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(54) **MAINTENANCE DEVICE FOR A HEAT EXCHANGER AND METHOD FOR PERFORMING MAINTENANCE ON A HEAT EXCHANGER**

(57) The invention relates to a maintenance device (10) for a heat exchanger (200) comprising a protection cover (20) for covering an access opening (204) of the heat exchanger (200) and support means (30) adapted

to rotatably support the protection cover (20) on the access opening (204) with respect to an axis of rotation (R), wherein the protection cover (20) has an opening (22) for the insertion of a shaft (102) of a cleaning tool (100).

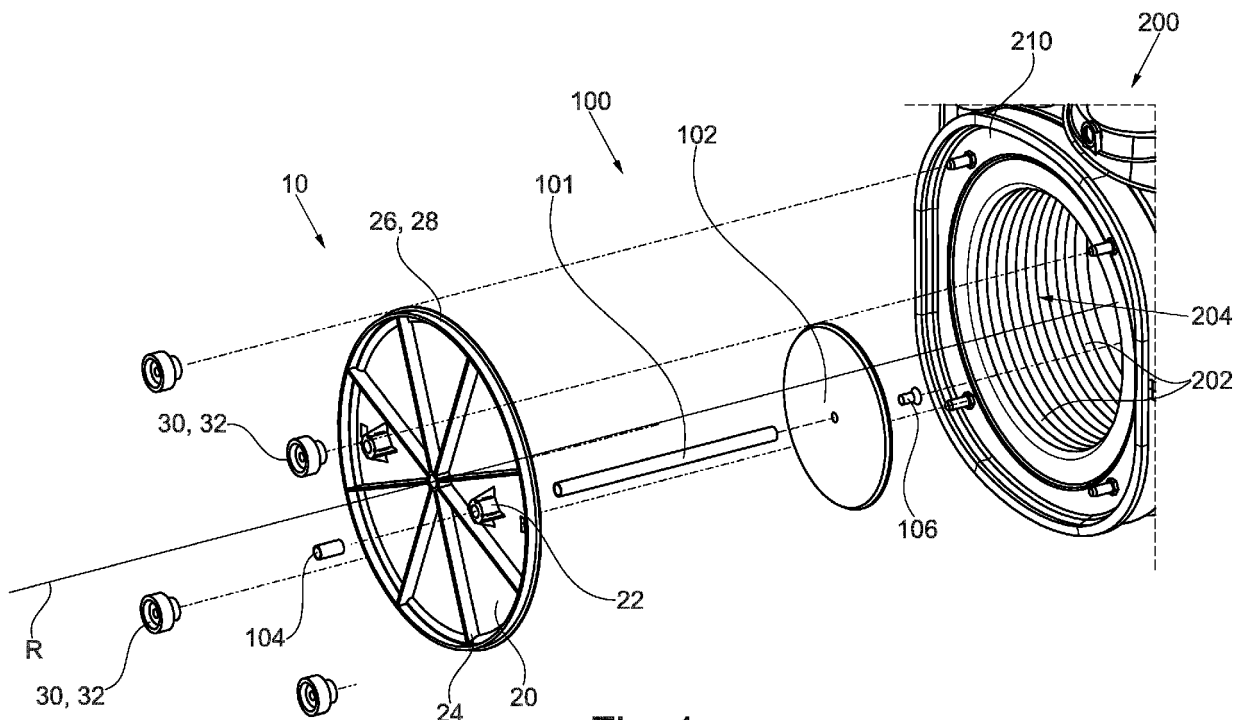


Fig. 1

Description

[0001] The invention relates to a maintenance device for a heat exchanger and to a method for performing maintenance on a heat exchanger.

[0002] Boiler and/or burner configured to combust a combustible gas or a combustible mixture of gases are well established in state of the art, in particular in the field of domestic hot water generation or central heating. The combustible gas or the mixture of gases is typically combusted in a combustion chamber, which is in thermal contact with a heat exchanger for transferring heat to a fluid, in particular water. In typical appliances, the heat exchanger comprises at least one duct for conducting the fluid which is usually arranged in coils around the periphery of the combustion chamber for facilitating the heat transfer.

[0003] During regular use, dust and debris accumulates in the combustion chamber and/or in the heat exchanger which may severely reduce the efficiency of the device over time. In particular, debris on or in between the coils of the heat exchanger may induce additional thermal strain on the fluid containing ducts, which may result in malfunctions.

[0004] It is thus recommended to clean the heat exchanger in regular intervals. This is typically done by removing a door to provide an access opening to the combustion chamber and the interior of the heat exchanger. The heat exchanger, in particular the coils, are usually cleaned by use of regular cleaning tools, like vacuum cleaner, manually or electrically operated brushes and the like.

