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(54) A heating boiler with flue-gas recirculation and a combustion chamber unit for such boilers.

(57) A heating boiler (10) which operates with flue-gas recirculation, said boiler comprising a water magazine (11) which is defined by an outer shell (12) and an inner shell (13) of circular cross-section, and two outer walls (25, 27) and a cylindrical combustion chamber (20) mounted inwardly of the water magazine (11) and comprising a plurality of surrounding flue-gas channels (17) which are mutually divided by longitudinally extending flanges (15) or the like disposed around the periphery of the circular inner shell (13) of the water magazine. The combustion chamber (20) is defined by a cylindrical pipe (16), a first combustion-chamber wall (18) which is connected to one end of said pipe and which is provided with a burner-accommodating opening, and a second combustion-chamber wall (19) connected to the other end of the pipe (16). The cylindrical pipe (16) is provided with a saddle-shaped outlet (22) which is located in the vicinity of said second wall (19) and which extends at most around half the circumference of the pipe (16). The outlet (22) has communication with a first group of flue-gas channels (17a) which include those flue gas channels that are located in the near vicinity of said half circumference and which, in turn, are connected solely to a flue-gas turning chamber (14) on the burner side delimited by the outer wall (25) and the first combustion-chamber wall (18). The flue-gas turning chamber (14) is connected with the combustion chamber (20) by means of a gap (23) located in the vicinity of the burner-accommodating opening, and is also connected to a second group of flue-gas channels (17b) including the remainder of the flue gas channels, which are connected to a flue-gas pipe (28) which extends through the other outer wall (27), the pipe (28) communicating with the surroundings.

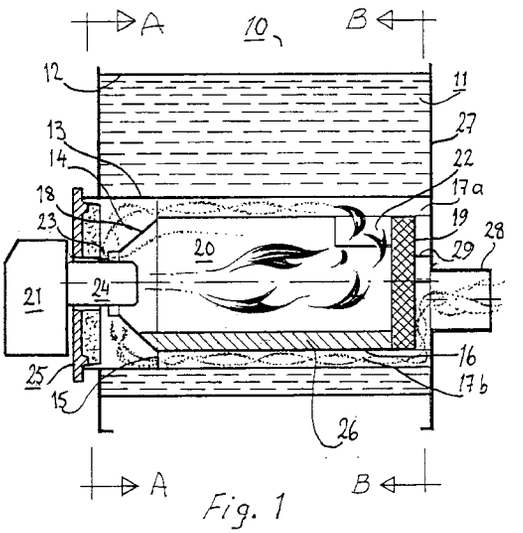

Fig. 1

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The present invention relates to a heating boiler with flue-gas recirculation according to the preamble of Claim 1, and also to a combustion chamber unit for one such boiler.

A heating boiler which includes a water storage facility or magazine that is surrounded by a cylindrical combustion chamber is described in our European Patent Specification EP 0166703. This boiler is a so-called low temperature boiler with which the thermal energy of the flue gases is used effectively by dividing the flue-gas channels, which are located between the water magazine and the combustion chamber, into four groups so that flue gases arriving from the combustion chamber on the burner side are led to the lower group of channels and from there to side channels by means of a flue-gas turning chamber on the opposite side of the burner side, and are then led from the side channels to the upper group of channels by means of a second flue-gas turning chamber on the burner side, this upper group of channels leading the flue gases to a flue-gas exhaust pipe.

For environmental reasons, strict requirements are placed on the nitrogen oxide content (NO_x) of the flue gases and, accordingly, strenuous efforts have been made in recent times to further reduce the NO_x contents of gases generated in low temperature boilers of the kind defined in the introduction. One known solution in this regard involves recirculating part of the flue gases to the combustion chamber to a location in the vicinity of the burner, so that the gases generated in the combustion chamber are dilute with the flue gases and therewith dampen the process of combustion and also contribute towards maintaining the fuel combustion temperature at a level which can be kept sufficiently low to counteract the formation of NO_x. Heating boilers in which flue gases are recirculated to dilute added reactants are described in DE-A1-3601000, DE-A1-3628293, DE-C1-3738623 and EP-A-0288031, for instance. When seen against the background of the ever increasing strict demands placed on the emission of harmful substances, the dilution of added reactants by recycling the flue gases of such boilers is not sufficient to lower the nitrogen oxide content of the gases.

