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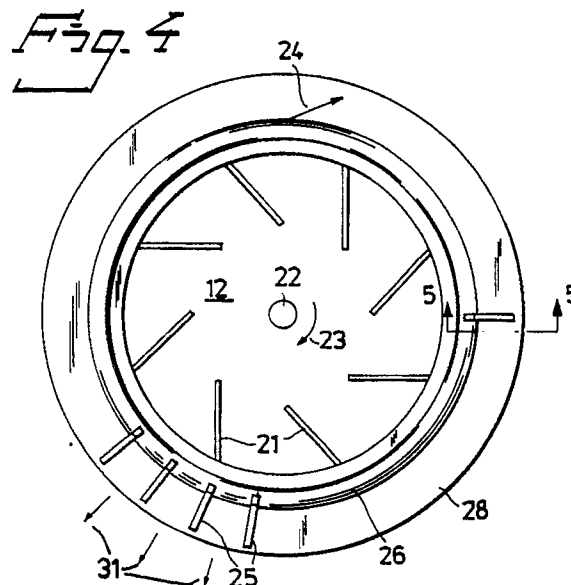
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(57) The invention relates to a hot air oven in which a fan provided with an impeller (12) circulates air past heating elements (26) located in the periphery of the impeller. The air is sucked in into the center of the impeller (12) from the oven cavity and is thrown out from the impeller (12) past the heating elements (26) in order to be reintroduced through apertures at the edges of the oven cavity into the cavity. In order to eliminate the tangential velocity component of the airflow leaving the fan and improve the heat transfer from the heating elements to the airflow and due to that obtain a more uniform heat distribution in the oven cavity a fan provided with airflow guiding means (25) is located on or beyond the heating elements viewed in a radial direction from the center of rotation of the impeller.

**EP 0 409 324 A1**

HOT AIR OVEN.

Field of the invention

The invention relates to a hot air oven having a oven cavity and an air heating space, the air heating space being located in connection to one of the walls of the oven cavity and comprising a driven impeller, airflow guiding means, heating elements and apertures to the oven cavity, the impeller sucking in air from the oven cavity in its center and blowing out the air with a radial and a tangential direction component towards the airflow guiding means and the heating elements and back to the oven cavity through apertures of the oven cavity. The invention is also intended to include ovens of the so called combination type, for example a hot air oven combined with a microwave oven.

Background of the invention

A hot air oven according to the above is previously known from for example EP 0152571. In this embodiment the impeller is located on the top side of the oven cavity. Such a location of the impeller causes a very non-uniform heat distribution in the oven cavity. In the case that for example, an oven plate divides a cavity into two sections. The heated air from the upper section of the cavity then has difficulties to pass to the lower cavity section.

In order to obtain an improved heat distribution it is common to locate the impeller in a space in connection to one of the vertical side-walls of the cavity, see for example EP 0344743. Primarily in the vicinity of the oven cavity side wall abutting on the air heating space a non uniformed heating however often occurs even when the ovens are used having the impeller located in connection to a vertical side wall. The air stream thrown out by the impeller has a flow direction deviating from the radial flow direction of the impeller because the impeller due to its rotation gives the air both a radial and a tangential velocity component. This situation with a resulting flow direction out from the impeller differing from the radial direction causes a rotating flow around the impeller. When the air flows past the heating elements and into the oven cavity, the rotating component remains. This fact implies a flow direction in the oven cavity downwards towards the oven bottom in one half of the cavity and upwards towards the top in the other half of the oven cavity in the case that the air heating space is located in connection to a vertical wall of the oven cavity. The described situation for the flow directions has the consequence that a

spread load, for example fancy biscuits on a plate positioned in the middle of the oven gets relatively to much top heat in one half and relatively to much bottom heat in the other half. This in its turn results in non-uniform quality of the finished load, for example fancy biscuits, disappointing the consumer. In one half of the oven the bottoms of the biscuits becomes scorched while in the other half the biscuits top part become scorched before the biscuits are totally baked throughout the biscuits.

In order to obtain a uniform temperature distribution airflow guiding means are located between the impeller and the heating elements in the above prior art ovens. However, the ovens have the disadvantage that the airflow having a suppressed tangential direction component leaving the airflow guiding means are disturbed by the following heating elements. This results in that the airflow blowing into the oven still contains airflow direction components causing an ununiform temperature distribution.