[0005] It is the technical object of the present invention to facilitate maintenance operations on heat exchanger and, more particularly, to suppress debris and dust from entering the environment during maintenance operations.

[0006] This technical object is achieved by a maintenance device for a heat exchanger in particular having coils at least partially extending around a circumference of a combustion chamber, comprising a protection cover for covering an access opening of the heat exchanger and support means adapted to rotatably support the protection cover on the access opening with respect to an axis of rotation, wherein the protection cover has an opening for the insertion of a shaft of a cleaning tool.

[0007] The above mentioned technical object is also achieved by a method for performing maintenance on a heat exchanger comprising the steps of

providing access to the heat exchanger by means of an access opening;
covering the access opening with the protection cover of the maintenance device;
cleaning the heat exchanger; and
removing the protection cover from the access opening.

[0008] The protection cover may substantially extend over the access opening of the heat exchanger when assembled and thus may prevent dust and debris from entering the environment during the maintenance operations. The protection cover has an opening which may be used for operating a clean tool arranged within the combustion chamber while it is substantially shielded to the outside by the protection cover. For example, the cleaning tool may include a flexible or rigid shaft which extends through the opening of the protection cover during maintenance, so that a force or torque may be exerted on a tool head of the cleaning tool, in particular a brush or the like, to carry out a cleaning operation. The protection cover may prevent dust and debris from entering the environment while it is assembled to the heat exchanger. After cleaning the heat exchanger, the protection cover is typically removed from the access opening and loose debris that accumulated within the heat exchanger during the cleaning process may easily be removed, for example by means of a vacuum cleaner or the like. Performing maintenance operations may thus substantially be facilitated.

[0009] The heat exchanger may for example be in thermal contact or exchange with a burner combusting a fuel gas, in particular a natural gas, methane, ethylene, propane, butane, coal gas, bio gas etc., mixtures of the same, and mixtures of the same additionally comprising hydrogen or hydrogen, in particular pure hydrogen. Pure hydrogen is present if the fuel gas has at least 90 mol%, in particular 98 mol%, of hydrogen.

[0010] In some embodiments, the opening in the protection cover may be arranged off-center relative to the axis of rotation. Since the support means allow for a rotation of the protection cover when assembled for maintenance, the cleaning tool may be moved together with the protection cover over a wide range to reach different locations within the combustion chamber. The off-center arrangement of the opening with respect to the axis of rotation may eliminate the need to remove the protection cover from the access opening and rearrange the protection cover relative to the access opening in order to reach all locations that need cleaning. Since the cleaning tool extending through the opening may at least be moved along a section of a circular arc, this embodiment is particularly adapted to facilitate cleaning of combustion chambers having an approximately cylindrical shape and/or heat exchanger comprising coils for conducting a fluid that essentially circularly wind around an outer periphery of the combustion chamber.

[0011] The protection cover may be rotated at least over an angular range around the rotation axis. Preferably, the support means allows for a rotation of the protection cover over the full angular range of 360° to further facilitate cleaning of the heat exchanger.

[0012] The support means may be adapted to be detachable attached to the heat exchanger, in particular to a housing of the heat exchanger. The support means may have a male or female threaded part adapted to

engage a correspondingly shaped part of the heat exchanger. In other embodiments, the support means include clamps, bolts or the like adapted to positively engage for example a housing part of the heat exchanger to detachable mount the protection cover over the access opening. In particular embodiments, the support means may include a threaded part adapted to engage a correspondingly shaped fastening means that mounts a door to the access opening during regular operation of the heat exchanger or boiler.

[0013] In some embodiments, the protection cover has generally the shape of a disk or a similar rotation body. The support means may in particular be adapted to support a circumferential outer surface of the protection cover to rotatably retain the protection cover in place over the access opening.

[0014] The support means may be adapted to limit an axial displacement of the protection cover with respect to the axis of rotation. The support means may for example have a notch to retain a circumferential outer surface or edge of the protection cover and to hold the protection cover securely in place.

[0015] The support means may be embodied as or include a plurality of nuts or bolts adapted to rotatably support the protection cover on the access opening. For example, the protection cover may be rotatably mounted to the access opening by means of a plurality of nuts that support an outer circumferential edge or surface of the protection cover at several positions. In particular, the nuts may be positioned around the circumference of the protection cover at regular distances or angles. The circumferential surface of the protection cover may preferably move or slid relative to the nuts to provide a rotatable support with respect to the axis of rotation. The nuts may additionally be provided with a knurled outer surface to facilitate manual assembly of the maintenance device to the heat exchanger.

