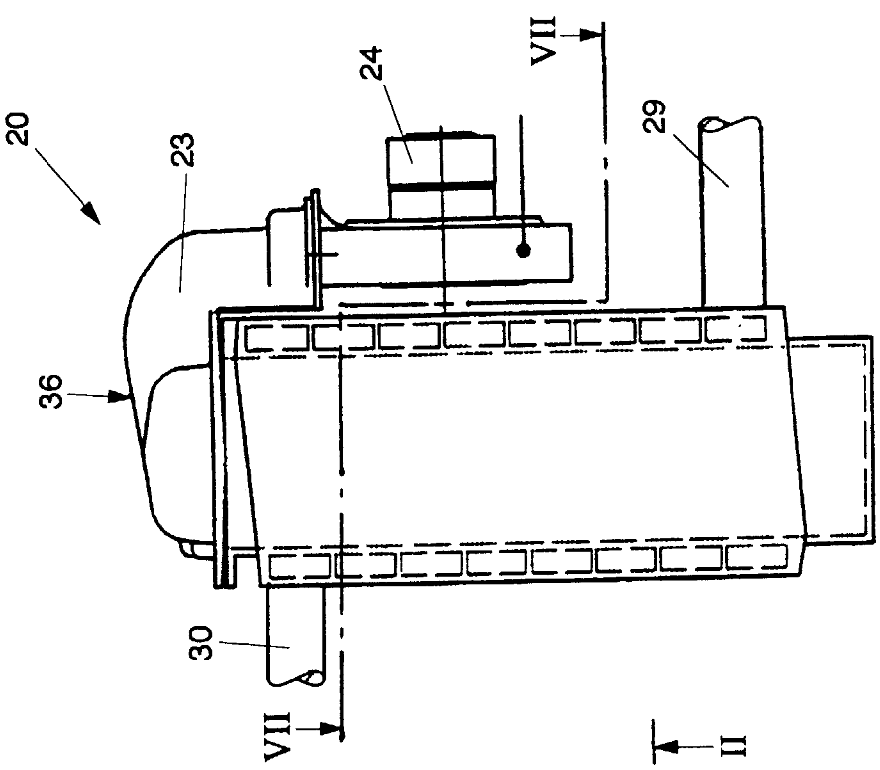

Fig. 6

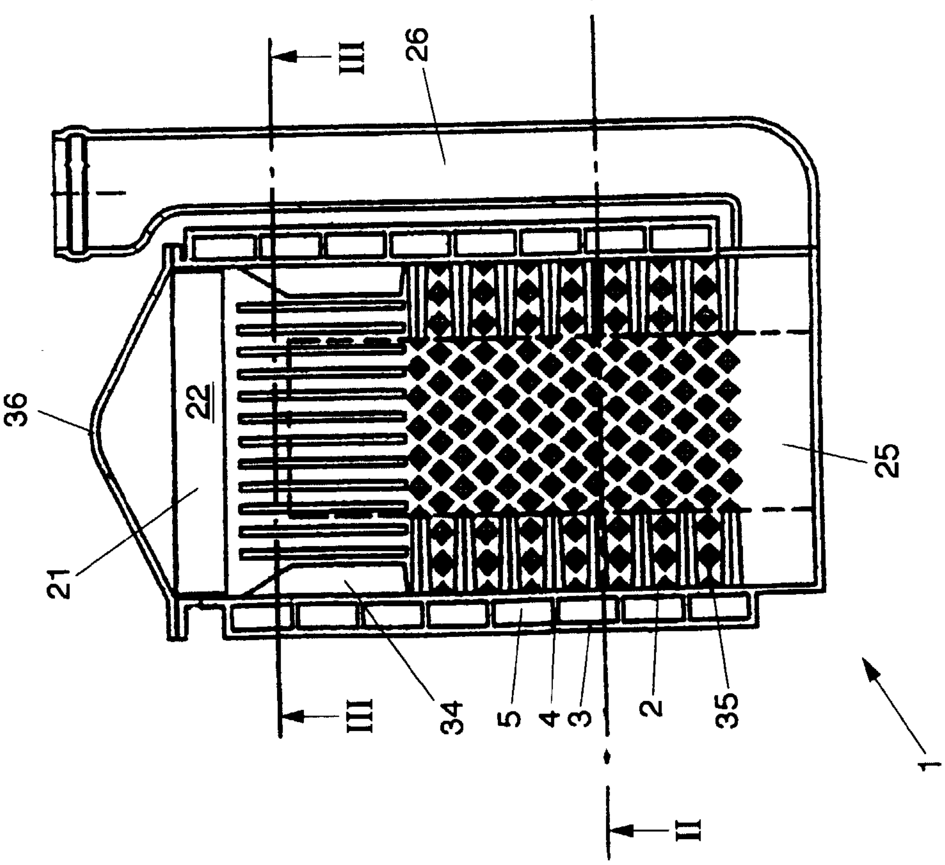

Fig. 1

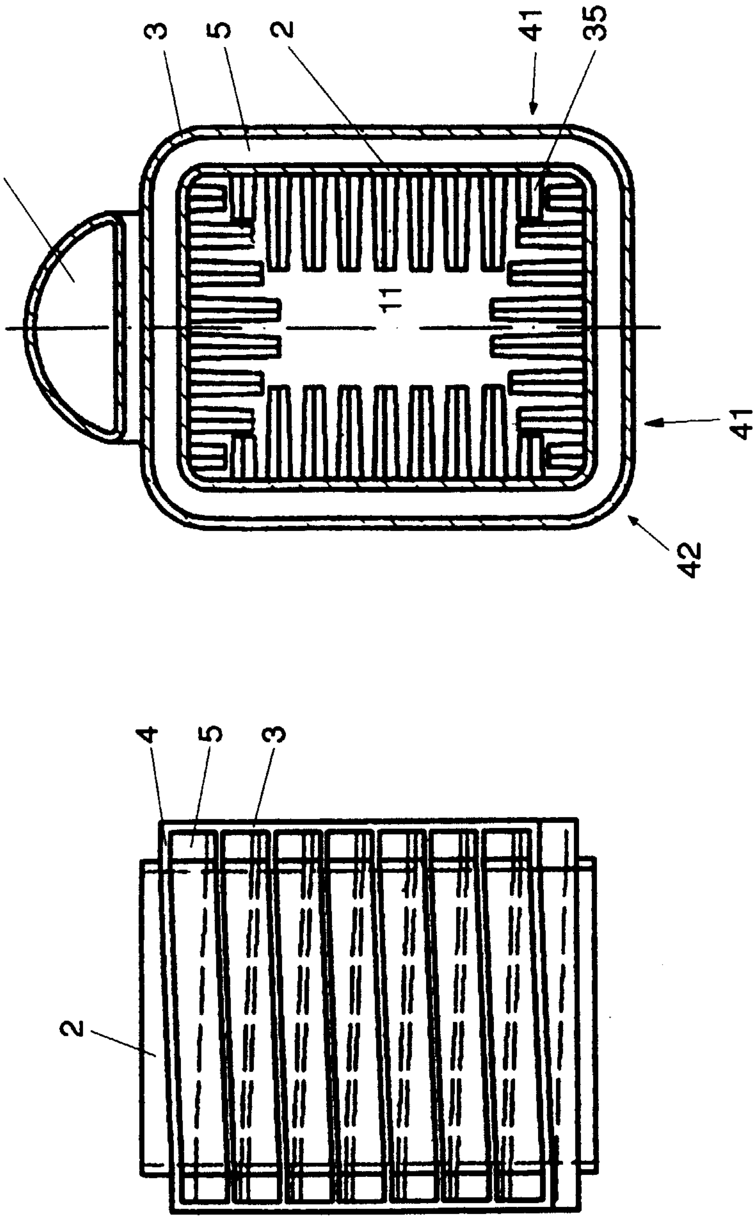

Fig. 2

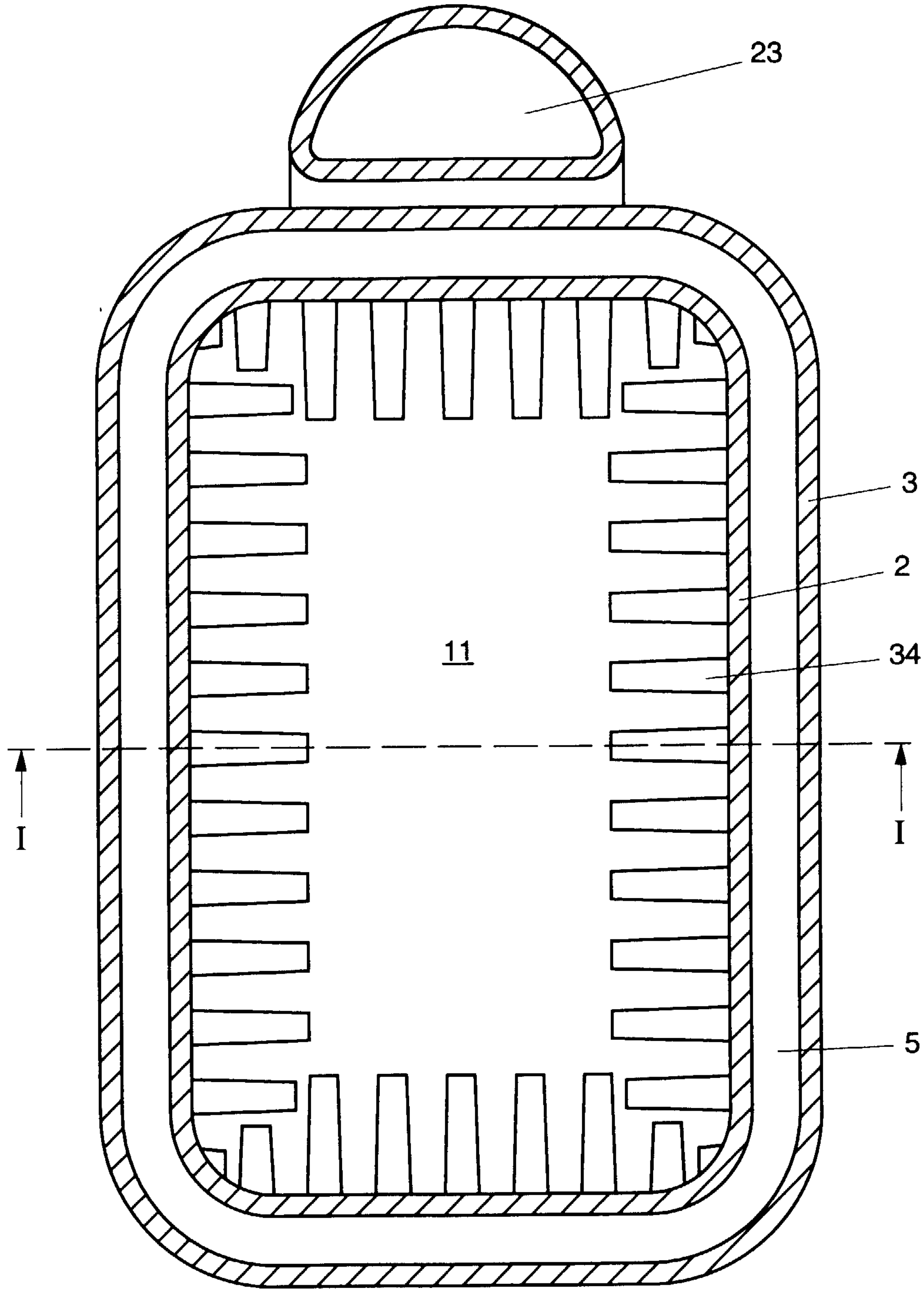

Fig. 3

