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Method of controlling the temperature in a fluidized bed, and power plant to which the method is applied.

Method of controlling the temperature distribution in a fluidized bed of particulate material when firing with oil. The oil is supplied to the bed in the form of a water/oil emulsion, whereby the water, on the one hand, delays the combustion so that the fuel has time to spread in the bed prior to combustion, and, on the other hand, bursts the fuel droplets so as to obtain additional dispersal of the fuel within the bed. The application further includes a power plant, preferably of the PFBC type, for carrying out method.

FIG. 7

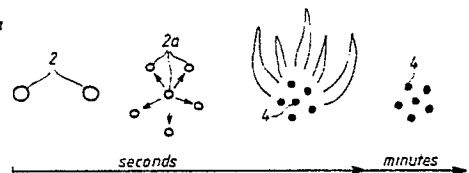
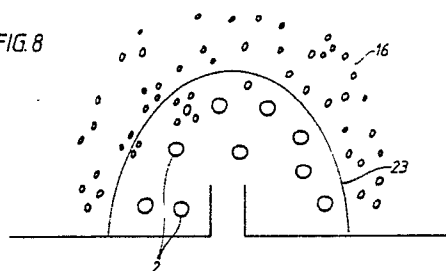


FIG. 8



Method of controlling the temperature in a fluidized bed

The invention relates to a method of controlling the temperature in a fluidized bed according to the precharacterising part of claim 1. The invention also relates to a power plant to which said method is applied.

Temperature distribution control in a fluidized bed is important to reduce thermal stresses in the construction material forming the combustor. This goes particularly for a combustor of a PFBC power plant which is alternatively fired with coal or oil or simultaneously with coal and oil. In a PFBC power plant the combustion is performed at a pressure exceeding the atmospheric pressure. The term "PFBC" is composed of the initial letters of the English term "Pressurized Fluidized Bed Combustion".

Oil firing in a fluidized bed of particulate material entails a number of technical problems as regards the temperature distribution within the bed compared to coal firing. The problems are particularly pronounced when firing at a pressure exceeding the atmospheric pressure, which is the case in a PFBC power plant. The content of volatile substances in an oil droplet is considerably greater than in a coal particle. This results in a more rapid and more concentrated combustion, the fuel being burnt before satisfactory distribution of the fuel within the bed paste has been obtained. The temperature distribution within the bed becomes non-uniform, which is unfavourable and leads to undesired and harmful thermal stresses in the construction material of the bed vessel, in particular in the steam tubes housed in the bed vessel. Also, big oil droplets may stick together to form agglomerates and accumulate on the bottom as a putty-like sludge. This is particularly the case when firing with sticky oil with high viscosity, for example Bunker oil C or residual oil from refineries.

To achieve good temperature distribution both horizontally and vertically in an oil-fired fluidized bed, it has been considered necessary to apply oil nozzles close to each other and possibly at two or more levels. This renders a plant more complicated and expensive. The drawbacks are particularly great in a PFBC power plant which is to be fired with both coal and oil.

The invention aims at developing a method and a power plant for carrying out the method of the above-mentioned kind, which ensures a highly uniform temperature distribution throughout the bed and prevents the formation of a nozzle-clogging sludge on the bottom of the combustor.

To achieve this aim the invention suggests a method according to the introductory part of claim 1, which is characterized by the features of the

characterizing part of claim 1.

Further developments of the method according to the invention are characterized by the features of the claims 2 and 3.

5 A power plant for carrying out the method according to the invention is characterized by the features of claim 4.

According to the invention, a satisfactory temperature distribution is attained by supplying the oil in the form of an emulsion of water and oil. The water delays the combustion. Around a nozzle a heating zone is formed, and outside of this a combustion zone within a larger bed volume. Upon evaporation, the water bursts the fuel so that it is spread within the bed. A power plant to which the invention is applied comprises - in addition to equipment normally present in such plants - also equipment for the preparation of an oil emulsion and control equipment for driving the same.

