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(54) **Gasogen for the production of gases for external combustion in boilers, furnaces, internal combustion engines and other devices or apparatuses which use said gases and the process to improve the treatment of biomass by means of the gasogen**

(57) Gasogen to produce combustion gases for external combustion in boilers, furnaces internal combustion engines and other devices or apparatuses which use said gases, being the gasogen of the fixed upstream type with refrigerated walls where the biomass or material to be gasified is subjected to a series of processes such as drying, pyrolysis, reduction of the carbon dioxide generated into carbon monoxide and burning of the residual carbon. The walls of the gasogen arc composed of a number of cooling pipes with heat dissipation membranes, the gasogen includes an exocentric rotating grid for the extraction of ashes, at least one peripheral and one central blower with the corresponding sets of steam and/or inert gases injection nozzles to ease the extraction of ashes, at least one gas exhaust gate which blocks the pipe connected to the combustion chamber and an ancillary funnel with an exhaust valve for the paralyses gases. The treatment of the biomass is improved adding selected compounds between calcium hydroxide, calcium carbonate and/or double calcium and magnesium carbonate in variable proportions according to the type of fuel that enters the gasogen

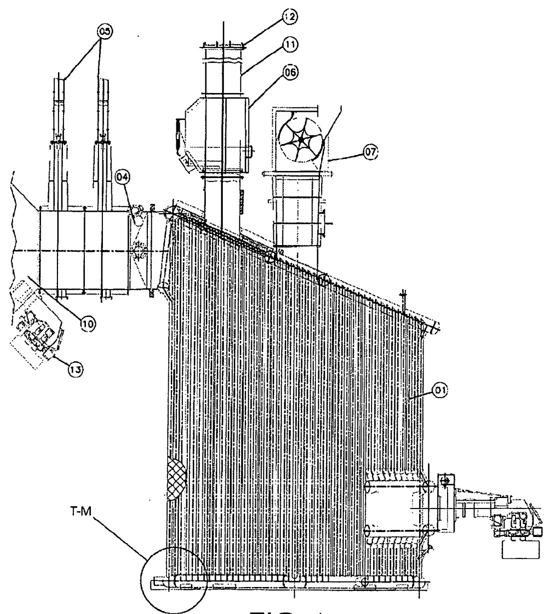

FIG. 1

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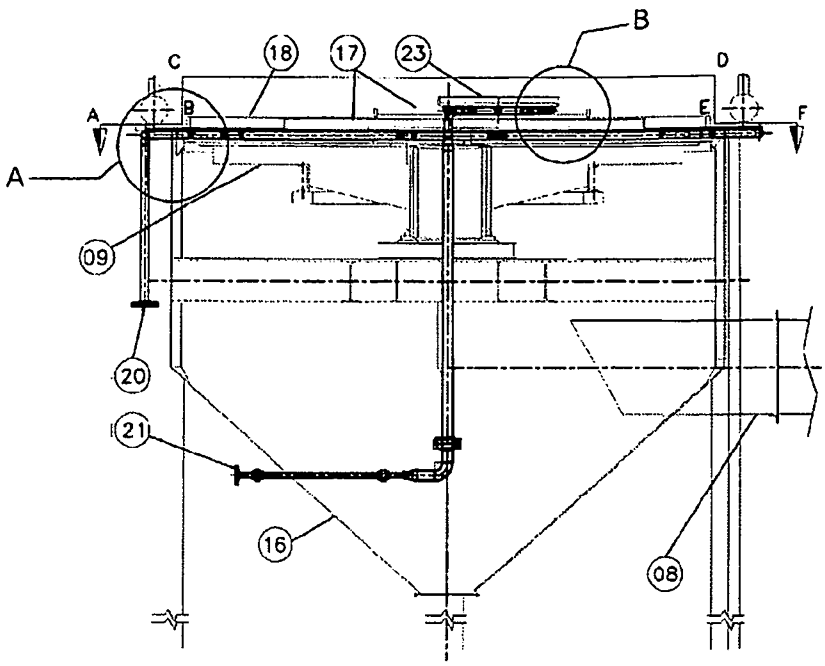

FIG. 7

Description

Field of the invention

[0001] The present invention refers to a gasogen to produce gases for external combustion in boilers, furnaces and internal combustion engines and other devices or apparatuses which use said gases. More specifically the invention refers to a fixed, upstream type gasogen where the material to be gasified goes through a feeding system and is subjected to a series of processes such as drying, pyrolysis or carbonization, reduction of the carbon dioxide generated, to carbon monoxide, burning of the residual carbon with the oxygen in the combustion air which is injected at the bottom of the gasogen and other processing stages. The invention also refers to a process to improve the treatment of the biomass by means of the gasogen.