Another reason for the nonequal heating in the prior art oven is bad heat transfer from the heating element to the airflowing past the heating elements due to the small surface of the heating elements relative to the power and relieving phenomena when the air leaves the heating elements. The bad heat transfer results in a high outer temperature on the heating elements which in its turn results in a high radiant efficiency to the cavity wall in connection to the air heating space. This cavity wall is owing to that heated to high temperatures, which results in scorched parts of the load closest to said wall.

Summary of the invention

The present invention has for its object to provide a hot air oven which by the simple and cost-advantageous construction provides a more uniform heating within the oven cavity. The object of the invention is obtained by means of a hot air oven according to the first paragraph characterized in that the airflow guiding means are located on or beyond the heating elements viewed in a radial direction from the center of rotation of the impeller to suppress the tangential direction component. The airflow guiding means suppress and may essentially eliminate the tangential velocity component of the airflow at the same time as they contribute to a better heat transfer from the heating elements resulting in a more uniform heating of the load.

According to an advantageous embodiment of

the invention radiation shields are located between the heating elements and the cavity wall in connection to the heating space and these radiation shields and the airflow guiding means are integrated. The embodiment is non-complicated and may be obtained to a low cost due to the fact that the radiation shields and the airflow guiding means may be manufactured starting from a metal plate by means of punching and bending. Another advantage is that the air heating space in which the impeller and the heating elements are located together with the airflow guiding means and the radiation shields according to the invention may be made very compact and owing to that does not encroach on the total volume of the oven or the oven cavity in any decisive degree.

According to another favourable embodiment, the hot air oven is characterized in that the airflow guiding means comprise an inlet section having an airflow direction essentially coinciding with the direction for the airflow from the impeller and an outlet section having an essentially radial airflow direction. Inlet and outlet sections having the stated airflow directions causes a minimum of disturbances in the airflow delivered by the impeller simultaneously as the tangential direction component is efficiently suppressed.

The above and other aspects of the invention will be described and elucidated with reference to the drawings and examples.

Brief description of the drawings

Below the invention is described by way of example with reference to the accompanying drawings, in which

Fig. 1 is a schematical perspective view of a hot air oven according to the invention;

Fig. 2 shows the hot air oven according to the invention in a vertical section along the line 2-2 in Fig. 1;

Fig. 3 shows the hot air oven according to the invention in a vertical section along the line 3-3 in Fig. 1;

Fig. 4 schematically in side view shows an impeller having airflow guiding means according to a first embodiment of the invention;

Fig. 5 shows a section along the line 5-5 in Fig. 4 for the first embodiment;

Fig. 6 schematically in side view shows an impeller having airflow guiding means and radiation shields according to a second embodiment of the invention;

Fig. 7 shows a section along the line 7-7 in Fig. 6 for the second embodiment of the invention completed with a plate separating the air-heating space from the oven cavity;

Fig. 8 schematically in side view shows an impeller having airflow guiding means according to a third embodiment of the invention;

Fig. 9 and 10 show a first and a second example of the more detailed embodiment of airflow guiding means included in the third embodiment according to Fig. 8 within a frame indicated by broken lines in the figure, the figures 9a, and 10a showing the airflow guiding means in side view and fig. 9b and 10b showing the airflow guiding means in a radial section along the line 9-9 in Fig. 8.

Description of preferred embodiment

The principal construction of the hot air oven will now be described with reference to the figures 1-3. The oven comprises an oven cavity 2 and an air heating space 3 delimited by four vertical walls 4-7, an upper horizontal wall 8 and a lower horizontal wall 9. The air heating space 3 and the oven cavity 2 are separated by a plate 10, preferably of metal. An oven door 1 is located in the front wall of the horizontal walls 4. Between the horizontal back wall 6 and the plate 10 a drive motor 11 is located to drive an impeller 12. Preferably, the drive motor 11 is separated from the impeller 12 by means of a wall 19. Heating elements and airflow guiding means are located at the periphery of the impeller. The heating element and airflow guiding means are only schematically indicated and has been given the reference numeral 13 in fig. 2, but will be described in more detail with reference to more detail drawings below. The plate 10 is shaped in such a way that apertures are formed between the oven cavity 2 and the air heating space 3. Apertures 14-17 and 18, respectively, are present both at the edges of the plate and in the center of the plate just opposite the impeller 12. In operation the impeller 12 sucks in air from the oven cavity through the aperture 18 in the center of the plate 10 towards the central part of the impeller. At the same time the impeller 12 throws out the air with a radial and a tangential direction component from the center of the impeller and past the heating elements and airflow guiding means 13 located at the periphery of the impeller and back to the cavity 2 through apertures 14-17 at the edges of the plate 10. In fig. 2 the air flows through the oven are indicated by arrows 20.