20 A suitable oil emulsion contains 4-50 percent by weight of water and suitably 0-2% percent by weight of an emulsifier, the balance being oil. A suitable water content is dependent on the sort of oil included in the fuel.

25 By way of example, the invention will now be described in greater detail with reference to the accompanying drawings showing in

Figure 1 the course of events when burning an oil droplet,

30 Figures 2 and 3 the combustion zone at an oil nozzle for small and large oil droplets, respectively,

Figure 4 combustion when the nozzles are positioned relatively far from each other, and the horizontal and vertical temperature distributions in the bed,

35 Figure 5 combustion when the nozzles are positioned close to each other, and a the vertical temperature distribution in a bed,

40 Figure 6 problems with oil accumulation at the bed bottom,

Figure 7 the course of events when burning an oil emulsion,

45 Figure 8 combustion around an oil nozzle when firing with an oil emulsion,

Figure 9 combustion in a bed when firing with an oil emulsion, and the horizontal and vertical temperature distributions within the bed.

50 At time 0 on the time scale 1 in Figure 1, an oil droplet 2 leaves a nozzle, volatile constituents designated 3 leave the oil droplet 2 and are burnt, and a coke residue 4 is obtained. The process takes only a few seconds. The coke residue 4 is then burnt. Coal combustion is performed, in principle, in the same way, but because of the lower content

of volatile constituents, the combustion is performed more slowly and more uniformly within a fluidized bed.

Figures 2 and 3 show nozzles 5 and 6. Small oil droplets are burnt in a small, intense combustion zone 7, large droplets in a larger combustion zone 8. Particularly with small droplets, it is very difficult to attain the desired, uniform temperature distribution in a bed.

In Figure 4, numeral 10 designates a combustor with a bed 11 of particulate material and steam tubes 12 for cooling the bed 11. At the bottom 13 of the combustor 10 oil nozzles 14 are positioned at a relatively large distance from each other, and air nozzles 15 are provided for the supply of air for fluidization of the bed 11 and combustion of the oil from the nozzles 14. Because of the high content of volatile constituents, the combustion is performed rapidly in limited combustion zones 16 and part of the combustion can be performed in the freeboard 17 of the combustor 10. The unsatisfactory distribution of the combustion entails a non-uniform temperature distribution within the bed 11 with a low temperature in regions 18 between the combustion zones 16. Combustion taking place in the freeboard 17 may result in the temperature becoming very high there. The non-uniform temperature distribution within the combustor 10 results in harmful thermal stresses in construction parts, for example the tubes 12. The curve 19 below the combustor 10 shows the temperature distribution in a horizontal section, and the curve 20 to the right of the combustor 10 shows the temperature distribution in a vertical section through the combustor 10.

A uniform horizontal temperature distribution within the bed may be attained with closely located oil nozzles 14 at the bottom 13 of the combustor 10. As shown in Figure 5, the combustion then takes place within a limited vertical area and the combustion zones 16 will be low. A temperature distribution of the kind as shown by the curve 21 is obtained. The combustion gases are cooled down in the cooling zone formed by the tubes 12. The low temperature of the gases leaving the combustor entails a low efficiency of a turbine driven by the gases. The vertical temperature distribution entails thermal stresses on the construction material.

Figure 6 shows another problem that arise in oil firing. In case of insufficient disintegration of the oil, i.e. when feeding big oil droplets, the oil droplets, on leaving the nozzle 4, may form agglomerates 22 which accumulate at the bottom 13 of the combustor 10. The bottom 13 becomes depleted of volatile constituents and is eventually coked with a slag which disturbs the combustion and renders difficult or prevents the feed out of residual products of the combustion from the com-

bustor 10. It may also prevent or render difficult a restart, or clog nozzles.