State of the art

[0002] The gasogens or gasification systems for both the production of gases for external combustion in boilers, furnaces, etc. and the operation of internal combustion engines have been known for ages. The fixed, upstream gasogens are basically reactors where the material to be gasified goes downstream while the gasification air and then the generated gases go upstream. During the downstream process, the material to be gasified goes through a feeding system in the following stages:

- Drying: It is an endothermic process by means of which, on account of the effect of the ascending hot gases, the material loses its humidity which is extracted together with the generated gases.
- Pyrolysis or carbonization: When the material reaches about 240°C / 270°C, the process of pyrolysis, which is the extraction of all the volatile materials which are combustion gases, starts. This process is slightly exothermic and is produced without oxygen.

- Reduction: This process reduces the carbon dioxide (CO_2) generated to carbon monoxide (CO) according to the Boudoir equation. The CO is also a combustible gas. This process is endothermic.
- Finally, the residual carbon from the previous stage is burnt with the oxygen from the combustion air injected at the bottom of the gasogen in the previous stage (about 30% of the total combustion air). This reaction, which is strongly exothermic produces CO_2 and is the one which generates all the gasification process.
- After the carbon combustion there are ashes left which are cooled by the same gasification air when it flows upstream, and which is heated previous to the carbon combustion in CO_2 The ashes are then extracted after passing through an exocentric rotating grid.

[0003] In case it is necessary to turn off the gas flame in the gasogen, for example on account of a sudden stop of the steam turbine fed by the boiler with gasification, a breakage of the pipes, an emergency stop, etc, the flow of gasification air is cut off then reducing the process of combustible gas generation abruptly. Nevertheless, the pyrolysis process which as stated above is exothermic and do not need the presence of oxygen, continues and a certain amount of combustible gases is still generated. Consequently, it is still necessary to treat that generated gas in a way similar to any other combustible gas, such as fuel natural gas or fuel liquid gas with a low loss of pressure due to the gas flow in the duct and minimizing the "soiling" effect with tar under temporary running conditions.

[0004] Fixed, upstream gasogens especially suitable for external combustion have been perfected by Mr. Jacobo Agrest, engineer, and his legal successors Messrs Eduardo León, Jorge Ferrer and Octavio Canal, holders of Ingeniería Agrest SRL, in particular, to be used with different types of biomasses. An important step was the design of gasifiers with cooled water walls in general by means of water pipes connected using mounting pipes going downwards to the boiler's domes and hence to its system. This is not the only cooling method since it is also possible to use a flow of water, air or any other cooling liquid. This increases performance and reduces maintenance to the minimum. Apart from this, another important state of the art feature was the connection of the combustible gases generated to the torsional combustion system which enables to guarantee the combustion stability in these low calorie gases.

[0005] The cooling of the gasogens' walls by means of pipes made of refractive material behind them has been the ground for some fake beliefs regarding the need to use said refractive materials to maintain the thermal conditions that guarantee the stability of the process. Contrary to these beliefs the full refrigeration of the gasogens' walls by means of piped walls with membranes joined by metal plates with suitable thickness and width, the present invention shows that even with relatively cool walls, the stability of the gasification process can be perfectly maintained without direct or indirect difficulties being able to obtain an important increase in the gasogen's sealing. This cooling system makes it possible to reduce the chances of pyrolysis gases (rich in hydrocarbons and carbon monoxide) going into the air and to reduce the annual gasogens' maintenance costs and times among other advantages due to the improvements introduced in the gasogens according to the present invention.

Summary of the invention

[0006] The purpose of the present invention is to improve the gasogen's gasification system, increase the safety and reliability of its operation, ease the extraction of ashes and make it more efficient by improving the rotating exocentric grid and adding steam blowers or if not present, inert gasses from time to time and allow the gasogens to run without stops for maintenance and/or cleaning.

[0007] Hence the purpose of this invention is to provide a gasogen to produce gases for external combustion in boilers, furnaces, internal combustion engines and other devices or apparatuses which use said gases being the gasogen of a fixed upstream type with refrigerated walls where the material to be gasified goes through a feeding system and is subjected to a series of processes such as drying, pyrolysis, reduction of the produced carbon dioxide into carbon monoxide, and burning of the residual carbon. The walls of the gasogen are formed by a number of cooling pipes with heat dissipation membranes. The gasogen includes an exocentric rotating grid to extract the ashes, at least one peripheral blower and a central blower with their corresponding steam and/or inert gases injection nozzles to ease the extraction of ashes, at least one gas, exhaust gate which blocks the connection pipe to the combustion chamber and an auxiliary funnel with an exhaust valve for the pyrolysis gases. It is also the purpose of this invention to provide for a process to improve the treatment of the biomass by means of the gasogen adding, together with the biomass, selected compounds between calcium hydroxide, calcium carbonate and/or double calcium and magnesium carbonate in variable proportions according to the type of fuel that enters the gasogen.

