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(54) Heat exchanger for a boiler and gas boiler, in particular a condensation boiler, provided with said heat exchanger

(57) A heat exchanger (4) for a gas boiler for producing hot water is provided with a casing (11) through which combustion fumes flow and which extends along an axis (A), and a pipe (12) along which water flows and which is arranged inside the casing (11) and coiled about the axis (A) so as to form a succession of turns (20); the pipe (12) has a cross-section (32) comprising at least one outwardly concave portion (33) and one outwardly convex portion (34) opposite the concave portion (33). Adjacent turns (20) face one another parallel to the axis (A) so that the concave portion (33) of one turn faces the convex portion (34) of the adjacent turn to delimit a channel (41) through which the combustion fumes flow, said channel (41) extending along a curved and/or non-rectilinear axis. Optionally, an outer surface (22) and/or an inner surface (23) of the pipe (12) are longitudinally grooved.

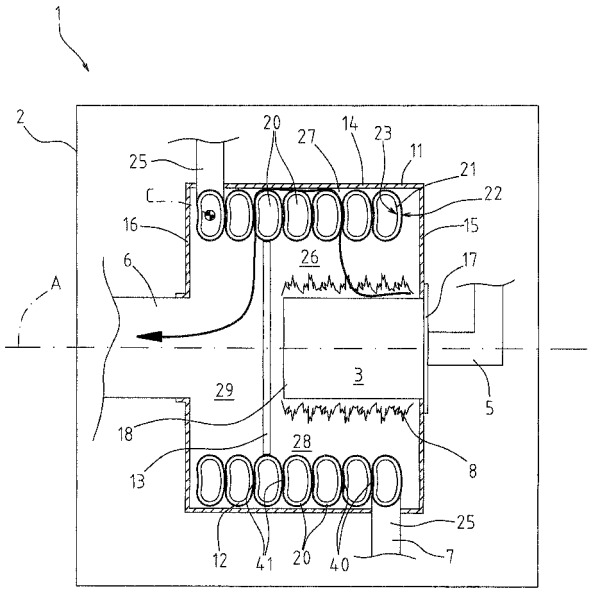

Fig.1

EP 2 012 071 A2

Description

[0001] The present invention relates to a heat exchanger, in particular for a gas boiler used to produce hot water, and to a gas boiler for producing hot water provided with said heat exchanger.

[0002] The invention is particularly suitable for use in condensation boilers, to which reference is made in the following description purely by way of example.

[0003] A gas boiler for producing hot water (for a sanitary water system and/or for a heating system) normally comprises a gas burner and at least one heat exchanger in which the combustion fumes produced by the burner transfer heat to circulating water.

[0004] Condensation boilers condense the steam in the combustion fumes and also transfer the latent heat in the fumes to the water. The exchange of heat between the fumes and the water and the condensation of the fumes can be performed in separate heat exchangers or in a single heat exchanger which provides solely for heat exchange in a first portion and for both heat exchange and fume condensation in a second portion.

[0005] In particular, the condensation boilers of the known type are provided with heat exchangers comprising a casing through which the fumes flow and housing a coiled pipe through which the water flows; the fumes flow between the turns of the pipe, over the outer surface of the pipe and transfer heat to the water flowing along the pipe.

[0006] A known method for improving heat exchange efficiency consists of providing the outer surface of the coiled pipe with various types of fins. However, finned pipes are relatively complex and expensive to produce, and are not entirely satisfactory in terms of heat exchange efficiency.

[0007] Moreover, in the known heat exchangers, the coiled pipe has a cross-section (flow cross-section) that is essentially round or rectangular or, in some cases, a flattened oval or ellipse shape. In any case, the outer surface of the pipe is essentially convex or flat in each point of the pipe. The gap between two successive turns of the pipe, through which the fumes flow, is thus delimited by opposing convex surfaces or essentially parallel flat surfaces. These surfaces essentially delimit a channel through which the fumes flow which extends along an essentially rectilinear axis and may have a centrally throttled cross-section; this geometry causes flows with reduced heat exchange efficiency.

[0008] Moreover, this geometry allows the flame of the burner to directly irradiate the wall of the casing, which is not shielded in a radial direction, further reducing the overall efficiency of heat exchange.