[0016] In an alternative embodiment, the support means include a flange adapted to rotatably support the protection cover on the access opening. The flange may for example be adapted to substantially cover an outer periphery of the access opening and to provide a circumferential support for a generally disc-shaped protection cover that is adapted to substantially cover the central region of the access opening.

[0017] The support means may preferably include a slide bearing for rotatably supporting the protection cover on the access opening. In particular embodiments, the slide bearing may be embodied by the plurality of nuts engaging the outer circumferential surface or edge of the protection cover in a slidable arrangement. In other embodiments the slide bearing may for example be embodied by a flange engaging the outer circumferential surface or edge of the protection cover in a slidable arrangement. Slide bearings provide a cost efficient way to implement a rotatable support for the protection cover and may optionally be provided with a seal.

[0018] The protection cover may in particular include

a labyrinth seal for sealing the access opening during maintenance. Labyrinth seals are particularly preferred in terms of cost efficiency. The labyrinth seal may for example be disposed around the outer surface of the protection cover and/or around the periphery of the flange rotatably supporting the protection cover to further suppress release of dust and debris to the environment when the heat exchanger is cleaned.

[0019] The protection cover may for example include reinforcement webs, in particular reinforcement webs that extend over a section of the protection cover in a radial direction. The reinforcement webs may improve the mechanical stability of the maintenance device and increase its lifetime.

[0020] The protection cover may for example be made from a plastic or polymer. In some embodiments, the protection cover is made from a transparent material, in particular from a transparent polymer. A transparent protection cover is preferred, since it does not block the view of the person operating the cleaning tool during maintenance on the heat exchanger.

[0021] Cleaning the heat exchanger may in particular include operating a cleaning tool having a brush disposed on a rotating shaft that is retained within the opening of the protection cover. In an aspect of the method, cleaning the heat exchanger may include moving the cleaning tool and the protection cover over an angular range around the axis of rotation while the shaft is retained within the opening of the protection cover. In typical applications of the method, cleaning the heat exchanger may include moving the cleaning tool and the protection cover repeatedly over the full angular range of 360° around the axis of rotation while the shaft is retained within the opening of the protection cover.

[0022] The shaft of a cleaning tool may in particular be loosely or at least rotatably supported within the opening of the protection cover. Preferably, the opening is sized to allow for an axial displacement of the shaft relative to the protection cover. The shaft preferably carries a rotary or rotating brush at its end that may for example be configured to clean the coils of the heat exchanger. In order to reduce strain imposed on the coils during maintenance, the bristles of the brush may be made from a relative soft material, like a polymer or, more particularly, nylon or polyamid. In some embodiments, the cleaning tool may be adapted to be manually rotated around the shaft to clean the interior of the heat exchanger. Preferably, the shaft is adapted to be engaged by an electrical tool, in particular an electrical screw driver or drill. Use of an electrical, in particular cordless electrical tool, convenient when cleaning the spaces in between the coils of the heat exchanger.

[0023] Preferably, the rotary or rotating brush is particularly sized and shaped to facilitate cleaning of heat exchanger having coils that are arranged around the periphery of the combustion chamber. In some embodiments, the brush extends over an axial section of the shaft that is of the size or smaller than an average axial

distance between neighboring coils of the heat exchanger. In other words, the axial dimension of the brush is adapted to facilitate penetration of the brush bristles in the space between the coils.

[0024] The brush typically extends in a radial direction from the shaft. In some embodiments, the radial dimension of the brush is sized to facilitate cleaning of the interior of the heat exchanger while the rotating shaft of the cleaning tool is substantially orientated in a direction perpendicular to the protection cover. Preferably, the radial dimension of the brush is larger than the radial distance of the opening in the protection cover to the coils of the heat exchanger. In this way, the orientation of shaft does not necessarily have to be substantially changed when cleaning the heat exchanger, which also facilitates the use of an electrical tool.

[0025] In the figures, the subject-matter of the invention is schematically shown, wherein identical or similarly acting elements are usually provided with the same reference signs.

FIG. 1 illustrates an exemplary embodiment of a maintenance device in an exploded view;

FIG. 2 shows the embodiment of FIG. 1 when assembled to a heat exchanger for maintenance in a perspective view;

FIG. 3 illustrates another exemplary embodiment of a maintenance device in a perspective view.