Brief description of the drawings

[0008] For better understanding and clarification of the purpose of the present invention, it has been illustrated in several pictures which depict it according to the preferred forms of realization only as an example, where:

Figure 1is a general scheme for an installation which includes the gasogen which is the object of the present invention.

Figure 2 is an extended detail of the structure of pipes and membranes of the gasogen shown in Figure 1 within the T-M circle.

Figure 3 is a an extended detail of the A-A crosscut of Figure 2.

Figure 4 is a partial view which shows the upper end of the gasogen from where it is functionally and structurally connected to a combustion chamber, the gates for the gases to go out, a funnel and a feeding system for the material to be processed among other devices.

Figure 5 is an extended detail of the parts illustrated in Figure 7 within circle A.

Figure 6 is an extended detail of the parts illustrated in Figure 7 within circle B.

Figure 7 is a raised view and X-X crosscut of Figure 8.

Figure 8 is a flat view of the gasogen according to crosscuts A, B, C, D, E y F shown in Figure 7.

Detailed description of the invention

[0009] In figure 1, and in the details illustrated in figures 2 and 3, it is shown that in the fixed upstream type gasogen 1, the proposed improvement consists of the general cooling of its walls by means of piped walls 2 with membranes 3 defined by metal plates welded to said pipes 2, which have specifically calculated thickness and width. In this way it is possible to maintain the perfect stability of the gasification process and an important increase in the sealing of gasogen I even with relatively cold walls and low risks of leakage of pyrolysis gases.

[0010] The material to be gasified by means of gasogen 1 enters downwards through the feeding system 7 and then start the processes of drying, pyrolysis, reduction of carbon dioxide (CO2), burning of the residual carbon and the extraction of the resulting ashes.

[0011] The drying is an endothermic process by means of which because of the effect of the ascending hot gases, the material to be gasified loses its humidity which is extracted together with the gases generated through the outlets 5. When the material reaches a temperature of 240 °C to 270 °C, starts the pyrolysis process for the extraction of all the volatile components. This process is slightly exothermic and it is produced without the presence of oxygen. After the pyrolysis process only the fixed carbon is left and the process for the reduction of carbon dioxide (CO2) into carbon monoxide (CO) starts. Finally the residual carbon is burnt with the oxygen from the combustion air approximately 30% of the total combustion air which is injected from the bottom of the gasogen 1 through the air injection pipe 8 which is shown in figure 4. This reaction is highly exothermic, produces CO_2 and generates all the gasification process.

[0012] As a result of the carbon combustion there are ashes which are cooled by the gasification air itself when it flows upstream being heated previous to the carbon combustion into CO_2 and they are extracted after going through an exocentric rotating grid 9 as illustrated in figures 7 and 8.

[0013] In case it is necessary to turn off the gas flame in the gasogen, for example on account of a sudden stop of the steam turbine fed by the boiler with gasification, a breakage of the pipes, an emergency stop, etc, the flow of gasification air is cut off then reducing the process of combustible gas generation abruptly. Nevertheless, the pyrolysis process which as stated above is exothermic and do not need the presence of oxygen, continues and a certain amount of combustible gases is still generated. Consequently, it is still necessary to treat that generated gas in a way similar to any other combustible gas, such as fuel natural gas or fuel liquid gas with a low loss of pressure due to the gas flow in the duct and minimizing the "soiling" effect with tar under temporary running conditions.

[0014] Consequently, the purpose of this invention is to treat these generated gases in a way similar to any other combustible gas, such as fuel natural gas or fuel liquid gas although the gas exhaust pipe 4, connected to the combustion chamber 10, has got a cross section which is much wider than the ordinary ones for these other fossil fuels for example between 10 and 50 times bigger, depending on the burner and the combustion chamber to be used. The bigger section of the pipe makes it possible to obtain a low loss of pressure because of the flow of gases in the pipe and to minimize the tar ''soiling" effect under temporary running conditions

[0015] The improvements proposed with the present invention consist of installing a gate for exhaust gases 5 with a special design so as to block the pipe and connection of the gasogen 1 to the combustion chamber 10, preventing the combustible gases from entering it. Eventually, it is possible to install two serial gates such as the ones shown in figures 1 and 2. At the same time, an exhaust valve 6 for the pyrolysis gases generated in the gasogen 1 will open through an ancillary funnel 11 to divert said gases towards the exterior. Besides a torch 12 can be installed to bum said gases.