[0009] The purpose of the present invention is to provide a heat exchanger for a gas boiler for producing hot water that overcomes the drawbacks described above in a simple and inexpensive manner, both in terms of functionality and construction.

[0010] In particular, one purpose of the invention is to provide a heat exchanger that is extremely efficient in terms of heat exchange and that is also simple and inexpensive to produce.

[0011] According to the present invention a heat exchanger is produced as set forth in claim 1.

[0012] The invention will now be described in detail in the following non-limiting embodiments, with reference to the accompanying drawings in which:

- figure 1 is a schematic and partially cross-sectional view, with some parts removed for the sake of clarity, of a gas boiler for producing hot water provided with a heat exchanger according to the invention;
- figure 2 is a schematic perspective view of a portion of a pipe used in the heat exchanger of figure 1;
- figure 3 is an enlarged-scale view of a detail of the heat exchanger of figure 1;
- figure 4 is an enlarged-scale view of the detail shown inside a circle in figure 3.

[0013] In figure 1, reference number 1 indicates, as a whole, a gas boiler for producing hot water, in particular a condensation boiler; it is, however, understood that the invention may be applied to other kinds of boilers; the boiler 1 may be used to produce hot water for a sanitary water system and/or to supply a heating system.

[0014] The general structure of the boiler 1 is essentially known and only the essential components thereof are described below; the boiler 1 comprises an outer structure 2, which is of a known type and only schematically illustrated in figure 1, in which are housed a gas burner 3, a heat exchanger 4, a conduit 5 to supply an air/gas mixture to the burner 3, an exhaust pipe 6 for the combustion fumes produced in the burner 3, and a water circuit 7 for the water to be heated, which is only partially illustrated.

[0015] The burner 3 is arranged inside the heat exchanger 4 and generates a flame 8 which burns the air/gas mixture supplied by the supply conduit 5; in the heat exchanger 4, the combustion fumes generated by the burner transfer heat to the water flowing in the circuit 7. The burner 3, of a type that is substantially known, is for example essentially cylindrical and has a cylindrical side wall provided with holes (not illustrated) for emitting the air/gas mixture and feeding the flame 8.

[0016] The heat exchanger 4 is essentially cylindrical in shape and extends along an axis A; the heat exchanger 4 comprises a casing 11 through which the combustion fumes flow, a pipe 12 along which the water in the circuit 7 flows, and a baffle 13 or other equivalent diverting means for directing the combustion fumes along a fixed path, schematically illustrated by the arrow in figure 1, inside the casing 11.

[0017] The casing 11 comprises an essentially cylindrical side wall 14 arranged about the axis A and two walls 15, 16 of opposite ends, essentially parallel to one another and perpendicular to the axis A. The wall 15 supports the supply conduit 5 and the burner 3; the wall 16

supports the exhaust pipe 6. The burner 3 extends centrally inside the casing 11 essentially along the axis A and thus coaxially to the heat exchanger 4 and is provided with one end 17 fitted to the wall 15 and one free end 18, opposite the fitted end 17.

[0018] The pipe 12 is arranged inside the casing 11 and is coiled about the axis A so as to form a succession of adjacent turns 20 arranged so as to be essentially parallel along the axis A in proximity to the side wall 14; the pipe 12 extends along a longitudinal axis C (curved) coiled about the axis A and is provided with a side wall 21, having an outer side surface 22 and an inner side surface 23, and two opposite ends provided with respective fittings 25 for connecting the pipe 12 to the water circuit 7.

[0019] The coiled pipe 12 delimits inside the casing 11 a radially internal zone 26 and a radially external zone 27 arranged coaxially in relation to one another.

[0020] The baffle 13 is arranged so as to be essentially perpendicular to the axis A in the casing 11 and specifically in the zone 26; the baffle 13 faces the free end 18 of the burner 3 and is arranged radially inside the pipe 12; the baffle 13 divides the zone 26 into two chambers 28, 29 aligned along the axis A; the chamber 28, adjacent to the wall 15, houses the burner 3 and also acts as a combustion chamber; the chamber 29, adjacent to the wall 16, is connected to the exhaust pipe 6.

[0021] As shown in detail in figures 2-4, the cross-section 32 of the pipe 12 (perpendicular to the longitudinal axis C of the pipe 12), which is preferably constant, comprises at least one outwardly concave portion 33 and one outwardly convex portion 34 opposite the concave portion 33.

