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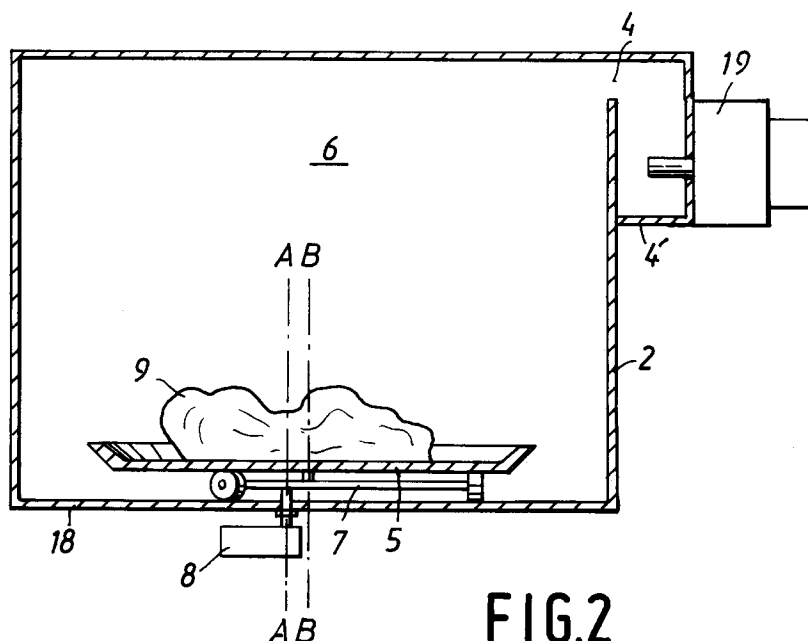
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DE FR GB IT SE(71) Applicant: **WHIRLPOOL INTERNATIONAL B.V.**
Luchthavenweg 34
NL-5507 SK Veldhoven(NL)(72) Inventor: **Carlsson, Hakan**
c/o INT. OCTROOIBUREAU B.V., Prof.
Holstlaan 6
NL-5656 AA Eindhoven(NL)(74) Representative: **Bos, Kornelis Sjoerd et al**
INTERNATIONAAL OCTROOIBUREAU B.V.
Prof. Holstlaan 6
NL-5656 AA Eindhoven(NL)(54) **Oven with a rotating bottom plate.**

(57) The invention relates to an oven, preferably a microwave oven, having a rotatable bottom plate (5) in the bottom (18) of a oven cavity (6). According to the invention the center of rotation (B-B) of the bottom plate (5) is moveable essentially in the rota-

tion plane of the bottom plate. Hereby a more even heating of a load (9) applied on the bottom plate is obtained. Furthermore it is prevented that a magnetron (19) included in the microwave oven is stressed by the applied load (9).

**FIG.2****EP 0 474 306 A1**

The present invention relates to an oven, preferably a microwave oven comprising an oven cavity, a rotatable bottom plate provided in the oven cavity for rotation of a load applied on the bottom plate, a drive motor for rotation of the bottom plate, and a transmission coupling between the drive motor shaft and the rotatable plate.

An oven according to the above with a rotating plate is previously known from, for example, US 4 757 173. In such prior art ovens the microwave energy commonly forms a so called standing wave pattern which not essentially varies in time but varies in the space with distributed field maxima and field minima in the oven space or cavity. A load, for example, the food to be cooked will be moved relative to the field maxima and field minima when the bottom plate is rotated, resulting in a certain levelling out of the heating in time.

A problem with this kind of ovens is that each point in its movement is delimited to a circular shape. If furthermore the circle followed by the point has a small radius, which is the case in the vicinity of the center of rotation, the movement will be small or almost non-existing. To a large extent the levelling out in time of the heating does not take place. A consequence of the feeding principle is that a region in the middle of the load often gets a too strong heating or a too weak heating, a so called "hot spot" or "cold spot", that is a warm or cold region arises. One and the same oven may have both types of regions in dependence of the load applied on the bottom plate. Another consequence of the feeding principle in the case when the load is essentially round, is that the operating point of the magnetron not is influenced but is fixed in time. This situation in its turn results in a fixed magnetron frequency and due to that fact the magnetron may be stressed when the operating point is unfavourable. Such a condition results in that the life time of the magnetron is reduced to an essential extent.

In order to mitigate the problems of the stated feeding principle and obtain a more even heating of the load, the bottom plate according to said US patent specification is arranged to be movable up and down during its rotation. Such a movement of the load however requires a relatively expensive and complicated construction. Among other things a strong motor is required to be able to lift the load and the comprised coupling element due to that fact must be dimensioned for the strength of the required strong motor.