[0016] To set the gasification gases again on fire in the combustion chamber 10, first a pilot burner will be turned on 13, then valve 6 in the ancillary chamber I I will be turned off and immediately the gate(s) 5 will open, returning to the status before the stop.

[0017] As it was already explained, after all the above mentioned processes specially after the combustion of the fixed carbon, there are ashes proper to the fuel which are extracted from the bottom of the gasogen 1 by means of the rotating grid 9, which is generally exocentric.

[0018] Whichever the humidity of the fuel to be used is, and the percentage of its volatiles, the end process always involves burning dry carbon since in the previous processes the water is evaporated during the drying process and the volatiles are gasified during the pyrolysis process.

[0019] The biomasses used for the gasification include alkali in its composition, especially potassium (K). Some biomasses also contain silica and in many other cases there is silica which comes from the ground itself as a result of the collection and/or storage system of the fuel biomass. This silica together with the potassium from the ashes, form alkaline silica eutectics with very low fusion points. In these cases, it is frequent that in the combustion area temperatures which reach 750 C° to 900 °C are higher than the ashes' fusion point, so they end up forming stone like, very hard, big deposits which become difficult to be extracted causing maintenance stops to clean the equipment.

[0020] The present invention also solves those problems by means of the addition together with the biomass of calcium hydroxide (slake lime) o limestone (calcium carbonate) and/or dolomite (calcium and magnesium double carbonate) in variable proportions according to the type of fuel entering the gasogen usually between 0, 1 y 5 Kg of calcium per ashes contained in the combustible biomasses. If possible, it will be necessary to add these composites as granules and not as powder to prevent their being drifted by the gases generated in the gasogen 1 and getting to the combustion area on grid 9.

[0021] In the combustion area of the gasogen 1 there is a chemical reaction to substitute the potassium (K) for calcium (Ca), making a composite which has a much higher fusion point preventing the above mentioned problems with the formation of hard, big deposits which might jam the grid's rotating movement grid 9 and block the channels 15 for the passage of air illustrated in figure 5. In this way, it is possible to ensure a steady, long run without stops.

[0022] The rotating exocentric grids have been frequently used for the extraction of the ashes in gasogens. As shown in figures 5 to 8, it is a set of overlapping plates 17, 18 and 23, which rotate on a shift not coincident with the vertical gasogen shift 1. Among said plates 17, 18 and 23, whose diameter gets smaller and smaller, channel 15 for air passage is defined, where both the gasified air goes in and the ashes formed fall down according to figures 5 and 6. Being the rotating movement exocentric off the grid, the ashes are pushed towards the spaces defined between plates 17, 18 and 23, and fall to the bottom of the hopper 16 shown in figure 7. This is good for powder-like ashes but not for the compacted ones, as it usually happens more and more frequently because of the use of biomasses with a high percentage of ashes and the presence of silica and alkalis. In this case, these ashes which are in fact pieces of compacted ashes and/or partially melted do not fall in the spaces between plates 17, 18 and 23, but they are pushed towards the gasogen's periphery.

[0023] The improvements introduced according to the present invention as shown in figure 5, consist of increasing the distance between the external plate 18 and the periphery up to values between 5 and 150 mm according to the type of fuel, adding also thicker plates 19. These plates 19, which are generally between 6 mm and 50 mm thick, strengthened for example with metal welded plaques and gusset plates covered with hard metal 24, of the Conarcrom 450 or 4940 Eutectic type or similar to minimize wear, produce an abrasive effect and the breakage of compacted ashes easing their extraction. In this way, the grid 9 works not only as a system to extract the ashes but as a mill to break the larger sized ashes deposits and allow its extraction by the running gasogen 1.

[0024] To ease the ashes' extraction process a peripheral blower has also been installed 20 and a central blower 21, with nozzles 22 that blow steam from time to time or in their absence inert gases. The central blower 21 with nozzles 22 is installed in the space between the upper plate 23 in the grid and the first lower plate 17. The nozzles 22 blow steam in the areas which are immediately below the combustion area. The steam impacts on the compacted ashes which still have high temperatures between 750 °C and 900 °C, and on account of the thermal shock and the pressure of the steam jet, they help to break said compacted ashes into smaller pieces easing their extraction. Besides the steam jets which go out of the nozzles 22 move the fixed biomass, making its distribution more uniform and levelling the air flow, perfecting gasification by preventing preferential channels where air passes without performing the gasification process. A second set of nozzles 22, is installed in the peripheral blower 20, between the rotating external plate 18 and the fixed area at the bottom, lateral lock 25 in the gasogen 1, helping the movement and extraction of the ashes. In all these cases, the blowing using steam or inert gases can be continuous or intermittent depending on the combustible biomass to be used and the characteristics of its ashes.