[0022] Each turn 20 thus comprises a concave surface portion 35 and a convex surface portion 36 of the surface 22 of the pipe 12, arranged on opposite sides of a central plane P of the turn 20 essentially perpendicular to the axis A.

[0023] Adjacent turns 20a, 20b, (shown for example in figure 3) face one another parallel to the axis A so that the concave portion 33 of one turn 20a faces the convex portion 34 of the adjacent turn 20b; thus, the concave surface portion 35 of a turn 20a also faces the convex surface portion 36 of the adjacent turn 20b.

[0024] The turns 20 are arranged in succession along the axis A and are axially separated by respective gaps 40 defining essentially radial channels 41 through which the combustion fumes flow between the radially internal zone 26 and the radially external zone 27.

[0025] Each channel 41 delimited by a pair of adjacent turns 20a, 20b extends along a curved and/or non-rectilinear axis and is delimited by the concave surface portion 35 of a turn 20a and by the convex surface portion 36 of the adjacent turn 20b, which are essentially parallel to one another, the concave portion 33 and the convex portion 34 having essentially similar or complementary profiles.

[0026] In the non-limiting example that is illustrated, the cross-section 32 of the pipe 12 is flattened and/or elongated in an essentially radial direction with respect to the axis A and has a major axis X (essentially perpendicular to the axis A) and a minor axis Y (essentially parallel to the axis A). The concave portion 33 of each turn 20 is essentially arranged along the major axis X and the concave portion 33 and the convex portion 34 of each turn 20 are arranged on opposite sides of the major axis X.

[0027] Adjacent turns 20a, 20b are shaped and arranged so that there is essentially no direct radial gap between the radially internal zone 26 and the radially external zone 27, that is so that the pipe 12 provides an almost complete shield against direct irradiation between the zone 26 (which houses the burner 3) and the zone 27 (with the side wall 14 of the casing 11).

[0028] In other words, the turns 20 of the pipe 12 are shaped and arranged so that the coiled pipe 12 completely shields the side wall 14 of the casing 11 against the direct irradiation (schematically illustrated by the arrow in figure 3) by the flame 8 of the burner 3.

[0029] The outer surface 22 of the pipe 12 is longitudinally grooved (on all or part of the surface), being provided with a plurality of longitudinal grooves 42 parallel to one another and to the longitudinal axis C of the pipe 12.

[0030] In particular, at least the facing surface portions 35, 36, which delimit the channels 41, of adjacent turns 20 are provided with grooves 42. Adjacent turns 20 are thus provided with respective facing surface portions 35, 36 provided with respective pluralities of opposing longitudinal grooves 42; the grooves 42 of adjacent turns 20 provided on the facing surface portions 35, 36 protrude radially towards one another and may essentially be aligned with respect to one another, or staggered with respect to one another.

[0031] The grooves 42, for example evenly spaced with respect to one another, may be arranged solely on the facing surface portions 35, 36, and/or on other preferential surface portions of the surface 22, for example surface portions facing the burner 3 and thus facing the axis A, or essentially on the entire surface 22.

[0032] The grooves 42 are separated from one another by respective projecting parts 43 which protrude from the surface 22; each projecting part 43 is essentially perpendicular to the surface 22 and the projecting parts 43 are thus arranged radially or in a crown about the axis A on the surface 22.

[0033] The depth of the grooves 42 is preferably not more than approximately 5 mm.

[0034] Each groove 42 is delimited by a pair of lateral sides 45, essentially parallel to the longitudinal axis C of the pipe 12; in the example that is illustrated, the sides 45 converge towards a rounded base 46 of the groove 42; it is understood that the shape of the grooves 42 may differ from that described herein and illustrated merely by way of example. For example, the sides 45 could be essentially parallel to one another, and could be essen-

tially flat or even curved; the base 46 could be square-cornered, or even essentially flat.

[0035] Basically, the cross-section of the grooves may be essentially triangular with a square-cornered or rounded vertex, essentially trapezoidal, rectangular or generally quadrangular or polygonal, with curved sides and/or square or rounded corners, etc., or a complex shape optimized to generate turbulence suitable to improve heat exchange efficiency.