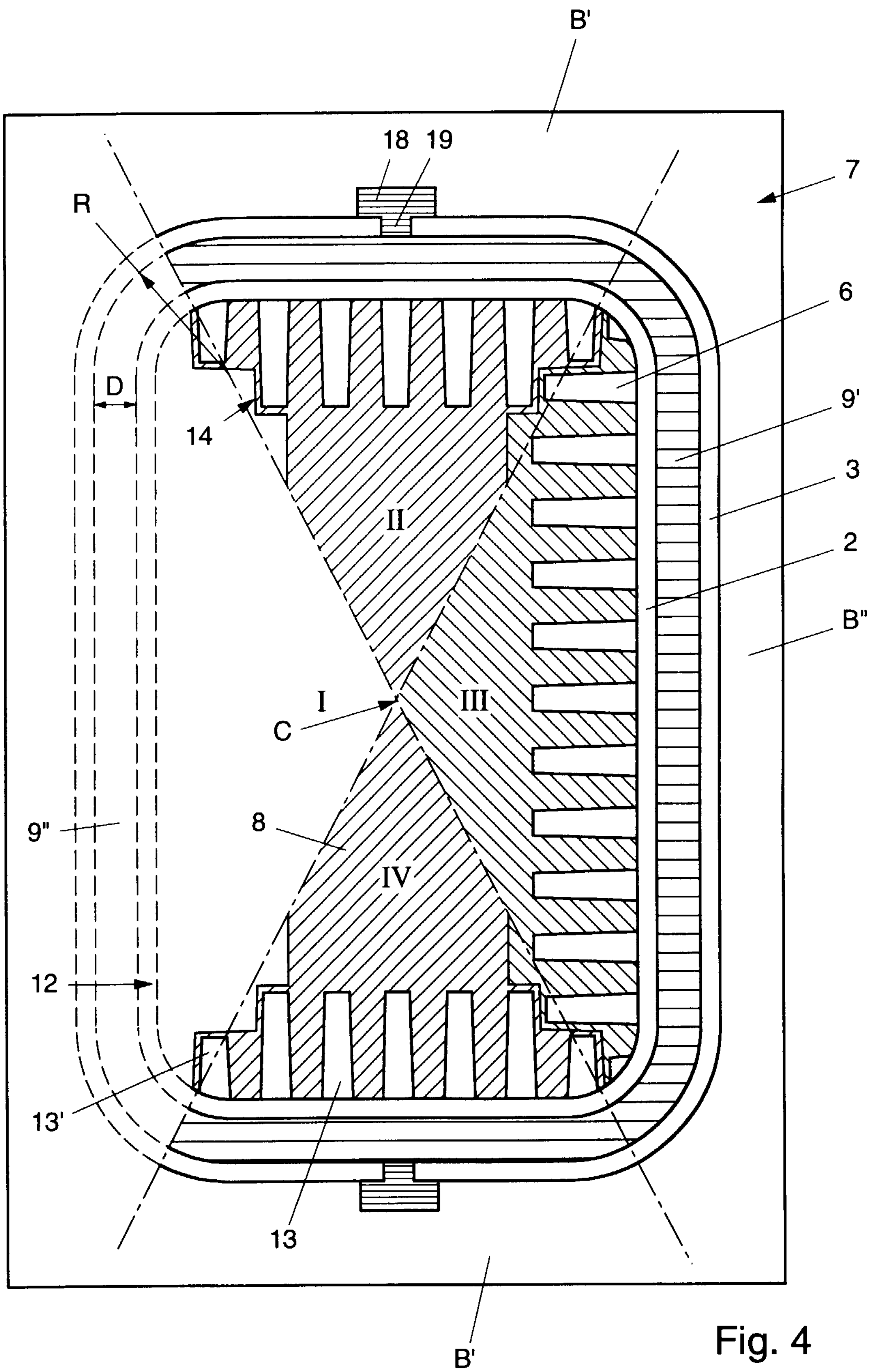

Fig. 4

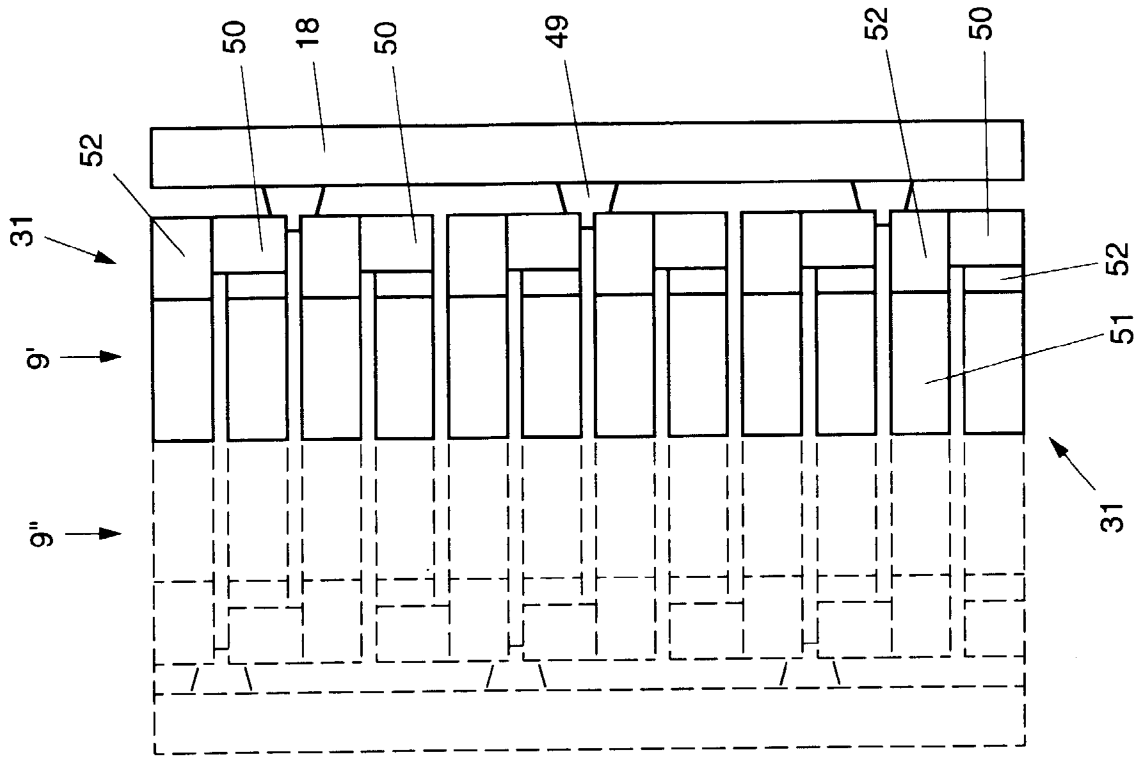

Fig. 5

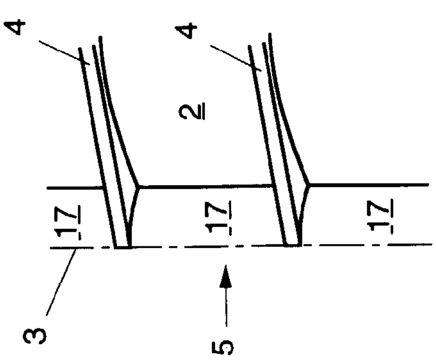

Fig. 5a

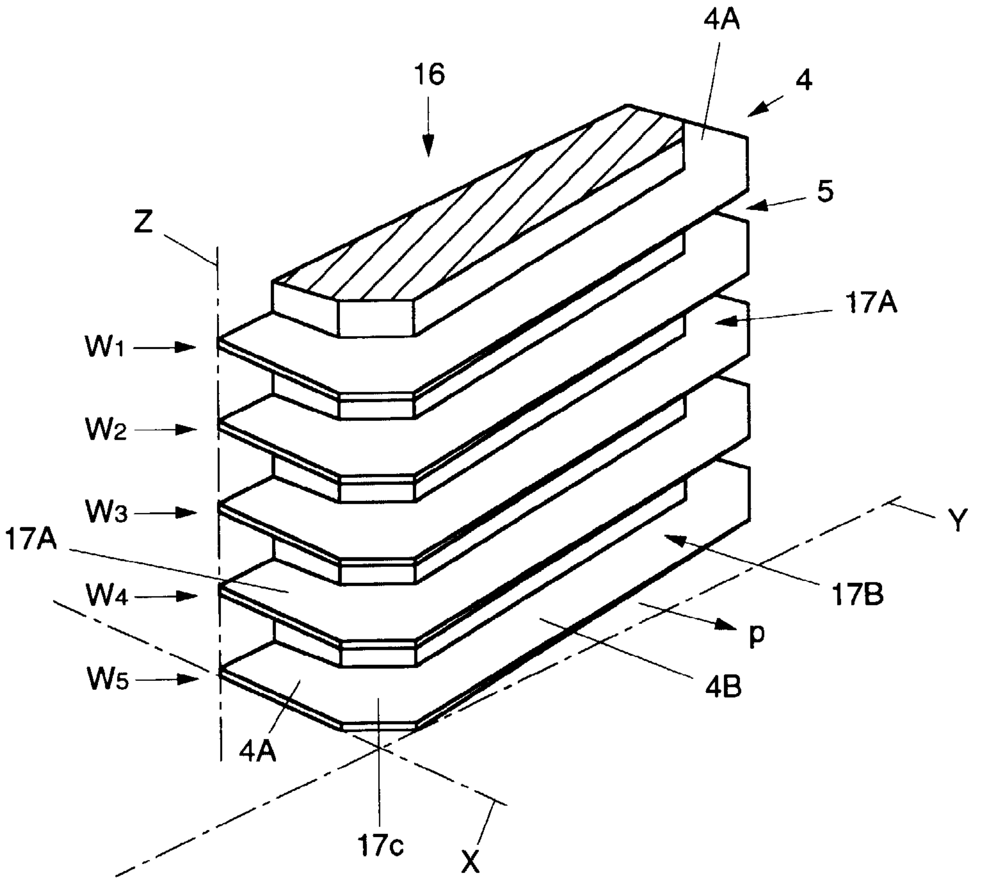

Fig. 5B

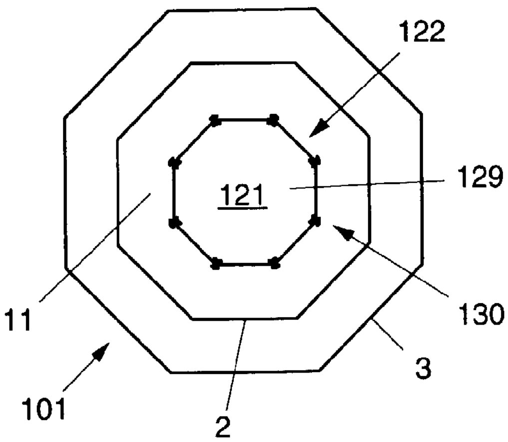