If the oil fuel is supplied to the bed 11 of the combustor 10 as an emulsion of water and oil, the drawbacks described above are, in all essentials, removed. The course of events when introducing the fuel into the bed 11 is illustrated in Figures 7 and 8. The water content of a fuel droplet 2 delays the heating and thus the escape of volatile substances. The fuel 2 is spread in the bed 11. After some time, volatile substances escape and the evaporating water bursts the fuel droplet 2 into smaller droplets 2a. This results in a good dispersal of the fuel and prevents the accumulation of oil agglomerates 22 at the bottom 13 of the combustor 10. Solid coal particles 4 are formed which spread in the bed 11 and are burnt.

In a zone 23 around the nozzle (Figure 8), the fuel droplets 2 are heated. At the zone border, the fuel droplets 2 start disintegrating by degassing of the volatile constituents of the fuel and by evaporation of the water contents. The water contents thus contribute to spread the fuel in a better way so as to enlarge the combustion zone 16.

By the invention the combustion zone around and above a fuel nozzle is enlarged so as to obtain a uniform distribution of the combustion in the entire bed and a largely uniform temperature and insignificant temperature gradients, also in the case of oil nozzles spaced relatively far away from each other. This is illustrated in Figure 9. The curves 25 and 26 below and to the right of the combustor 10, respectively, show the temperature distribution in the bed 11 in a horizontal and a vertical section, respectively, through the bed 11. The temperature is almost uniform and the temperature gradients are insignificant.

Claims

1. Method of controlling the temperature distribution in a fluidized bed of particulate material and avoiding the accumulation of oil at the bottom of the fluidized bed when firing with oil, **characterized** in that the oil is supplied to the bed in an emulsion of water and oil.

2. Method according to claim 1, **characterized** in that the water/oil emulsion contains between 5 and 40 percent by weight of water and less than 2 percent by weight of emulsifier, the balance being oil.

3. Method according to claim 1 or 2, **characterized** in that the water/oil emulsion is supplied to a fluidized bed in which the combustion is performed at a pressure exceeding the atmospheric pressure.

4. Power plant, preferably of the PFBC type,

for carrying out the method according to any of the preceding claims, **characterized** in that the plant, in addition to the conventional equipment for such plants, comprises equipment for the manufacture of a fuel consisting of oil, water and emulsifier, and control equipment for controlling the composition of the emulsion.