Figures 4 and 5 show an impeller having airflow guiding means according to a first embodiment. The impeller 12 is provided with a suitable number of fan blades 21 and is coupled to a not in more detail shown drive motor shaft 22 in its center. The drive motor 11 rotates the impeller 12 in the direction shown by the arrow 23. The resulting

velocity component that the airflow from the impeller 12 assumes is indicated by the arrow 24. Guide rails 25 are located around the periphery of the impeller and fixed to a heating element 26 in order to reduce the tangential velocity component of the airflow from the impeller. In the shown first embodiment the guide rails are secured to a circular flat ring 28, preferably of a resilient material. Each guide rail 25 has a recess 30 in order to at least partly clasp a heating element and is provided with an oblique edge 29. The guide rails 25 may be mounted by pressing them over the heating element 26 so far that the recesses 30 in the guide rails at least partly grasp the heating element. The oblique edge 29 on the guide rails 25 facilitates the applying of the guide rails by admitting a gradual deflection of the respective guide rails. The arrows 31 indicates the airflow direction after the passage of the guiderails. The shown flat ring 28 facilitates the mounting of the guide rails 25 but is not necessary and may possibly be removed after the mounting of the guiderails or totally spared in case of a more manual mounting.

The figures 6 and 7 show an impeller 12 having airflow guiding means and radiation shields according to a second embodiment of the invention. Two heating elements 26, 27 are located around the impeller 12 having fan blades 21 adjacent to which airflow guiding means and radiation shields are located. The heating elements are coupled to a connection plate in a suitable known way. The two elements may, for example, consist of a loop having two turns. The airflow guiding means and the radiation shields are made integrated starting from a metal blade. By means of punching and bending a circular ring has been manufactured having inwardly bent lugs 32 operating as radiation shields and essentially radially extending bendings 33 outwardly operating as guide rails. The radiation shields are located in close connection to the plate 10 but on such a distance that a small airflow 34 may pass between the plate 10 and the radiation shields 32.

When the impeller 12 rotates in the rotation direction of the arrow 23 an airflow is sucked in into the center of the impeller from the oven cavity 2. This airflow is pressed out from the center of the impeller with a flow direction 24 having a considerable tangential component. The main part of the amount of air is forced to flow through apertures 35 formed simultaneously with the bendings outwards of the guide rails and past the guide rails in the shape of bendings outward 33. The guide rails influence the airflow so that it leaves the guide rails or bendings in an essentially radial direction indicated by the arrows 31. Due to the fact that the circular ring is situated close to the heating element much heat is transferred from the heating

elements 26, 27 to the ring which in its turn is chilled by air. Accordingly, the construction increases the heat transfer from the heating elements 26, 27 to the circulating air in a considerable degree. The bent lugs in 32 operate as radiation shields in order to decrease a direct radiation from the heating elements to the plate 10, that is the rear portion of the oven space. The small airflow 34 which is admitted to pass between the plate 10 and the radiation shieldings of the ring keeps the heat transfer between the radiation shields of the ring and the plate 10 on a low level.

The figures 8-10 show a third embodiment of the invention. In this embodiment a number of flanges 40 are applied around the heating element 26 surrounding the impeller 12. The flanges 40 may be applied by means of welding, bracing or pressing. The heating element is connected to a connection plate 41 which together with the heating element 26 establish an essentially circular loop. The arrow 23 shows the rotation direction of the impeller 12 and the arrows 31 the direction for the airflow leaving the flanges 40.