[0026] Figure 1 shows components or parts of a maintenance device 10 in an exploded view. Figure 1 also shows components of a heater exchanger 200, in particular of a boiler for domestic hot water generation or central heating, that are typically accessed during maintenance inspection via an access opening 204. The access opening 204 provides in particular access to the combustion chamber and to fluid conducting coils 202 of the heat exchanger 200.

[0027] The maintenance device 10 of the illustrated embodiment is adapted to be detachable attached to the heat exchanger 200 at least when the interior combustion chamber is cleaned during maintenance. Figure 2 shows a perspective view of the maintenance device 10 assembled to the heat exchanger 200.

[0028] The maintenance device 10 comprises a protection cover 20 made from a transparent material, in particular a polymer. The protection cover 20 is adapted and sized to completely cover the access opening 204 so as to prevent debris and dust from entering the environment when the heat exchanger 200, in particular its fluid conducting ducts and coils 202, are cleaned.

[0029] The protection cover 20 has an opening 22 adapted and sized retain a shaft 101 of a cleaning tool 100 during maintenance inspection. A rotary or rotating brush 102 is fixed to the end of the shaft 100 by means of a screw 106. The cleaning tool 100 is adapted be ro-

tated around the shaft 100 in order to clean in particular the coils 202 of the heat exchanger and the spaces in between the coils 202. For convenience, the shaft 100 and the brush 102 is usually rotated by means of an electric tool, in particular an electric drill or screwdriver. The shaft 101 may in particular include a section that is adapted to be engaged by the electric tool. A stopper 104 is disposed on the shaft 101 to limit an axial displacement of the shaft 104 during use.

[0030] The protection cover 20 has essentially the shape of a disc and further includes a plurality of ribs 24 for increased mechanical stability. The ribs 24 extend radially from the center to an outer circumferential surface 26 of the protection cover 20. The outer circumferential surface 26 of the protection cover 20 is adapted to abut on a housing part 210 of a heat exchanger 200 during maintenance operations and includes one or more circumferential projections that embody a labyrinth seal 28 for sealing off the interior of the heat exchanger 200. The labyrinth seal 28 is adapted to abut on a circumferential housing part forming the periphery of the access opening 204 when the protection cover 20 is assembled to the heat exchanger 200.

[0031] The protection cover 20 is configured to be detachable attached to the heat exchanger 200 by the aid of support means 30. The support means 30 are adapted to allow for a rotational movement of the protection cover 20 relative to the heat exchanger 200 when the protection cover 20 is attached thereto. The support means 30 of the illustrated embodiment include four knurled nuts 32 that are disposed at regular intervals around the outer circumferential surface 26 of the protection cover 20. The nuts 32 engage the outer circumferential surface 26 of the protection cover 20 so as to provide a rotational support for the protection cover 20 on the access opening 202 in the assembled state that is in particular illustrated in Figure 2. In other words, the nuts 32 prove a slide bearing 36 for the protection cover 20 that allows for a rotation of the protection cover 20 over the access opening 204. The nuts 32 are additionally provided with shoulders that abut on the outer circumferential surface 26 to limit an axial displacement of the protection cover 20 with respect to the heat exchanger 200 in the assembled state.

[0032] When assembled, the protection cover 20 may be rotated relative to the heat exchanger 200 around an axis of rotation R over an arbitrary angular range. The opening 22 is arranged off center and at a distance to the axis of rotation R. The rotatable support of the protection cover 20 provided by the support means 30 allows for guiding the brush 102 around an inner circumference of the substantially cylindrical combustion chamber. Preferably, the brush 102 has a radial dimension extending in a direction perpendicular to the shaft 101 that is larger than the radial distance of the opening 22 to the coils 202 of the heat exchanger 200 so that bristles of the brush 102 can easily engage the surfaces of the heat exchanger 200 that are in need of cleaning. The brush 102 also has

an axial dimension that is sized to project into the inter-spaces between the coils 202 that are typically crucial to clean. Preferably, the brush 102 extends over an axial section of the shaft 101 that is of the size or smaller than an average axial distance or the gaps between neighboring coils 202 or spirals of the heat exchanger 200.

[0033] Preferably, the bristles of the brush 102 have a diameter less than a few millimeter (mm), in particular between 0,3 mm and 0,9 mm. The brush 102 and the method for performing maintenance described herein may be specifically adapted to clean heat exchanger 200 having fluid conducting coils or spirals made from stainless steel.

[0034] Figure 3 shows another embodiment of the maintenance device 10 in a perspective view. The embodiment illustrated in Figure 3 provides the same or similar technical benefits as described herein before with respect to the first embodiment illustrated in Figs. 1 and 2.