[0036] Optionally, as illustrated by means of the dashed line and only partially in figure 3, the inner surface 23 of the pipe 12 is also longitudinally grooved (on all or part of the surface), and is in turn provided with a plurality of longitudinal inner grooves 44 parallel to one another and to the longitudinal axis C of the pipe 12, identical in terms of geometry and dimensions to the grooves 42.

[0037] The pipe 12 is preferably made of metal, for example aluminium; preferably, but not necessarily, the pipe 12 is manufactured by means of an extrusion process; in this case, the grooves 42 and/or the grooves 44 are most advantageously produced directly during the pipe 12 extrusion process.

[0038] The boiler 1 provided with the heat exchanger 4 works in essentially the same way as similar boilers.

[0039] The combustion fumes generated by the burner 3 in the chamber 28 flow from the chamber 28 to the radially external zone 27, between the turns 20 of the pipe 12 through the channels 41 in a radially external direction and transfer heat to the water flowing along the pipe 12; the combustion fumes thus flow past the baffle 13 over the side wall 14 of the casing 11, and then flow back between the turns 20 of the pipe 12 in a radially internal direction through the channels 41, complete the transfer of heat to the water in the pipe 12 and then flow into the exhaust pipe 6.

[0040] The advantages of the present invention are clear from the above description.

[0041] Firstly, the heat exchanger 4 achieves high heat exchange efficiency, due to the particular geometry of the cross-section 32; in particular, the channels 41 through which the combustion fumes flow are arranged so as to prolong the time for which the combustion fumes remain in contact with the side wall 21 of the pipe 12, and produce dynamic effects that improve heat exchange. The shielding effect against the direct irradiation by the flame 8 on the side wall 14 of the casing 11 also contributes to increasing the efficiency of the heat exchanger 4.

[0042] Efficiency is further increased due to the presence of the grooves 42 and/or the grooves 44, the function of which is to increase the heat exchange surface and generate surface turbulence.

[0043] The heat exchanger 4 is both simple and inexpensive to produce, particularly since the pipe 12 can be obtained directly by means of an extrusion process, during which the grooves 42, 44 can also be produced.

[0044] Lastly, it is understood that numerous modifications and variations may be made to the heat exchanger and to the gas boiler described and illustrated herein without departing from the scope of the attached claims.

[0045] In particular, it is clear that the shape of the cross-section 32 may differ from that described and illustrated herein purely by way of example, for instance it could be essentially round, oval, essentially quadrangular or polygonal, with rounded edges and/or corners, etc. provided it always has a concave portion 33 and a corresponding convex portion 34.

[0046] The grooves 42, 44 may also differ in shape, for example they could be triangular with square or rounded vertices, or essentially rectangular or polygonal with square-edged or rounded corners, etc. or complex shapes optimized to generate turbulence in order to improve heat exchange efficiency.

Claims

1. Heat exchanger (4) for a gas boiler for producing hot water, comprising a casing (11) through which combustion fumes flow and which extends along an axis (A), and a pipe (12) along which water flows, thr pipe (12) being arranged in the casing (11) and being coiled about the axis (A) in order to form a succession of turns (20); the heat exchanger being **characterized in that** the pipe (12) has a cross-section (32) that comprises at least one outwardly concave portion (33).

2. Heat exchanger according to claim 1, **characterized in that** the cross-section (32) of the pipe (12) also comprises an outwardly convex portion (34) opposite the concave portion (33).

3. Heat exchanger according to claim 2, **characterized in that** the profiles of the convex portion (34) and the concave portion (33) are essentially similar.

4. Heat exchanger according to claim 2 or 3, **characterized in that** adjacent turns (20) face one another parallel to the axis (A) so that the concave portion (33) of one turn faces the convex portion (34) of the adjacent turn.

5. Heat exchanger according to one of the previous claims, **characterized in that** adjacent turns (20) face one another and are axially separated from one another by a gap (40) defining an essentially radial channel (41) through which combustion fumes flow, said channel (41) extending along a curved and/or non-rectilinear axis.

6. Heat exchanger according to claim 5, **characterized in that** the channel (41) delimited by a pair of adjacent turns (20) is delimited by a concave surface portion (35) of a turn and by a convex surface portion (36) of the adjacent turn.

7. Heat exchanger according to one of the previous claims, **characterized in that** the cross-section (32) of the pipe (12) is flattened and/or elongated in an essentially radial direction with respect to the axis (A).