In the figures 9 and 10 two alternative embodiments of a flange are shown. The figures 9a and 10a show enlargements of the framed region 44 indicated by a broken line in figure 8, while the figures 9b and 10b show a section along the line 9b-9b in fig. 8. According to the figures 9a and 9b, the flange 40 consists of an essentially flat square-shaped plate having an aperture in the middle through which the heating element 26 runs. The flange 40 is mounted on the heating element 26 in such way that the flat plate essentially coincides with the radial direction of the impeller 21. The airflow leaving the impeller will then enter between the flanges at a certain angle to the flange direction. The flanges will due to that provide a rather abrupt adjustment of the airflow which may cause the airflow to bounce forward between the flanges and leave these with a remaining tangential velocity component. In normal cases this remaining tangential velocity component may be accepted. In order to eliminate the tangential velocity component even more when desired, the inlet section 42 of the flanges may be adapted to the incoming airflow direction. In the figures 10a and 10b a flange is shown having such an inlet adapted to the airflow. The flange 40 consists of a rectangular plate which is bent on the inlet side so that the inlet section 42 of the flange essentially coincides with the inlet direction of the airflow. The outlet section 43 of the flange is as in the embodiment in fig. 9 directed to essentially coincide with a radial airflow.

A number of in the above description here not described embodiments are accommodated within the scope of the invention. It is inter alia possible to construct the airflow guiding means according to a

great number of alternative embodiments in order to obtain the desired radial airflow.