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FIG. 1

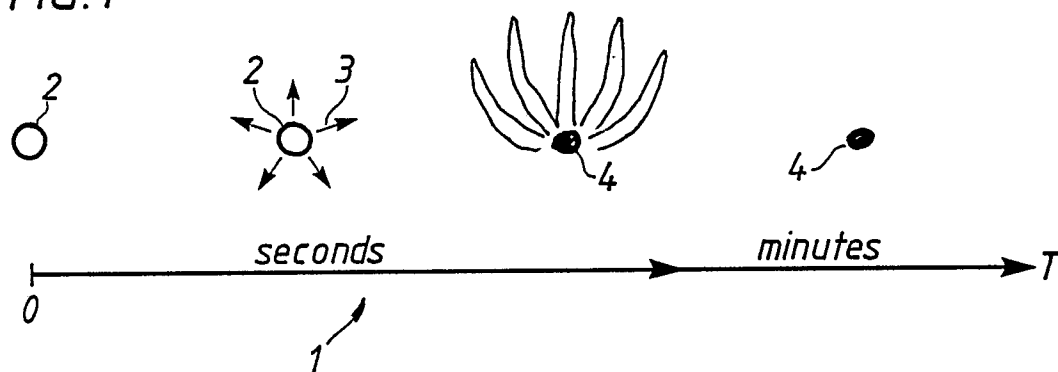


FIG. 2

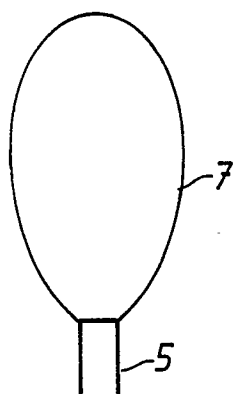


FIG. 3

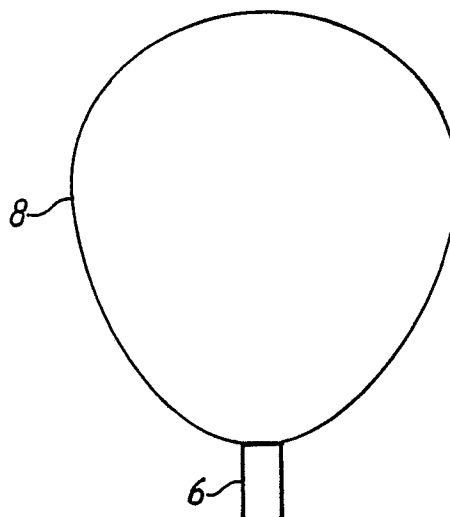


FIG. 4

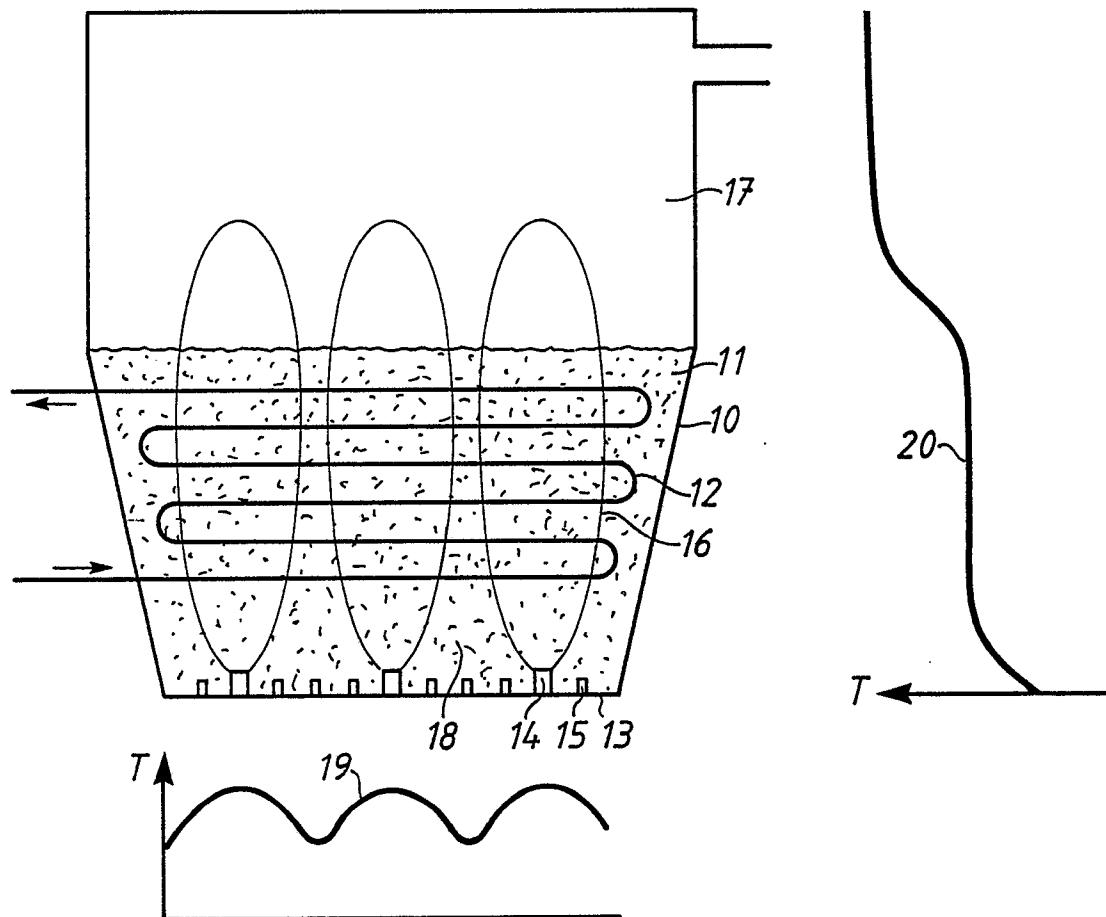


FIG. 5

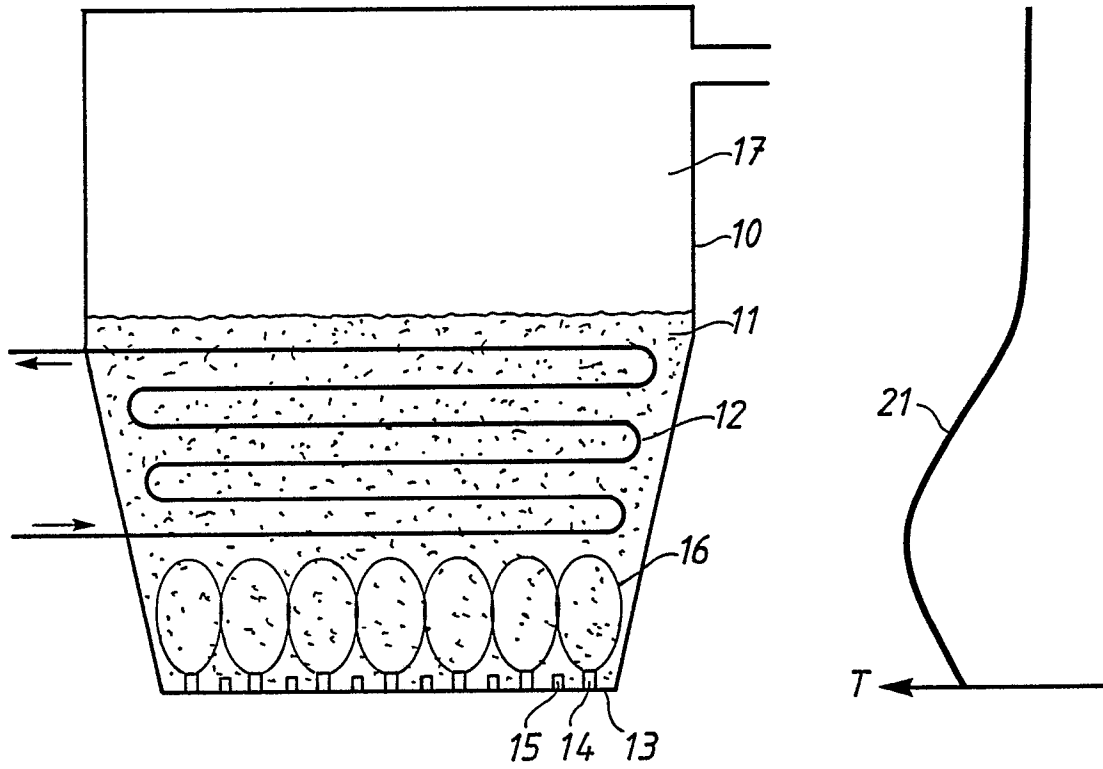