Consequently, it has been proposed to first cool the flue gases and then recirculate the gases to the combustion chamber. In this case, the recirculated gases have both a diluting and a cooling effect on the process of combustion, therewith further reducing the nitrogen oxide content of the gases in comparison with heating boilers in which the flue gases are only recycled and not cooled. DE-A-4 035 262 describes a boiler of this kind which has a through-penetrating gap for removing flue gases from the combustion chamber. These gases are passed towards the burner side, from where part of the flue gas is recycled back to the combustion chamber and part of the flue gas is taken out through four separate connecting conduits to a smoke stack. This results in a relatively complicated construction. Another such boiler, called the Heimax boiler, is described in DE-A-3905762 in which the volume of flue gases cooled and recycled can be adapted to the type of fuel concerned and also to other factors which influence the combustion process, by varying the size of the gap through which the cooled flue gases are recycled. This type of heating boiler fulfils all current requirements concerning low NO_x emissions and thus represents an effective solution to this problem. However, one drawback with this type of heating boiler is that, similar to the boiler described in DE-A-4 035 262, it is of relatively complicated construction and is therewith more expensive than other commercially available boilers which are less attractive from the aspect of NO_x emissions. The construction of the Heimax boiler is also made complicated by the requirement of additional channels for rearward outlet of the flue gases.

Thus, there is a need for a heating boiler with which the flue gases have a sufficiently low NO_x content but which can be found more attractive to those who would otherwise choose a less expensive but environmentally inferior heating boiler, for instance of the kind described above. There is also a need to be able to modify existing standard boilers, for instance boilers in which a water magazine surrounds a cylindrical combustion chamber and of which large numbers are to be found in many countries, so as to enable these boilers to be used while conforming to the stricter requirements concerning NO_x emissions.

The object of the present invention is to provide a heating boiler which will satisfy the aforesaid needs and demands, and also to provide a boiler combustion chamber unit by means of which a heating boiler comprising a water magazine that surrounds the combustion chamber can be modified in the manner indicated above.

These objects are achieved with a heating boiler having the features set forth in Claims 1-5, and with a combustion chamber unit which can be fitted to such a boiler and which has the features set forth in Claims 6-10.

The invention thus relates to a heating boiler which operates with flue-gas recirculation, said boiler comprising a water magazine which is surrounded by an outer and an inner circular shell. The outer mantle normally has an oval shape, but may also be circular or even rectangular in shape. The boiler has two outer walls and a cylindrical combustion chamber which is located inwardly of the inner shell and the outer walls. The combustion chamber includes a plurality of surrounding flue-gas channels or passageways which are mutually divided by longitudinally extending flanges, fins or the like, for instance U-shaped profiles, arranged around the periphery of the circular inner shell of the water magazine. The combustion chamber is defined by a cylindrical pipe, a wall at one

end of the pipe, said wall being provided with a burner-accommodating opening, and an imperforate second wall on the other end of the pipe. The cylindrical pipe is provided with a saddle-shaped aperture which is located in the vicinity of the other, distal wall and which extends at most around half the circumference of the pipe. This aperture communicates solely with a first group of flue-gas channels, including those flue gas channels that are located essentially in the vicinity of said half circumference and which in turn communicate solely with a flue-gas turning chamber provided on the burner side. The flue-gas turning chamber is defined by the outer wall on this side and by the wall that contains the burner opening. The flue-gas turning chamber is connected to the combustion chamber through a gap located in the vicinity of the burner opening, and also to a second group of flue-gas channels which include the remainder of said flue gas channels and which are connected to a flue-gas pipe which extends through the outer wall opposite to the burner side. The flue-gas pipe communicates with the surroundings.

It is preferred that the size of the flue-gas recirculating gap can be adjusted and that the recirculated, cooled flue gases will be returned to the combustion chamber essentially in a circular pattern around the burner flame.

The inventive heating boiler thus presents two so-called flue-gas paths, a lower path and an upper path, wherein the upper path is preferably connected to the combustion chamber through the outlet provided in the combustion chamber pipe. The flue gases will thus exit from the combustion chamber outlet and move upwards to the upper flue-gas path, which is comprised of a plurality of flue-gas channels in the upper half of the boiler.