In this connection it is also to be observed that the prior art bottom plate during its movement upwards and downwards also is subjected to a smaller rocking movement. However, this rocking movement is not comparable with the displacement of the bottom plate according to the invention in

the plane of rotation of the bottom plate. As a result of the rocking movement the bottom plate may be tilted a small angle θ relative to the horizontal plane. Accordingly a slight inclination of the bottom plate is obtained. It is necessary that the rocking movement is small and the movement does hardly result in any improvement of the heat levelling out due to the fact that the distance between field maxima and field minima of the so called standing waves in the oven cavity essentially exceeds the displacement obtained by means of the rocking movement and for example may be of the order of magnitude 30 mm.

It is an object of the present invention to obtain a microwave oven, which by means of a simple and cost-saving construction provides an even heating of an applied load and which reduces the risk of stressing the magnetron.

According to the invention the object is obtained by means of a microwave oven according to the first paragraph characterized in that the center of rotation of the bottom plate is arranged to be moved relative to the oven cavity essentially in the plane of rotation of the bottom plate at the same time as the bottom plate is rotated. In the microwave oven according to the invention there are no lifts of the load but this movement has been replaced by a movement in the horizontal plane. In order to move the bottom plate it is essentially only required to overcome the friction forces. Due to that fact a simple and a less powerful drive motor may be used which also results in that the transmission coupling may be simplified and thereby may be manufactured at a low cost. According to a specific embodiment the oven is characterized in that the center of rotation of the bottom plate is arranged to be moved along a circular path.

The bottom plate may in a known way rest on a transmission coupling provided with support wheels to transmit the rotation movement from the drive motor shaft to a rotation movement of the bottom plate via one or several support wheels. According to a favourable embodiment of the oven it is in this connection characterized in that the rotation center of the bottom plate is displaced relative to the rotation center of the transmission coupling to obtain a simultaneous displacement and rotation of the bottom plate in its plane of rotation. Such a separation of rotation centers in order to give the bottom plate a suitable movement is possible to obtain by means of simple but nevertheless reliable constructions.

The transmission coupling may comprise a transmission element having a centre section and at least three from the same emanating branches provided with at least one support wheel in the end of each branch for cooperation with the cavity bottom of the oven and the bottom plate, and

rotation movement transmission between the transmission element and the bottom plate. A favourable embodiment in connection with an oven having a transmission coupling according to the above is characterized in guide means acting between the transmission element and the bottom plate to guide the movement of the bottom plate.

Advantageously the guide means essentially act in the center of the bottom plate and according to this embodiment the guide means consist of a guide pin combined with a recess, the guide pin being provided on the transmission element and the recess in the rotation center of the bottom plate or vice versa. The guide means may according to another favourable embodiment act in the peripheral section of the bottom plate. A suitable embodiment is thereby characterized in that the guide means consist of an essentially circular ring-shaped raising provided on the underside of the bottom plate and which cooperates with at least one of the support wheels of the transmission element.

According to a favourable embodiment avoiding slippage between wheels and bottom plate and/or wheels and the cavity bottom, the oven is characterized in that a number of the branches of the transmission element are provided with two support wheels, one of the support wheels being arranged to bear on the bottom plate, the other support wheel being arranged to bear on the bottom of the oven cavity.

In order to prevent a short periodicity of a point on the bottom plate, that is that the point returns to the same position in the oven with short intervals, the oven suitably is characterized in that the ratio of the rotation speed of the bottom plate V_b and the rotation speed of the drive motor shaft has a value differing from 2.00.

These and other aspects of the invention will be apparent from and illuminated with reference to the embodiment described hereinafter.

The invention will now be described with reference to the accompanying drawings, in which

fig. 1 schematically in perspective view shows a microwave oven according to the invention;

fig. 2 shows a section through the microwave oven according to fig. 1 parallel with the dooropening and essentially in the middle of the oven;

fig. 3 shows a first embodiment to drive the bottom plate in a microwave oven in top view, fig. 3a, and side view according to the line 3b-3b in fig. 3a, partly in section, fig 3b;

fig. 4 shows a second embodiment to drive the bottom plate in a microwave oven in top view, fig 4a, and in section, fig 4b, according to the section 4b-4b in fig. 4a; and

fig. 5 shows a third embodiment to drive the

bottom plate in a microwave oven in side view partly in section.