[0035] The maintenance device 10 of Fig. 3 comprises support means 30 that include a flange 34 for rotatably supporting the protection cover 20 with respect to the axis of rotation R. The flange 34 is adapted to abut on the periphery of the access opening 204 of the heat exchanger 200 when assembled thereto. For example, the flange 34 may be detachably attached to the housing of the heat exchanger 200 by means of conventional fastening means, like, for example screws or bolts.

[0036] The flange 34 comprises a slide bearing 36 that rotatably supports the disc-shaped protection cover 20. The slide bearing 36 includes a labyrinth seal 28 for sealing off the covered space. The protection cover 20 of the illustrated embodiment is sized to cover a central part of the access opening 204, whereas the flange 34 is sized to cover a circumferential part around the periphery of the access opening 204.

[0037] Performing maintenance on a heat exchanger 200 with the aid of a maintenance device 10 typically involves the steps of providing access to the heat exchanger 200 by means of establishing an access opening 204, usually by removing a door confining the combustion chamber of a burner during regular use, covering the access opening 204 with the protection cover 20, cleaning the heat exchanger 200, in particular with the aid of the cleaning tool 100 of the maintenance device 10, and subsequently removing the protection cover 20 from the access opening 204.

[0038] Optionally, the condition of the door and/or the heat exchanger 200 may be checked prior to cleaning. Moreover, it may be necessary to clean the inside of the heat exchanger 200 before covering the access opening 204 with the aid of a vacuum cleaner or the like.

[0039] Preferably, a cardboard cover is inserted in the combustion chamber prior to attaching the maintenance device 10 to the heat exchanger 200. This may help to protect in particular an insulation panel that is typically located in the back of the heat exchanger 200 or combustion chamber.

[0040] After mounting the cleaning tool 100 to the pro-

tection cover 20 such that the shaft 101 projects through the opening 22, the protection cover 30 is arranged over the access opening 204 and fixed in position. Preferably, a cordless electrical tool is used to rotate the brush 102 for cleaning the heat exchanger 200. Typically, cleaning the heat exchanger 200 involves rotating the cleaning tool 100 repeatedly over the full angular range around the axis of rotation R. In particular, it may be advisable to rotate the cleaning tool 100 over the full angular range around the axis of rotation R to clean the space between two adjacent coils 202 of the heat exchanger 200. After a full rotation, the next coil 202 is cleaned, which typically involves an axial displacement of the cleaning tool 100 with respect to the protection cover 20 that is attached to the heat exchanger 200. This process is preferably repeated, until all coils 202 of the heat exchanger 200 are sufficiently clean.

Reference Signs

[0041]

10	maintenance device
20	protection cover
22	opening
24	rib
26	circumferential surface
28	labyrinth seal
R	axis of rotation
30	support means
32	nut
34	flange
36	slide bearing
100	cleaning tool
101	shaft
102	brush
104	stopper
106	screw
200	heat exchanger
202	coil
204	access opening
210	housing

Claims

1. A maintenance device (10) for a heat exchanger (200) in particular having coils (202) at least partially extending around a circumference of a combustion chamber, comprising a protection cover (20) for covering an access opening (204) of the heat exchanger (200) and support means (30) adapted to rotatably support the protection cover (20) on the access opening (204) with respect to an axis of rotation (R), wherein the protection cover (20) has an opening (22) for the insertion of a shaft (102) of a cleaning tool (100).