Subsequent to being turned in the flue-gas turning chamber on the burner side, those flue gases that are not recirculated to the combustion chamber are forced to flow in the direction of the flue-gas path towards the flue-gas pipe, and then through the pipe and out to atmosphere. As the flue gases pass along the two flue-gas paths, the gases are cooled by the colder water in the circular water magazine that borders on the two flue-gas paths. So as to achieve further cooling of the flue gases, it is convenient to thermally insulate the flue-gas path outgoing from the combustion chamber, either completely or partially, preferably by insulating the lower, inner half of the combustion chamber pipe. It will be evident from the aforegoing that the aperture in the cylindrical combustion-chamber pipe will preferably face upwards, wherein the first group of flue-gas channels border essentially on the upper half of the cylindrical water magazine.

The combustion chamber can conveniently be constructed as a readily removable unit which lies sealingly against those flanges that form part of the flue-gas channels. The combustion-chamber pipe will then form one of the defining surfaces of the flue-gas channels.

The inventive combustion chamber unit is intended for a heating boiler which operates with flue-gas recirculation and which comprises a water magazine having a circular inner shell, as defined in the preamble of Claim 1. The unit includes a cylindrical pipe having a first wall which is provided with a burner-accommodating opening. The other end of the pipe is fitted with an imperforate, second, distal wall. The pipe is provided with a saddle-shaped aperture or opening adjacent the distal wall, this aperture extending around half the periphery of the pipe. Also provided on the distal wall is an outwardly projecting edge which seals sealingly against the outer wall, such as to delimit the lower flue-gas path from the upper path. This edge may have different shapes and the shape of said edge will depend on whether or not the flue-gas pipe is seated in the lower part of the outer wall. For instance, the edge may be straight when the pipe is located in the lower half of the outer shell. If not, the edge must have a curved or some other non-straight shape, so as to provide room for the flue-gas pipe beneath the edge. The combustion chamber unit is conveniently insulated internally on the inner surface opposite to said aperture, this insulation covering said inner surface, either completely or partially, up to the level of the longitudinally extending fins or wings. Two diametrically opposed and radially arranged wings or fins, in the form of welded sheet-metal strips for instance, extend in the combustion chamber pipe throughout the whole of its length. The wings are dimensioned so as to sealingly abut the inner shell of the circular water magazine, and function to further delimit the two flue-gas paths one from the other. These rings also function to stabilize mounting of the combustion pipe inwardly of the flue-gas channel flanges.

The invention will now be described in more detail with reference to the accompanying drawings, in which Figure 1 is a longitudinal, sectional view of an inventive heating boiler; Figures 2 and 3 are sectional views of the inventive heating boiler taken on the lines A-A and B-B respectively in Figure 1; and Figures 4 and 5 are respective perspective views of a combustion chamber unit as seen from two different directions.

Figure 1 illustrates a heating boiler 10 which includes a water magazine 11 enclosed between an outer shell 12 and an inner shell 13. Although not shown, the outer surface of the outer shell 12 is insulated. Extending peripherally around the inner surface of the inner shell 13 are flanges 15 or the like which partially define longitudinally extending flue-gas channels. These flanges may have the form of U-shaped profiles and have a radial extension which is generally equal to the distance to a cylindrical com-

bustion-chamber pipe 16 mounted inwardly of the inner shell 13, thereby forming a plurality of longitudinally extending flue-gas channels 17 outside the combustion-chamber pipe 16. The boiler further comprises a combustion chamber 20, which is defined by the cylindrical combustion-chamber pipe 16 and combustion chamber walls 18, 19. The wall 18 is provided with an opening in which a burner 21 is mounted, said burner being shown fitted to the boiler. The other end of the pipe 16 has an imperforate wall 19, which is shown to be fitted with internal insulation. An aperture 22 through which flue gases exit from the combustion chamber 20 is provided in the end of the pipe 16 opposite to the burner opening. The wall 18 at the burner end of the pipe 16 is configured to form a gap 23 between the wall 18 and an outer wall 25 of the boiler.