Claims

1. Gasogen to produce gases for external combustion in boilers, furnaces internal combustion engines and other devices or apparatuses which use said gases, being the gasogen of the fixed, upstream type with refrigerated walls where the material or biomass to be gasified goes through a feeding system and is subjected to a series of processes such as drying, pyrolysis or carbonization, reduction of the carbon dioxide generated, to carbon monoxide, burning of the residual carbon **characterized in** the fact that the gasogen walls (1) are formed by a number of cooling pipes (2) with heat dissipation membranes (3); the gasogen (1) including at least one gas exhaust gate (5) which blocks the pipe (4) connected to the combustion chamber (10); an exhaust pipe (6) for the pyrolysis gases towards an ancillary gas exhaust funnel (11); an extraction grid (9) for the ashes proper to the fuel, which are extracted from the bottom of the gasogen generally exocentric; and at least one peripheral blower (20) and a central blower (21) to extract the ashes with at least two sets of steam and/or inert gases injection nozzles (22)

2. Gasogen according to claim 1, **characterized by** the fact that said membranes (3) are metal plates fixed to said cooling pipes (2).

3. Gasogen according to claims 1 or 2, **characterized by** the fact that the grid (9) to extract the ashes is an exocentric rotating grid.

4. Gasogen according to claim 3, **characterized by** the fact that said grid (9) is defined by a succession of overlapped plates with a decreasing diameter which consists of internal plates (17), one external plate (18) and an upper plate (23), which rotates on a shift not coincident with the gasogen's vertical shift.

5. Gasogen according to claim 4, **characterized by** the fact that between said overlapped plates (17), (18) and (23) there are channels (15) for the passage of the gasification air and the fall of the ashes towards a hopper (16) located at the bottom of the gasogen.

6. Gasogen according to claim 5, **characterized by** the fact that said channels (15) define respective spaces of between 5 and 150 mm high.

7. Gasogen according to any of the claims 1 to 6 above, **characterized by** the fact that said grid (9) includes a system of plates (19) whose thickness is between 6 mm and 50 mm, strengthened by metallic gusset plates covered with hard metal (24) to minimize wear and produce an abrasive effect and breakage of compacted ashes.

8. Gasogen according to any of the claims 4 to 7 above, **characterized by** the fact that said central blower (21) is located between the upper plate (23) and the plate immediately below it (17).

9. Gasogene according to any of the claims 4 to 8 above , **characterized by** the fact that one set of nozzles (22) is located in the peripheral blower (20), between the external plate (18) and the fixed area of the bottom lateral lock in the gasogen, to ease the movement and extraction of the ashes.

10. Gasogen according to any of the claims 1 to 9 above, **characterized by** the fact that there is an ancillary funnel (11), for the deviation of gases towards the exterior, where there is a gas exhaust valve (6) for the pyrolysis gases generated in the gasogen.

11. Gasogen according to claim 10 above, **characterized by** the fact that said ancillary funnel (11) includes a torch (12) to burn the gases generated.

12. A process to improve the treatment of the biomass by means of the gasogen in the claims above **characterized by** the fact that together with the loading of the biomass, selected compounds between calcium hydroxide, calcium carbonate and/or double calcium and magnesium carbonate in variable proportions according to the type of fuel that enters the gasogen.

13. A process according to claim 12, **characterized by** the fact that between 0.1 and 5 kg of calcium per kg of the ashes contained in the biomass fuel are added.

14. A process according to claims 12 or 13, **characterized by** the fact that said compounds are added in granulated form.