Claims

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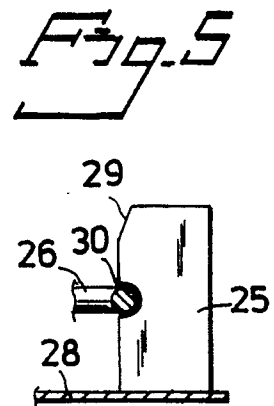
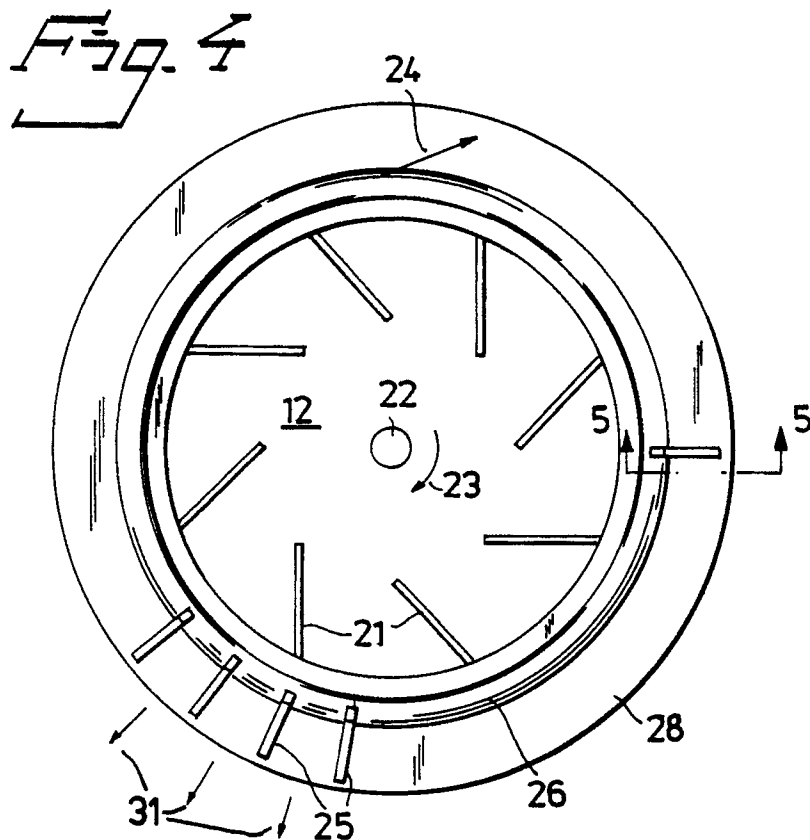
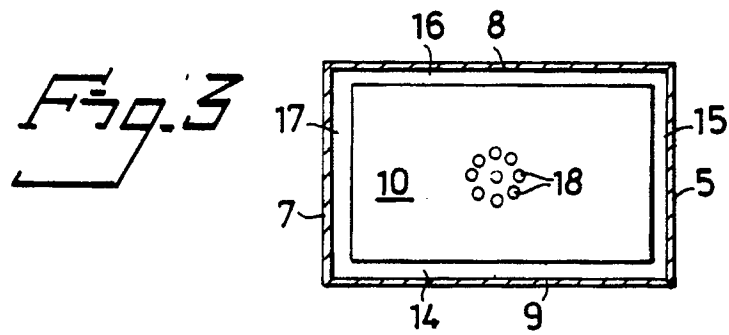
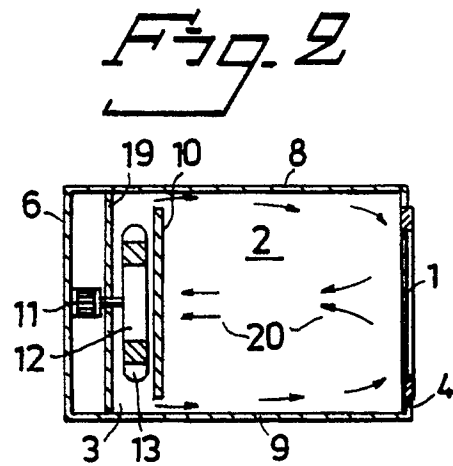
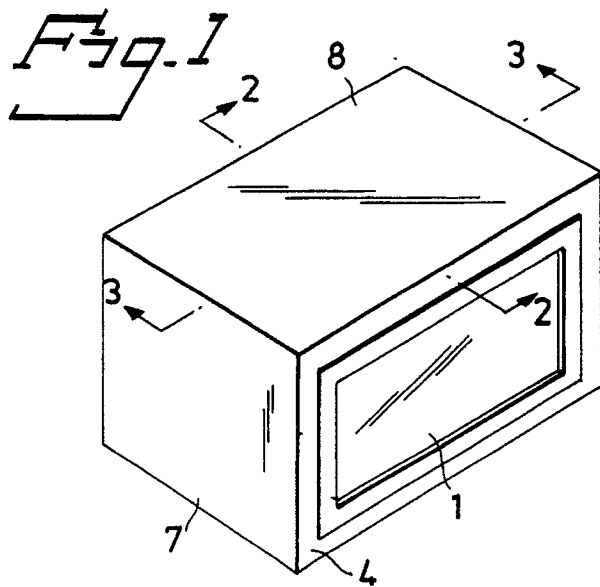
1. A hot air oven having an oven cavity and an air heating space, the air heating space being located in connection to one of the walls of the oven cavity and comprising a driven impeller, airflow guiding means, heating elements and apertures to the oven cavity, the impeller sucking in air from the oven cavity in its center and blowing out the air with a radial and a tangential direction component towards the airflow guiding means and the heating elements and back to the oven cavity through apertures of the oven cavity, characterized in that the airflow guiding means are located on or beyond the heating elements viewed in a radial direction from the center of rotation of the impeller to suppress the tangential direction component. 10 15 20
2. A hot air oven as claimed in Claim 1, characterized in that the airflow guiding means are guide rails.
3. A hot air oven as claimed in Claim 2, characterized in that the guide rails are located in an essentially radial direction. 25
4. A hot air oven as claimed in any of the preceding Claims, characterized in that radiation shields are located between the heating elements and the cavity wall in connection to the air heating space. 30
5. A hot air oven as claimed in Claim 4, characterized in that the airflow guiding means and the radiation shields are integrated.
6. A hot air oven as claimed in 1, characterized in that the airflow guiding means are flanges located on the heating elements. 35
7. A hot air oven as claimed in any of the Claims 1-2 and 4-6, characterized in that the airflow guiding means comprise an inlet section having an airflow direction essentially coinciding with the direction for the airflow from the impeller and an outlet section having an essentially radial airflow direction. 40 45

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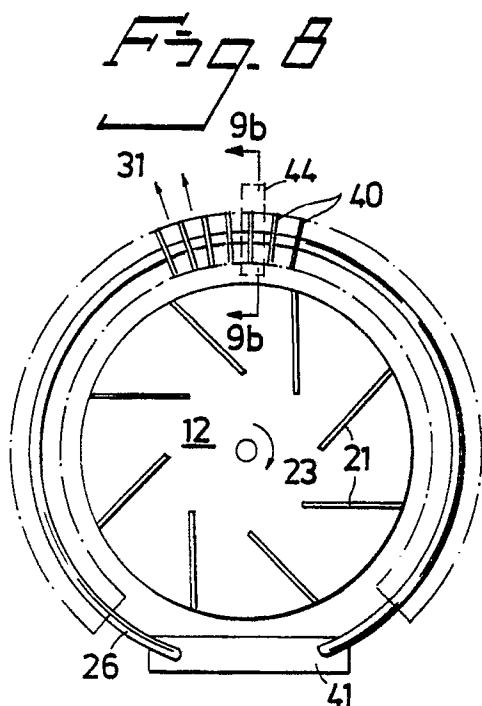