When the boiler is in operation, the burner 21 is inserted into the opening in the wall 18 of the combustion chamber and the outer wall 25 of the boiler. The combustion gases from the burner 21, which reach a temperature of about 1000°C at the distal end of the chamber 20, exit through the outlet aperture 22, as indicated by the flame symbols, and are therewith forced to flow in a reverse direction through the upper group of flue-gas channels 17, this upper group being referenced 17a, and are there cooled by the water in the upper part of the water magazine 11, to achieve a temperature of about 300-500°C at the burner end. At the burner end, the cooled flue gases reach a flue-gas turning chamber 14 located between the combustion chamber and the outer wall, and part of the thus cooled flue gases, or combustion gases, are drawn by suction through the gap 23 located around the burner 21 or the burner pipe 24, where they cool and dilute the combustion reactants and therewith enable a desired low combustion temperature to be achieved. The remainder of the flue gases flow back from the flue-gas turning chamber 14 towards the distal end of the boiler, through the lower group 17b of flue-gas channels and are therewith further cooled from a temperature of about 300°C to a temperature beneath 200°C at the time of reaching the outer wall 27 of the boiler, as indicated in the Figure. The inner surface of the bottom half of the combustion chamber pipe 16 is insulated, as shown at 26, to prevent reheating of the cooled flue gases. Located at the distal end is the outer wall 27 which has mounted therein a flue-gas pipe 28 through which the gases are caused to exit to the surroundings, through a smokestack or the like. An outwardly projecting edge 29 seals against the outer wall 27 and the combustion-chamber wall 19 and is connected to wings 30 (shown in Fig. 2) disposed along the long side of the burner pipe 16 and therewith forces the flue gases flowing from the burner side to pass solely through the flue-gas pipe 28 in the outer wall 27.

Figures 2 and 3 are sectional views of the boiler taken on respective lines A-A and B-B in Figure 1 and show the inner shell 13 of the water magazine. Connected to the inner shell 13 are longitudinally extending flanges 15. These flanges 15 define longitudinally extending flue-gas channels 17 together with the combustion-chamber pipe 16. The channels 17 are divided into two groups or paths by means of a seal located between the inner shell 13 of the water magazine and the combustion-chamber pipe 16. In the illustrated case, the seal has the form of a longitudinally extending wing 30 which is welded along the combustion-chamber pipe 16 and the width and length of which is such as to seal against the inner shell 13 of said magazine along the whole length of the pipe 16. Flue gases will thus flow inwardly, as seen in the plane of the drawing, in the upper group of flue-gas channels 17a, thus the group located above the wing 13, whereas the gases in the lower group of flue-gas channels 17b will flow outwards. It will be seen that the sealing, outwardly projecting edge 29 on the distal combustion-chamber wall 19 is configured to adapt to the flue-gas pipe 28, the position of which is also shown in the Figures.

Figures 4 and 5 illustrate a combustion chamber unit 31 constructed in accordance with a preferred embodiment of the invention, said unit being shown in perspective obliquely from above the burner side and the flue-gas pipe side respectively. The combustion chamber unit 31 is comprised of a cylindrical pipe 16 having a wall 18, which is provided with a burner accommodating opening 32, and an imperforate wall 19 at the opposite end of the pipe 16. This opposite end of the pipe 16 is provided with the aforesaid saddle-shaped aperture 22 through which the flue gases flow into the combustion chamber. The Figures illustrate the wings 30 extending along the sides of the pipe 16, these wings having the form of elongated narrow plates that are welded to the pipe, for instance. Located at the distal wall 19 is an outwardly projecting edge 29 whose ends are connected to respective wings 30, said edge having the form of a bent plate in the illustrated embodiment. The entire combustion chamber unit 31 is intended to be fitted to a heating boiler that comprises a water magazine having a circular inner shell and flanges or profiles which define flue-gas channels inwardly of the shell, as described above. The unit 31 may be used conveniently to replace other combustion chamber arrangements fitted in such heating boilers.

Thus, the aforedescribed arrangements operate in a manner which is highly satisfactory from an environmental point of view, since the NO_x content can be kept very low (<120 mg/kWh). The arrangements involved are extremely simple mechanical constructions which can be produced simply and cheaply. The arrangements are also easy handle from a servicing aspect. When cleaning the unit, the outer wall 25 is removed and the combustion chamber unit 31 with-

drawn from the boiler. When servicing or cleaning is completed, the unit 31 is simply inserted into the boiler and the boiler is then again operative.