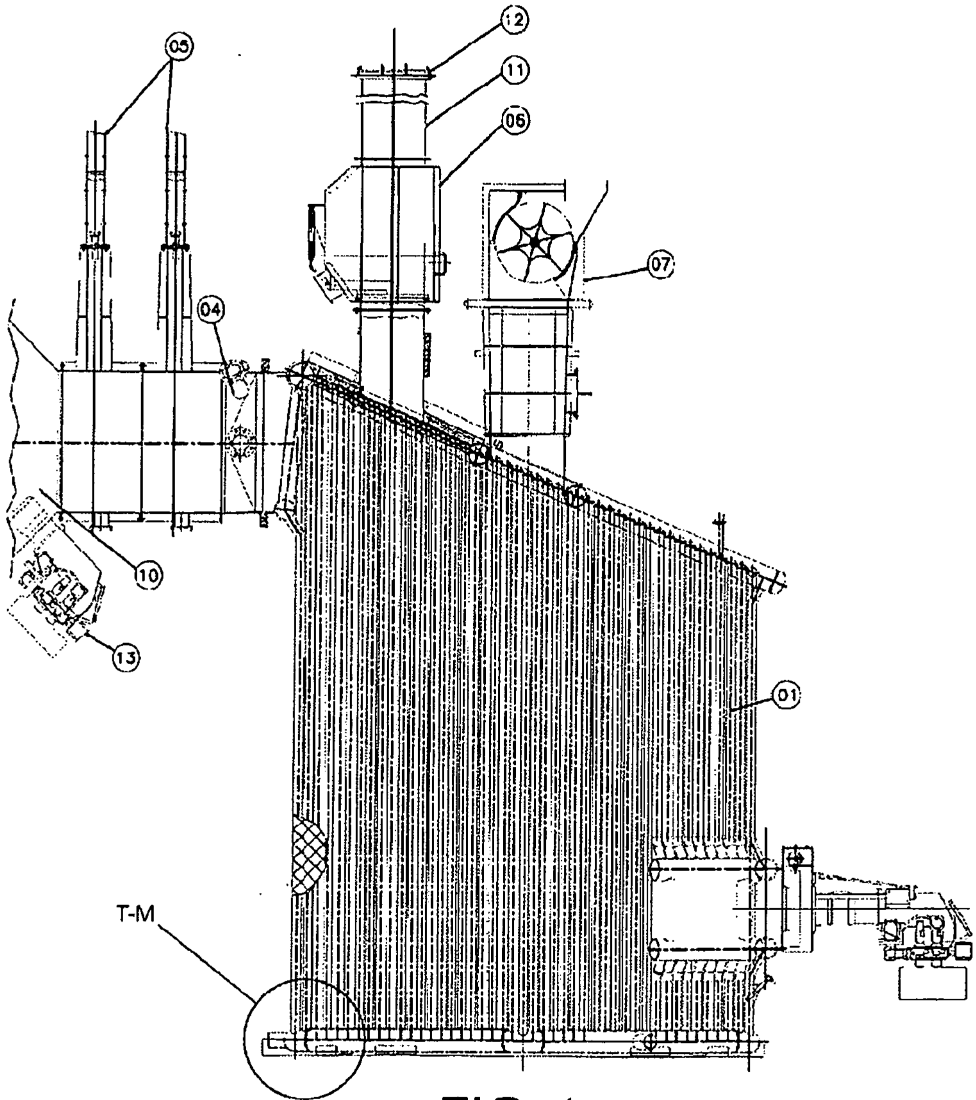

FIG. 1

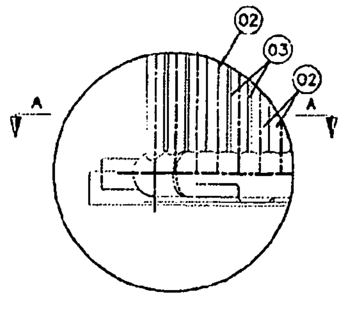

FIG. 2

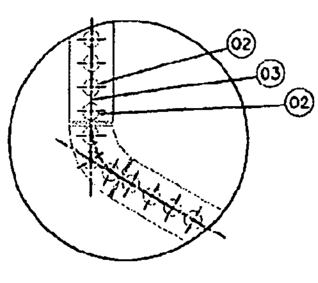

FIG. 3

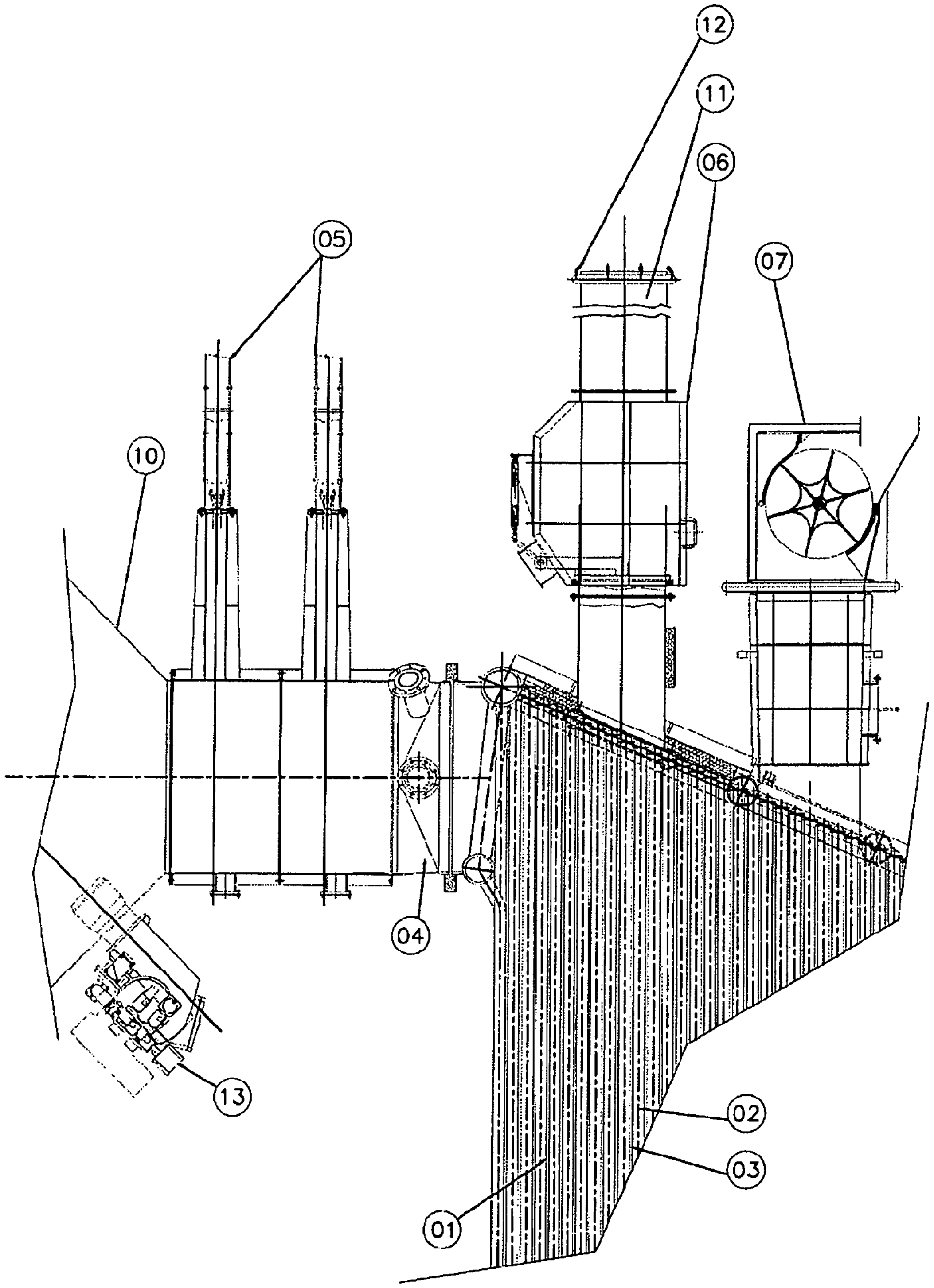

FIG. 4