8. Heat exchanger according to one of the previous claims, **characterized in that** the concave portion (33) is arranged essentially along a major axis (X) of the cross-section (32) of the pipe (12).

9. Heat exchanger according to one of the previous claims, **characterized in that** the coiled pipe (12) delimits inside the casing (11) a radially internal zone (26) and a radially external zone (27) arranged coaxially in relation to one another; adjacent turns (20) being shaped and arranged so that there is no direct radial gap between the radially internal zone (26) and the radially external zone (27).

10. Heat exchanger according to one of the previous claims, **characterized in that** the pipe (12) has a longitudinally grooved outer surface (22).

11. Heat exchanger according to claim 10, **characterized in that** adjacent turns (20) are provided with respective facing surface portions (35, 36) which are provided with respective pluralities of opposing longitudinal grooves (42).

12. Heat exchanger according to claim 10 or 11, **characterized in that** the grooves (42) provided on the facing surface portions (35, 36) of adjacent turns (20) protrude radially towards one another and are essentially aligned with respect to one another, or staggered with respect to one another.

13. Heat exchanger according to one of the previous claims, **characterized in that** the pipe (12) has a longitudinally grooved inner surface (23).

14. Gas boiler (1) for producing hot water, in particular a condensation boiler, **characterized in that** it is provided with a heat exchanger (4) according to any one of the previous claims.

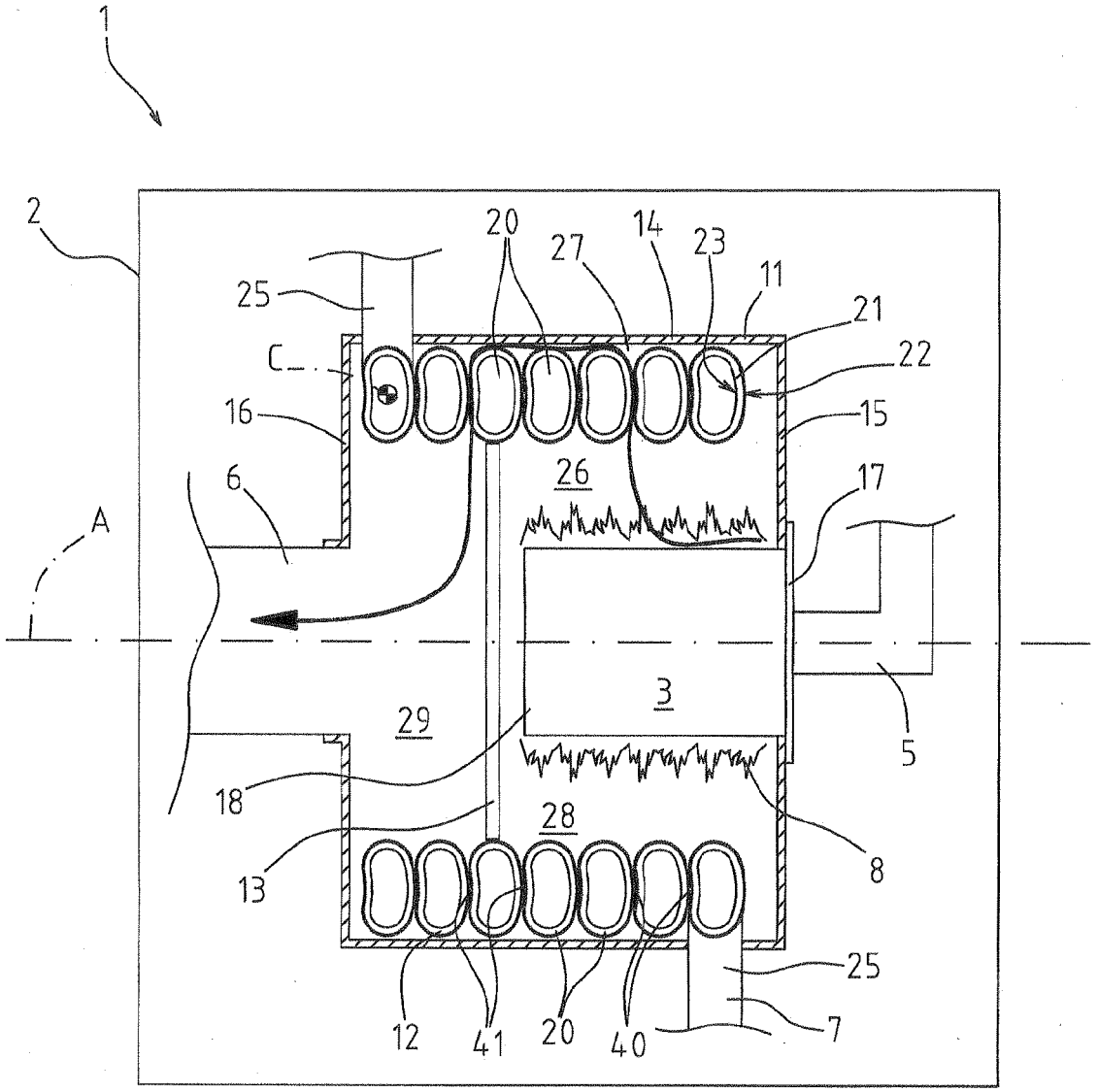
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Fig.1