Fig. 7A

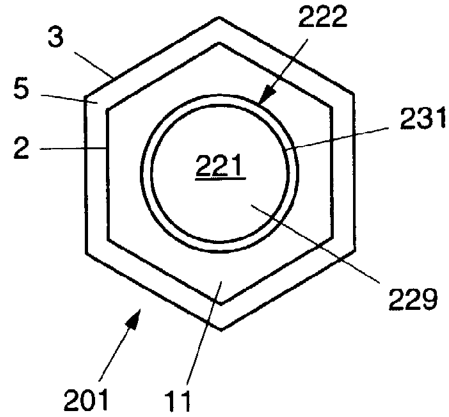

Fig. 7B

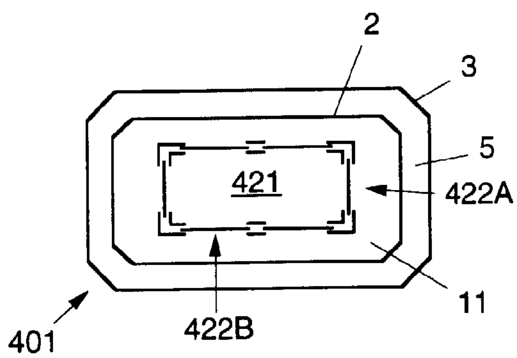

Fig. 7D

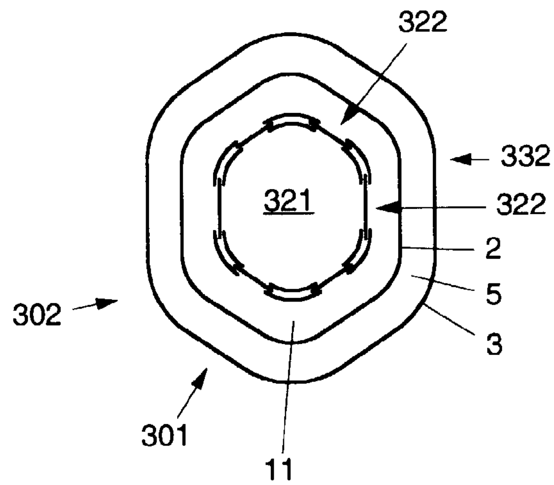

Fig. 7C

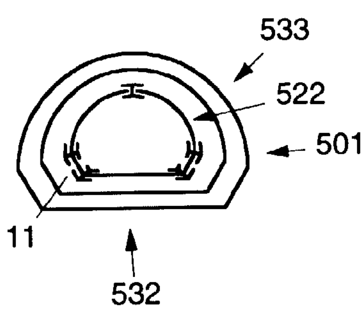

Fig. 7E

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 20 0704

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	FR 695 311 A (GAWA PATENTVERWALTUNGS A.G.) 13 December 1930 * the whole document * ---	1-5	F24H1/26 F24H1/43 F24H9/00
A	FR 854 120 A (PANGAUD) 5 April 1940 * the whole document * ---	1,3-5	
A	EP 0 157 893 A (KREIS TRUMA GERAETEBAU) 16 October 1985 * figures 2-4 * -----	1,7	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
F24H
F28F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	28 May 1997	Van Gestel, H

CATEGORY OF CITED DOCUMENTS

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