2. Maintenance device (10) according to claim 1, **characterized in that** the opening (22) in the protection cover (20) is arranged off-center relative to the axis of rotation (R).
3. Maintenance device (10) according to claim 1 or 2, **characterized in that** the support means (30) are adapted to be detachable attached to the heat exchanger (200), in particular to a housing (210) of the heat exchanger.
4. Maintenance device according to one of the claims 1 to 3, **characterized in that** the support means (30) are adapted to support an outer circumferential surface (26) of the protection cover (20).
5. Maintenance device according to one of the claim 1 to 4, **characterized in that** the support means (30) are adapted to limit an axial displacement of the protection cover (20) with respect to the axis of rotation (R).
6. Maintenance device according to one of the claims 1 to 5, **characterized in that** the support means (30) include a plurality of nuts (32) or bolts adapted to rotatably support the protection cover (30) on the access opening (204).
7. Maintenance device according to one of the claims 1 to 5, **characterized in that** support means (30) include a flange (34) adapted to rotatably support the protection cover (30) on the access opening (202).
8. Maintenance device according to one of the claims 1 to 7, **characterized in that** the support means (30) include a slide bearing (36) for rotatably supporting the protection cover (20) on the access opening (202).
9. Maintenance device according to one of the claims 1 to 8, **characterized in that** the protection cover (20) includes a labyrinth seal (28) for sealing the access opening (204) during maintenance.
10. Maintenance device according to one of the claims 1 to 9, **characterized in that** the protection cover (20) includes reinforcement webs (24), in particular reinforcement webs (24) that extend over a section of the protection cover (20) in a radial direction.
11. Maintenance device according to one of the claims 1 to 10, **characterized in that** the protection cover (20) is made from a transparent material, in particular from a transparent polymer.
12. Maintenance device according to one of the claims 1 to 11, **characterized in that** the shaft (101) of the cleaning tool (100) is loosely or at least rotatably supported within the opening (22) of the protection cover (20).
13. A method for performing maintenance on a heat exchanger (200) comprising the steps of
 - providing access to the heat exchanger (200) by means of an access opening (204);
 - covering the access opening (204) with a protection cover (20) of a maintenance device of one of the previous claims 1 to 12;
 - cleaning the heat exchanger (200); and
 - removing the protection cover (20) from the access opening (204).
14. Method according to claim 13, **characterized in that** cleaning the heat exchanger (200) includes operating a cleaning tool having a brush (102) disposed on rotating shaft (101) that is retained within the opening (22) of the protection cover (20).
15. Method according to claim 14, **characterized in that** cleaning the heat exchanger (200) includes cleaning coils (20) of the heat exchanger and rotating the brush (102) around the shaft (101), wherein the brush (102) has
 - a. extends over an axial section of the shaft that is of the size or smaller than an average axial distance between neighboring coils (202) of the heat exchanger (200) and/or
 - b. has a radial dimension that is larger than the radial distance of the opening (32) in the protection cover (30) to the coils (202) of the heat exchanger (200).