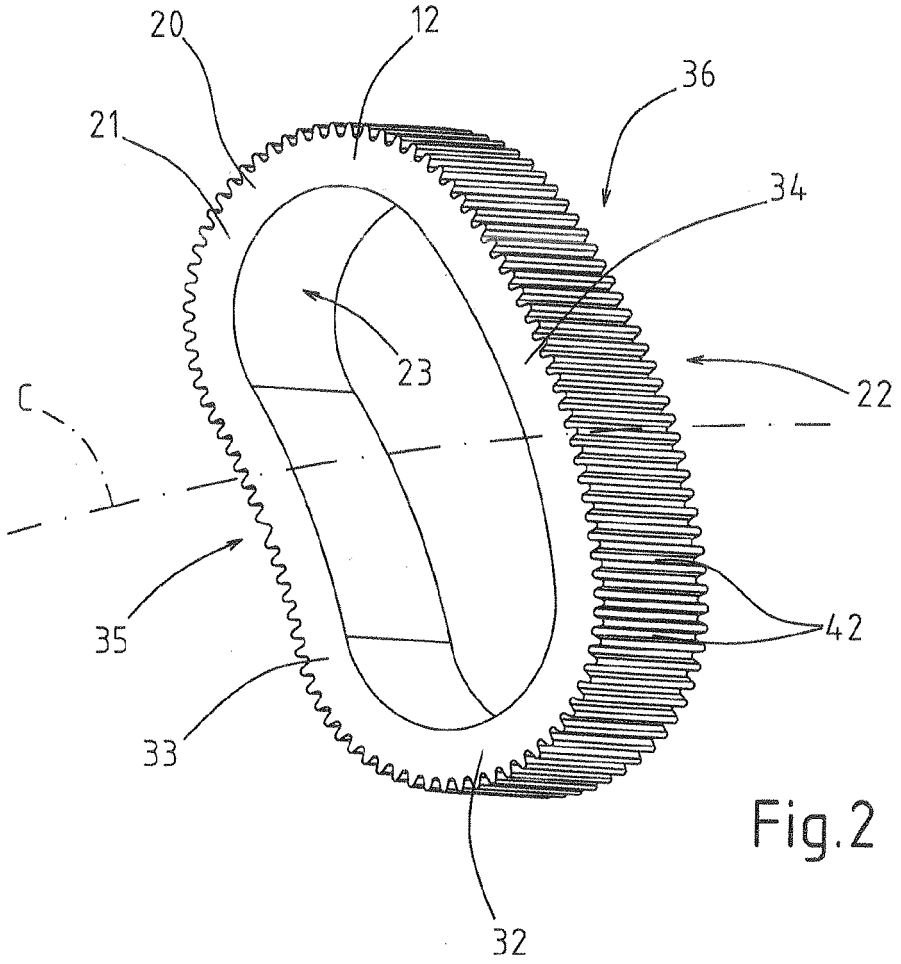

Fig.2

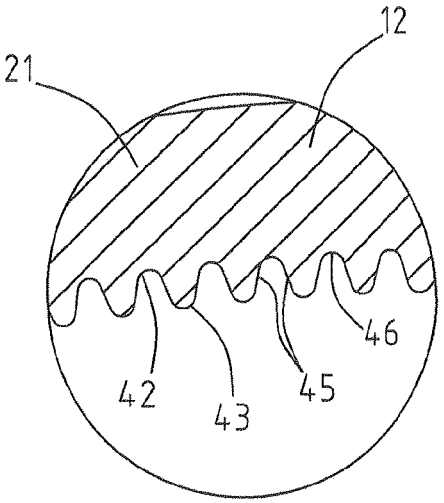