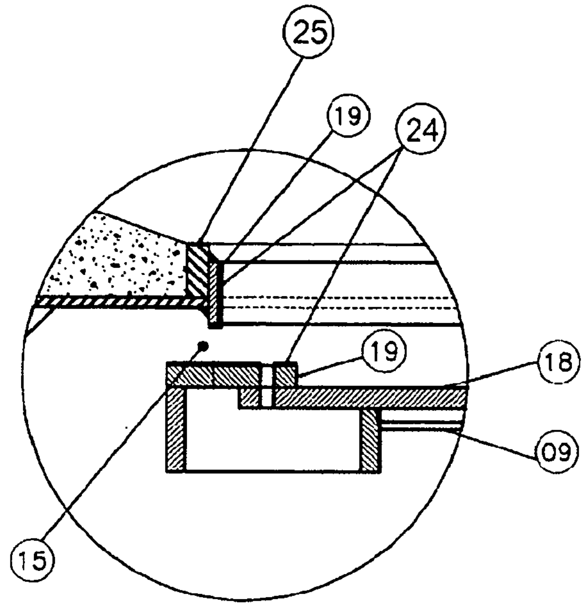

FIG. 5

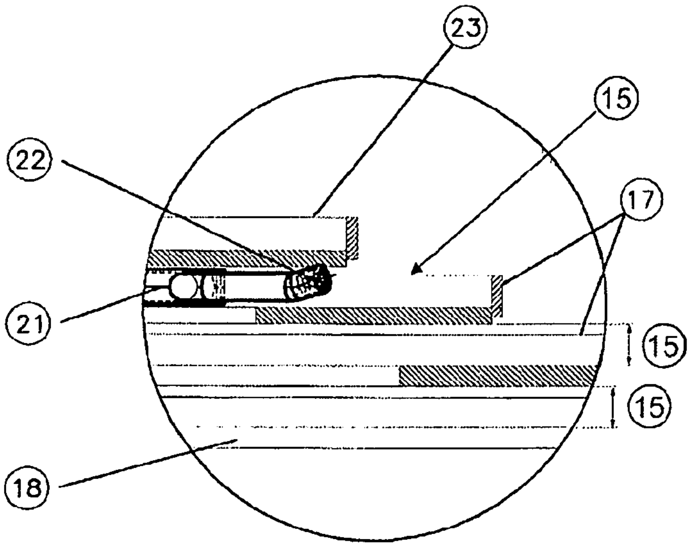

FIG. 6

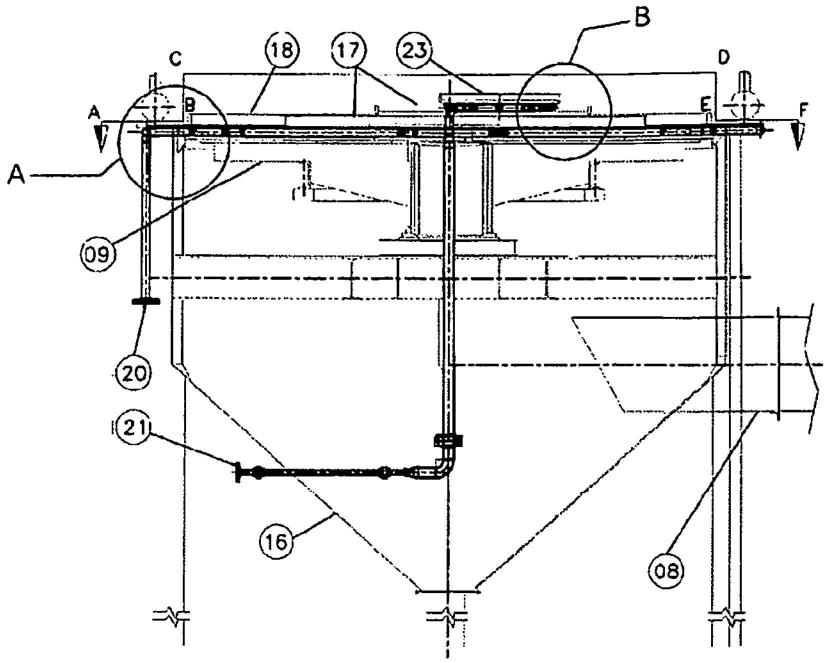

FIG. 7

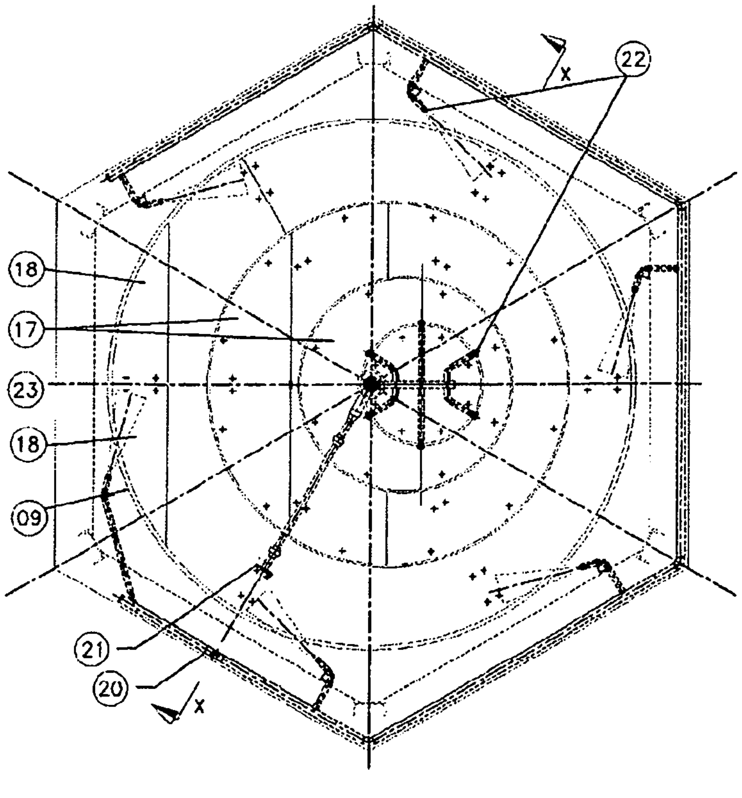

FIG. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 12 00 2891

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	30 August 2012	Lachmann, Richard

CATEGORY OF CITED DOCUMENTS

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