Claims

1. A heating boiler (10) which operates with flue-gas recirculation, said boiler comprising a water magazine (11) which is defined by an outer shell (12) and an inner shell (13) of circular cross-section, and two outer walls (25, 27) and a cylindrical combustion chamber (20) mounted inwardly of the water magazine (11) and comprising a plurality of surrounding flue-gas channels (17) which are mutually divided by longitudinally extending flanges (15) or the like disposed around the periphery of the circular inner shell (13) of the water magazine, wherein the combustion chamber (20) is defined by a cylindrical pipe (16), a first combustion-chamber wall (18) which is connected to one end of said pipe and which is provided with a burner-accommodating opening, and a second combustion-chamber wall (19) connected to the other end of the pipe (16), **characterized** in that in that the cylindrical pipe (16) is provided with a saddle-shaped outlet (22) which is located in the vicinity of said second wall (19) and which extends at most around half the circumference of the pipe (16); in that the outlet (22) has communication with a first group of flue-gas channels (17a) which include those flue gas channels that are located in the near vicinity of said half circumference and which, in turn, are connected solely to a flue-gas turning chamber (14) on the burner side delimited by the outer wall (25) and the first combustion-chamber wall (18); in that the flue-gas turning chamber (14) is connected with the combustion chamber (20) by means of a gap (23) located in the vicinity of the burner-accommodating opening, and is also connected to a second group of flue-gas channels (17b) including the remainder of the flue gas channels, which are connected to a flue-gas pipe (28) which extends through the other outer wall (27), said pipe (28) communicating with the surroundings.

2. A boiler according to Claim 1, **characterized** in that the size of the gap (23) can be varied.

3. A boiler according to Claim 1 and 2, **characterized** in that the combustion chamber (20) is thermally insulated, either completely or partially, against the second group of flue-gas channels (17b).

4. A boiler according to Claims 1-3, **characterized** in that the outlet (22) in the cylindrical pipe (16) faces upwards; and in that the first group of flue-gas channels (17a) border essentially on the upper half of the cylindrical water magazine (11).

5. A boiler according to Claims 1-4, **characterized** in that the combustion chamber (20) has the form of a detachable unit (31) which lies sealingly against the flanges (15).

6. A combustion chamber unit (31) for a heating boiler (10) that comprises a water magazine (11) having an inner circular shell (13) and flue-gas channels (17) which extend longitudinally inwardly of said inner shell (13) and which are delimited radially by inwardly facing flanges (15) or the like, wherein the unit (31) includes a cylindrical pipe (16), a first wall (18) connected to the pipe (16) and provided with a burner-accommodating opening, and an imperforate second wall (19) connected to the other end of the pipe (16), **characterized** in that the cylindrical pipe (16) is provided with a saddle-shaped aperture (22) in the vicinity of said second wall (19) and extending at most around half the periphery of the pipe (16), and two diametrically opposed and radially extending wings or like projections (30) which extend essentially along the full length of the pipe (16) and which are adapted to sealingly abut the inner shell (13) of the water magazine (11) and each of which connects with an outwardly projecting, transversely extending edge (29) mounted on the second wall (19) and adapted for sealing abutment with the outer wall (27) of the boiler.

7. A unit according to Claim 6, **characterized** in that the outwardly projecting edge (29) is straight.

8. A unit according to Claim 6, **characterized** in that the outwardly projecting edge (29) is curved or has some other non-straight form.

9. A unit according to Claims 6, **characterized** in that the inner surface of the combustion chamber pipe (16) remote from said opening is provided with insulation (26), said insulation extending completely or partially to the level of the longitudinally extending wings (30).