Fig.4

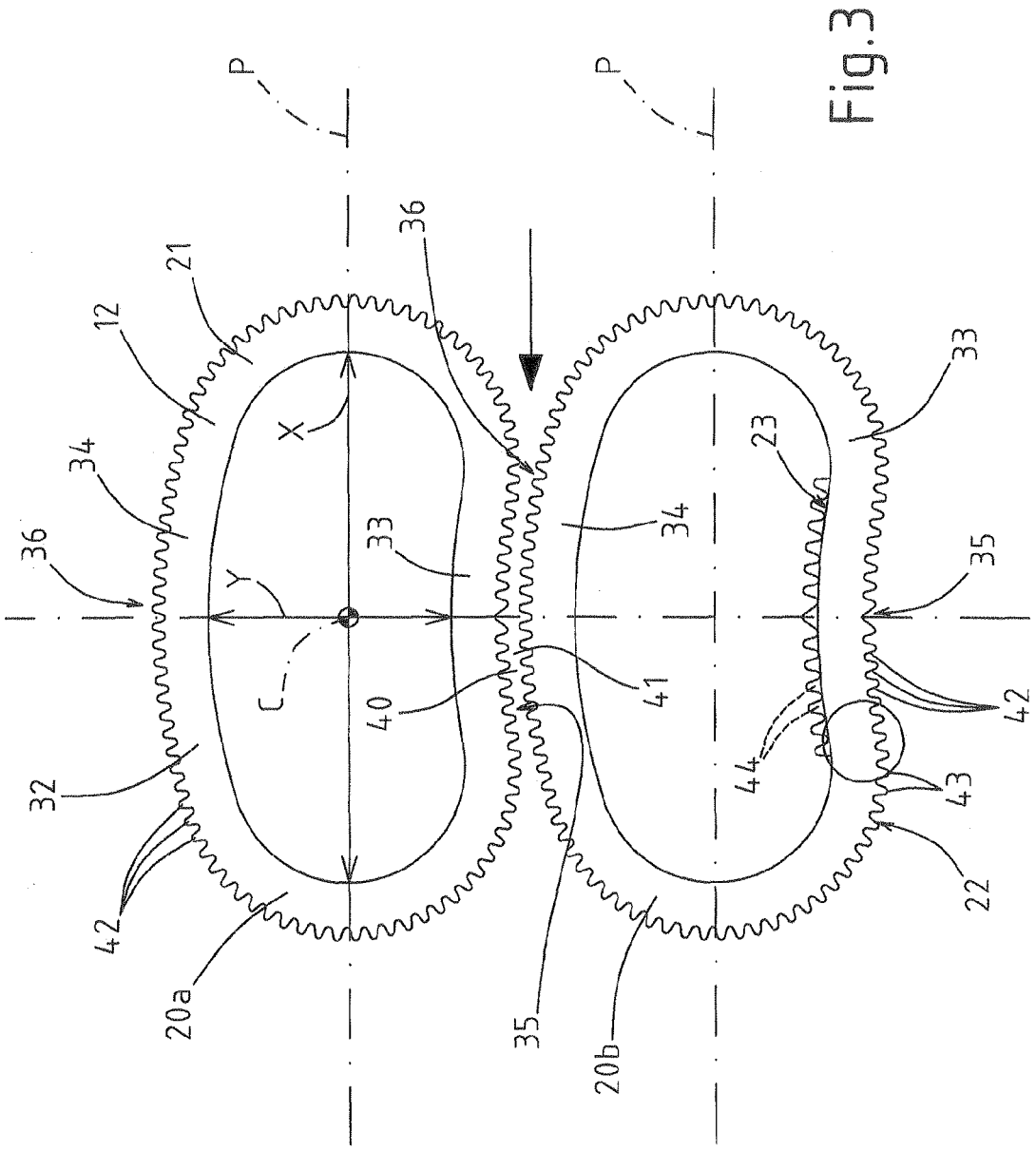

Fig.3