Fig. 9a *Fig. 9b*

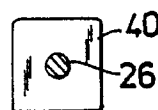


Fig. 10a *Fig. 10b*

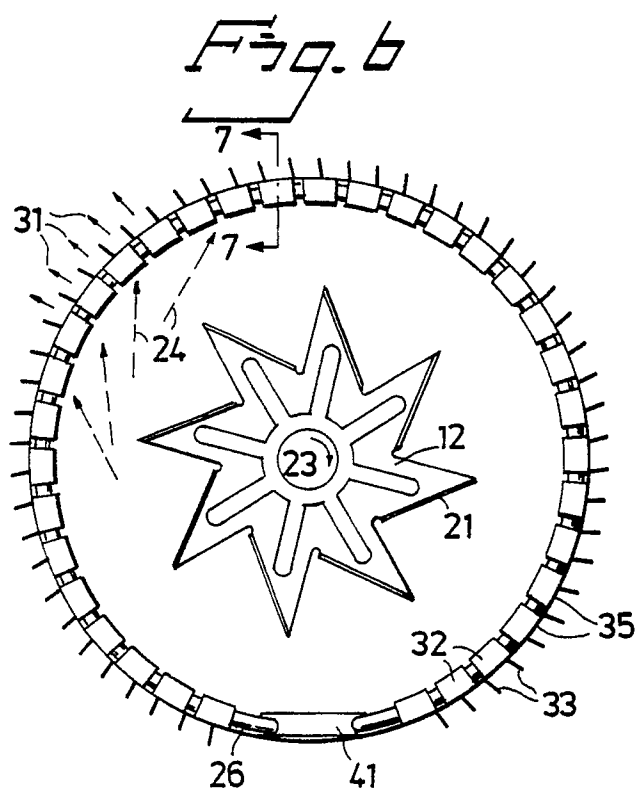
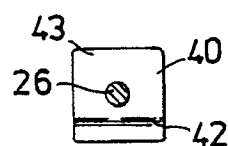
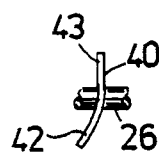
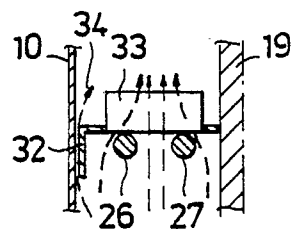


Fig. 7





European Patent
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EUROPEAN SEARCH REPORT

Application number
EP90201891.0

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (In Cl ¹)
X Y	AU-A-524 652 (EMAIL LIMITED) *Figure 2, details 19,20*	1-3 7	F 24 C 15/32 F 24 C 7/00 A 21 B 1/26
Y A,D	--- EP-A2-0 152 571 (ZANUSSI GRANDI IMPIANTI S.P.A.) *Figure 2, details 16,17; page 3, line 37 - page 4, line 9*	7 1-3	
X P,D	--- EP-A2-0 344 743 (ZANUSSI GRANDI IMPIANTI S.P.A.) *Column 4, lines 30-58; column 5, lines 52-57, figure 3*	1-3,6,7	
A	--- DE-B2-2 339 446 (BOSCH-SIEMENS HAUSGERÄTE GMBH) *Figure 1, details 71-85*	1,2,7	
A	--- DE-A1-3 517 559 (LICENTIA PATENT-VERWALTUNGS-GMBH) *Figure 2, detail 8*	6	TECHNICAL FIELDS SEARCHED (In Cl ¹)
A	--- GB-A-2 109 920 (GAS AND FUEL CORPORATION OF VICTORIA) *Figure 5, details 28*	1-3	F 24 C F 27 D A 21 B
A	--- US-A-3 324 844 (C.L. HUFFMAN) *Figure 4, details 45-49*	1-3	
A	--- DE-B2-2 557 867 (BOSCH-SIEMENS HAUSGERÄTE GMBH) *Figure 2, details 18-21*	1	
A	--- EP-A2-0 245 618 (KABUSHIKI KAISHA TOSHIBA) *Figures 3-10*	1,2	
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
STOCKHOLM		10-10-1990	BRUN 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	