FIG. 6

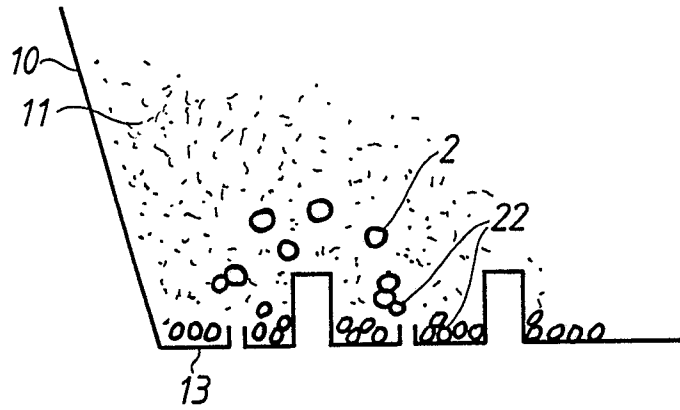


FIG. 7

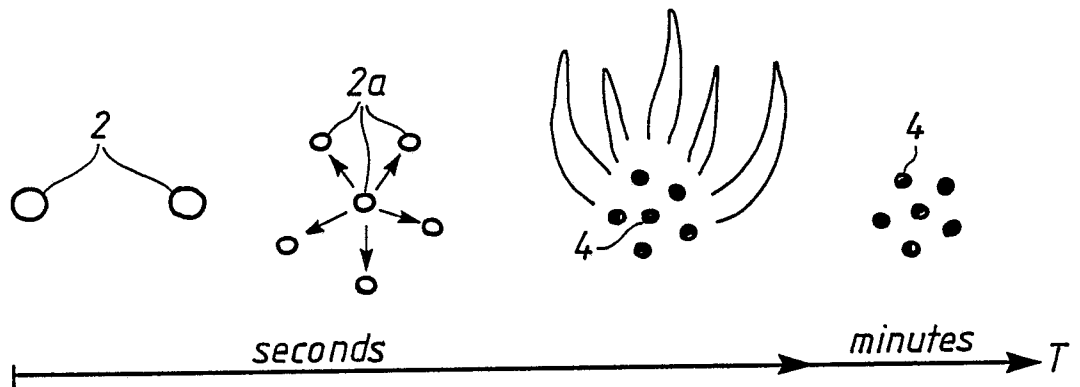


FIG. 8

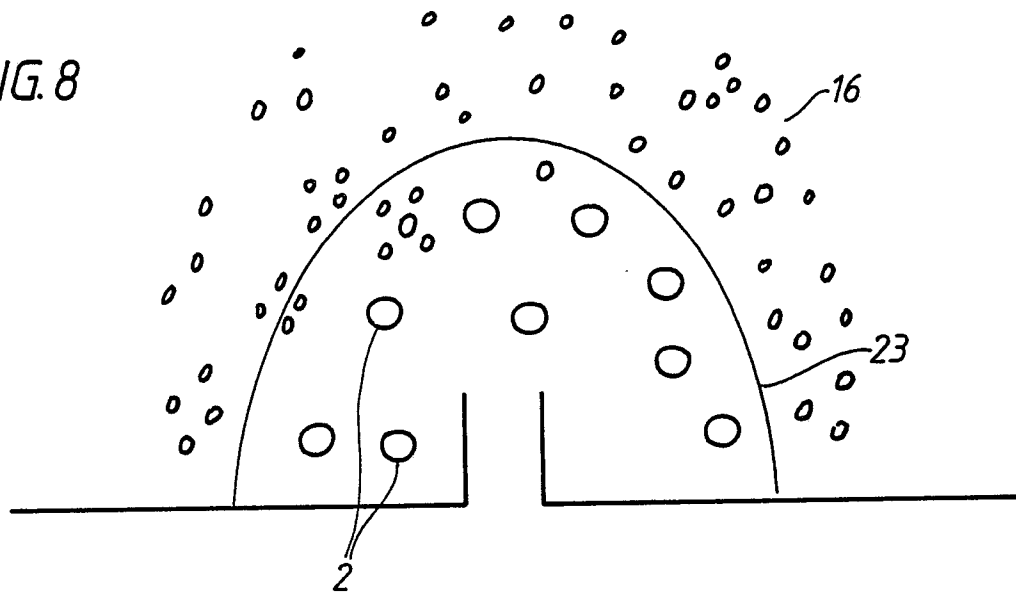
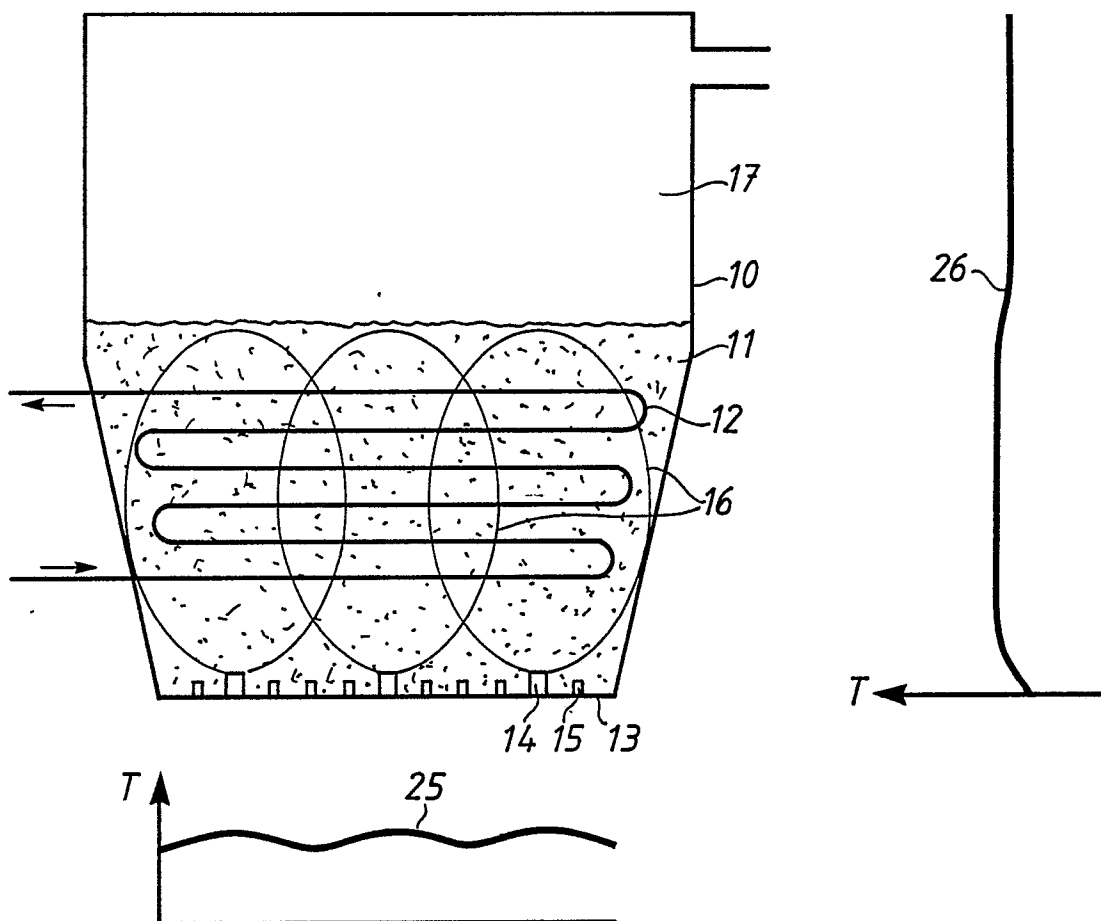


FIG. 9





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. 4)
A	DE-A-2 419 586 (MUSTAD STÖPERI & MEKANISK VERKSTAD A/S) * Claim 1; page 3 last paragraph; page 4 first paragraph *		F 23 C 11/02
A	DE-A-3 218 069 (TANAKA, AKIO, HIMEJI, HYOGO) * Claim 7; page 9 *		
A	DE-A-3 240 837 (PRETEROL AG) * Page 5, lines 14-34 *		
A	US-A-4 542 621 (AB ASEA-ATOM) * Column 3, lines 28-49; claim 1 *		
			TECHNICAL FIELDS SEARCHED (Int. Cl. 4)
			F 23 C F 23 D F 23 K
The present search report has been drawn up for all claims			
Place of search STOCKHOLM		Date of completion of the search 27-09-1989	Examiner BRUUN A.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	