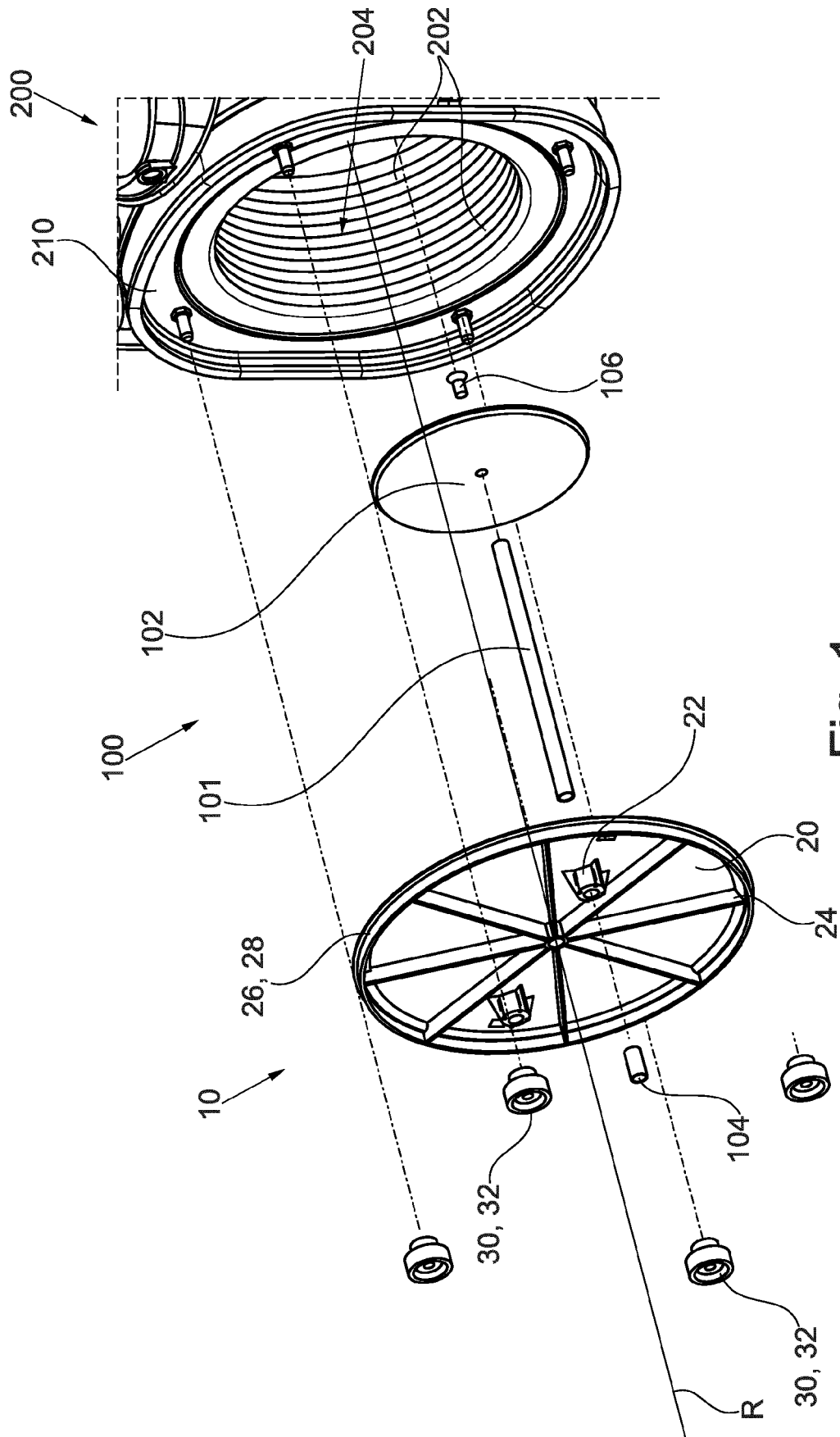


Fig. 1

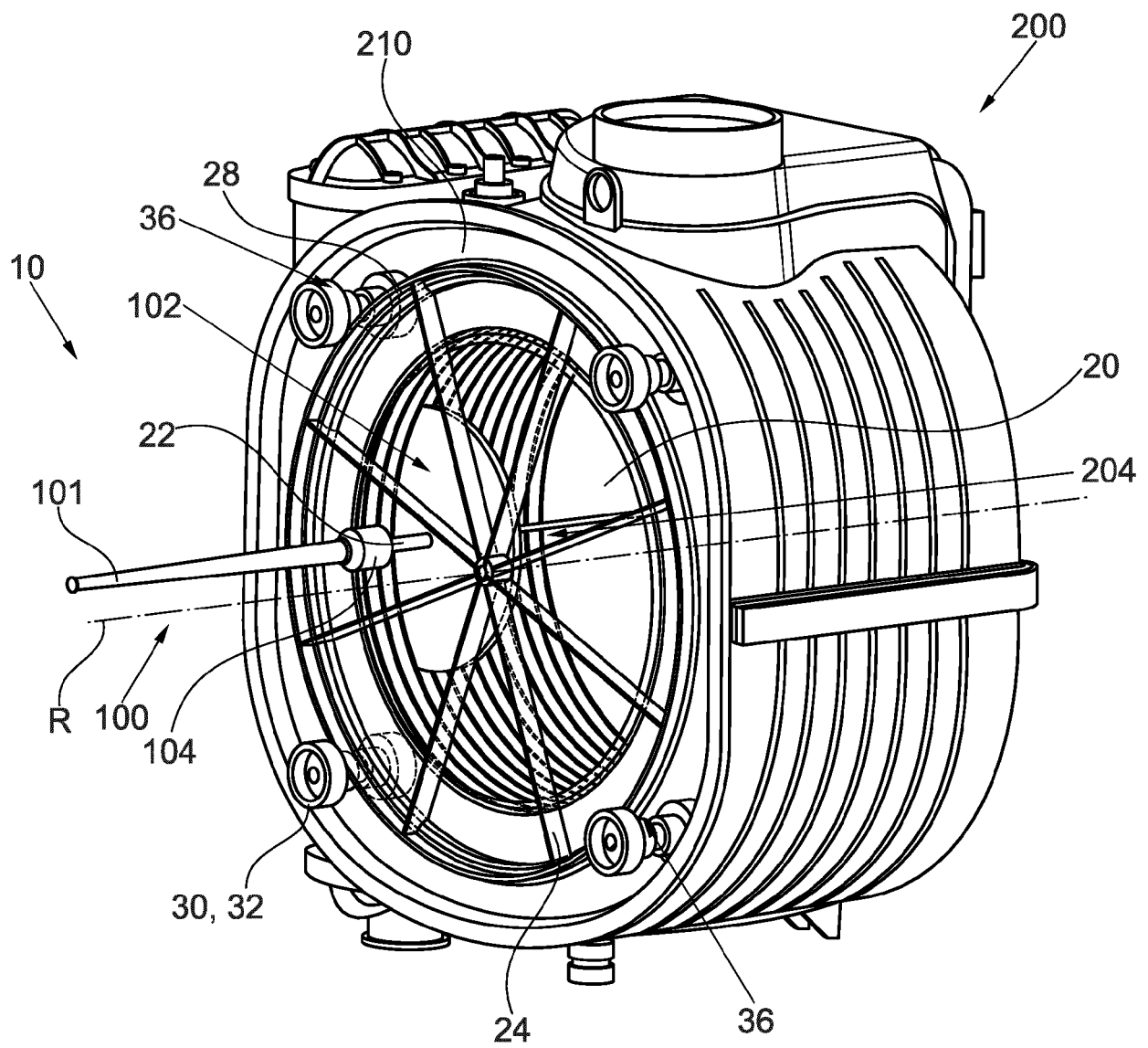


Fig. 2

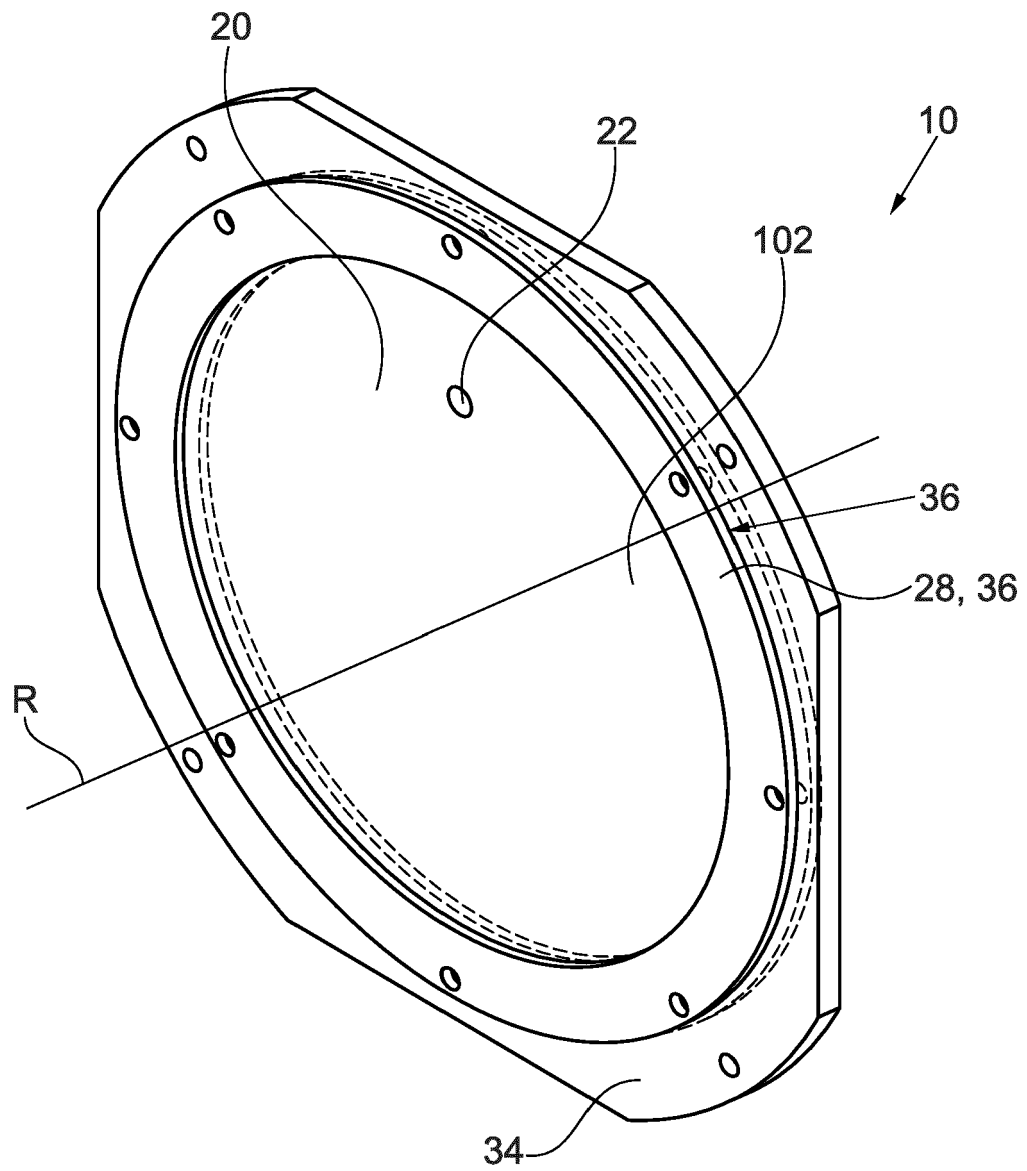


Fig. 3



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**ANNEX TO THE EUROPEAN SEARCH REPORT
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