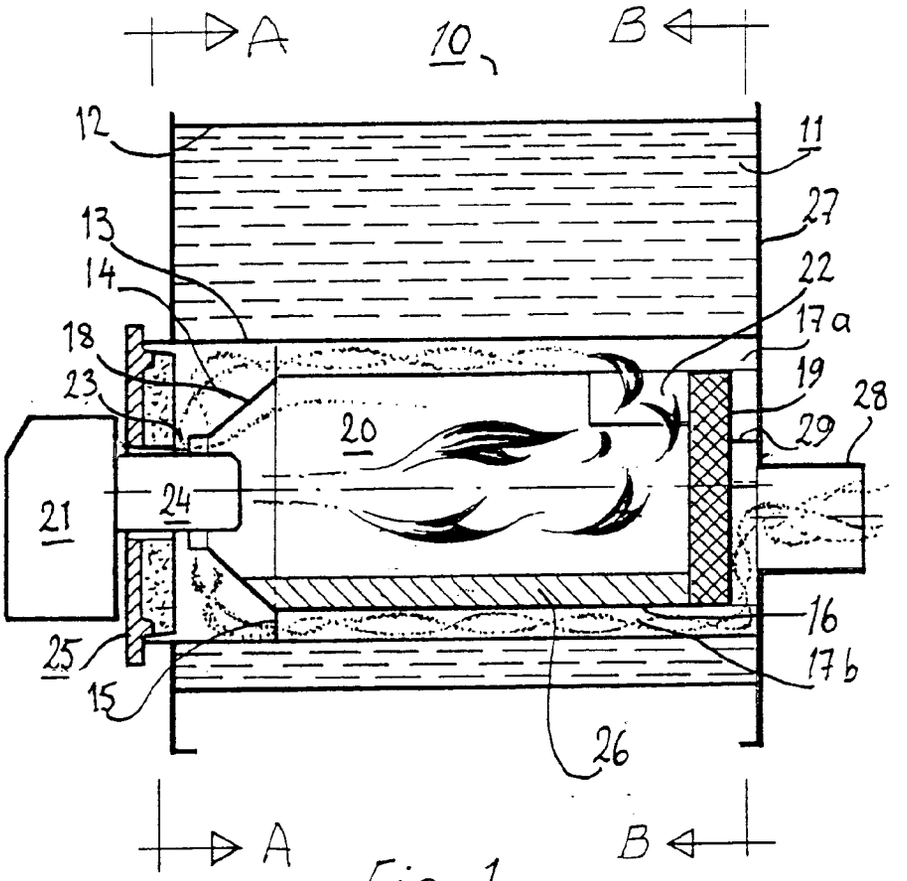

Fig. 1

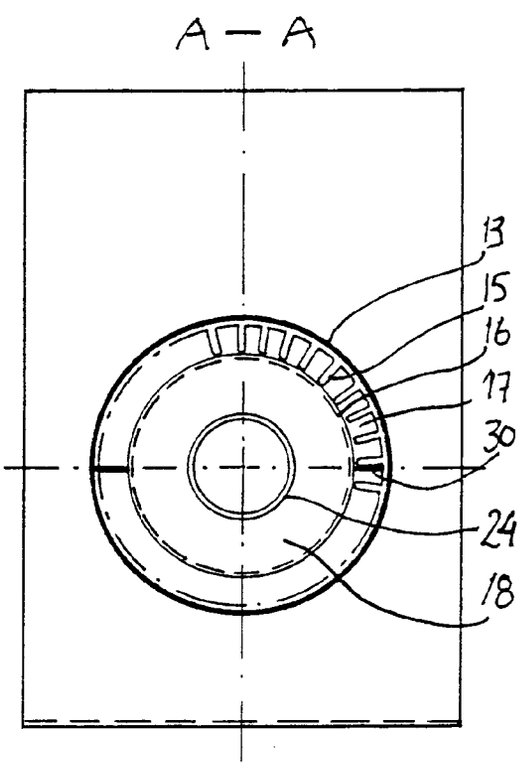

Fig. 2

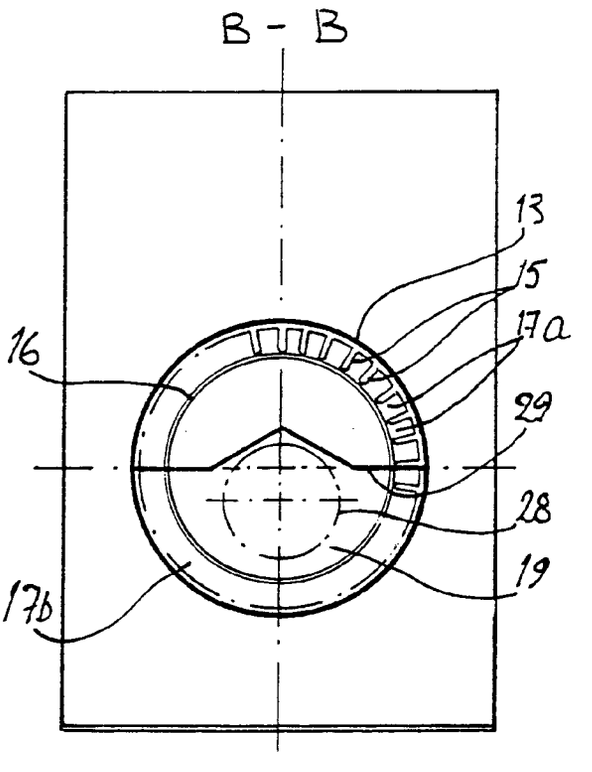

Fig. 3

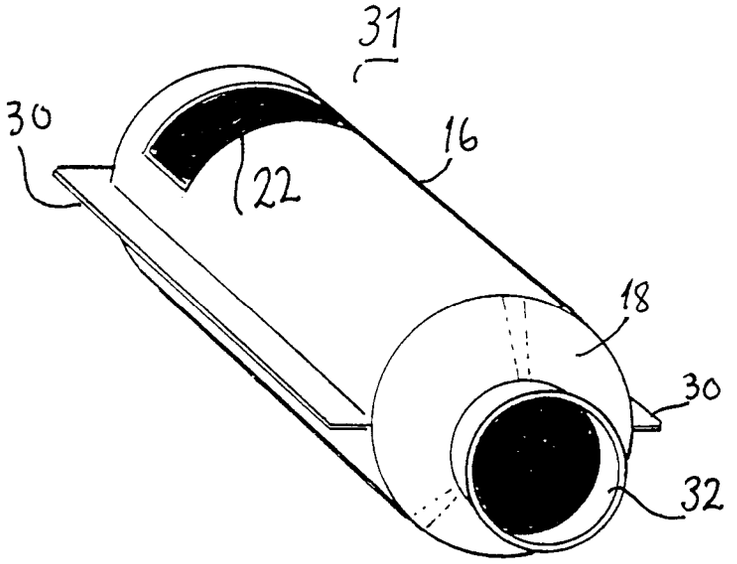

Fig. 4

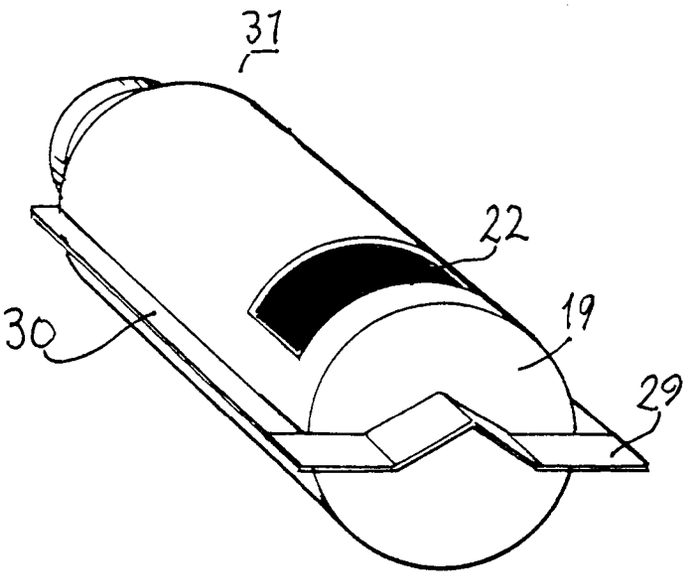

Fig. 5

EUROPEAN SEARCH REPORT

Application Number
EP 93 85 0219.2

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.5)
A	DE, A1, 4035262 (SBS B. SCHMIDT GMBH & CO.), 7 May 1992 (07.05.92) * column 4, line 62 - column 5, line 43, figures 1-3 * --	1,6	F23C 9/00 F24H 1/26 F24H 9/00 F23M 9/06
A	DE, C1, 3738623 (WOLF KLIMATECHNIK GMBH), 2 February 1989 (02.02.89) * column 3, line 9 - line 44, figure 1 * --	1,6	
A	EP, A2, 0428117 (VIESSMANN WERKE GMBH & CO.), 22 May 1991 (22.05.91) * figures 1,2, abstract * --	1,6	
A	EP, A2, 0166703 (AB CTC), 2 January 1986 (02.01.86) * figures 1-4, abstract * --	1,6	TECHNICAL FIELDS SEARCHED (Int. Cl.5) F23C F23M F24H
A	DE, C2, 3048044 (ULRICH), 9 June 1983 (09.06.83) * column 3, line 1 - column 4, line 25 -----	6	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
STOCKHOLM	1 March 1994	BRUUN ANDERS

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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