The microwave oven shown in fig. 1 in perspective view comprises a schematically shown outer envelope 1 and an inner envelope 2 covering the cavity 6. The cavity is closed by means of a door 3. The cavity is fed by means of microwaves from a not shown magnetron intended to be coupled to the input opening 4 of the cavity 6 via a wave guide 4'. In the bottom 18 of the cavity there is a rotatable bottom plate 5.

Fig 2 schematically shows in what way the bottom plate 5 is provided in the oven cavity 6. Components having correspondence in fig. 1 have been given the same reference numerals. According to fig. 2 the bottom plate 5 is supported by a transmission coupling 7 provided with support wheels and driven by a drive motor 8. A load 9 are shown applied on the bottom plate 5. A magnetron connected to the wave guide 4' has been given the reference numeral 19.

According to the embodiment shown in fig. 3a and 3b the drive motor 8 rotates a branch-shaped transmission element 11, comprising branches 12a, 12b, 12c and a center section 22 via its shaft 10. The rotation center of the shaft 10 and the transmission element is in the dash dotted center line A-A. Each branch supports a support wheel 13a, 13b, 13c respectively. The support wheels bear on the bottom 18 of the oven cavity 6 and support the bottom plate 5. In fig. 3a the bottom plate 5 is only indicated by means of dashed lines in order not to hide the transmission coupling. As is apparent from fig. 3b the bottom plate looks like a low circular vessel having an inclined edge. The drive motor shaft 10 is coupled to the transmission element 11 in a coupling point 16 with at least two different distances r_a , r_b , r_c to the support wheels 13a-13c. In the center of the transmission element 11 and at equal distances from the support wheels an essentially cylindrical guide pin 14 is projecting from the transmission element 11. The guide pin 14 cooperates with a recess 15 in the center of the bottom plate. The center line through the center of the guide pin is the center of the rotation for the bottom plate and is indicated by means of the dash dotted line B-B.

When the shaft 10 of the drive motor 8 is rotated, the transmission element 11 carries out a rotation movement around the center line A-A. The support wheels 13a-13c which are in friction contact with the cavity bottom 18 of the oven are thereby put into wheeling. This wheeling movement of the support wheels is transmitted to the bottom plate 5 which is put in rotation around the center of rotation of the bottom plate 5 in the center line B-B in the center of the guide pin of the transmission element. Accordingly the bottom plate 5 rotates

around its own center of rotation B-B at the same time as this center is moved along a curve which in this case is a circle.

In order that each point on the bottom plate not shall return to the same position in the oven to often the rotation speed of the bottom plate must deviate from the speed of the motor and furthermore the rotation speed of the bottom plate should not be an integral multiple rotation speed of the motor. In the case that the center of rotation for the center lines A-A and B-B are arranged to coincide and the support wheels are symmetrically arranged relative to the coinciding center point, the ratio of the bottom plate rotation speed and the transmission element rotation speed should show the ratio 2.00 expressed with two decimals in coincidence with known movement transmission rules. In that case the non-desired situation is present that the rotation speed of the bottom plate is an integral multiple of the rotation speed of the motor. By separating the rotation centers of the bottom plate and the transmission element a distance R, a ratio is obtained deviating from 2.00 and which, for example, may be 1.95 or 2.05. This separation of rotation centra results in that at least two of the support wheels become inclined in its wheeling path on the cavity bottom or the underside of the bottom plate. The inclination results in that the wheels will slip or glide relative to the wheeling path, rendering the ratio according to the above differing from 2.00. According to the embodiment shown in fig. 3a and 3b the support wheels 13a and 13c are inclined in its wheeling path on the cavity bottom.

If the distance R between the center of rotation of the bottom plate and the center of rotation of the transmission element is chosen to 10 mm, the center of rotation of the bottom plate will rotate along a circle having the radius 10 mm (=R) and the mid-point of which is on the center line A-A. A point 21 at the distance d from the center of the center of rotation of the bottom plate will move between two concentric circles. If the ratio of the rotation speed of the bottom plate and the rotation speed of the transmission element furthermore differs from 2.00, all of the surface between the concentric circles will be covered after several revolutions of rotation. The ratios of the concentric circles may be expressed by means of the following relations:

$$r_y = d + R$$

$$r_i = d - R$$

in which r_y is the radius of the outer concentric circle and r_i is the radius of the inner concentric circle. The common center of the concentric circles is past by the center line A-A. For $d = 10$ mm

and $R = 10$ mm, it holds that $r_y = 20$ mm and $r_i = 0$ mm, that is the total circle having the larger radius r_y is covered. For $d = 20$ mm, it holds that $r_y = 30$ mm and $r_i = 10$ mm, that is a circular band having the width $r_y - r_i = 20$ mm is covered.

From the above numerical example it is apparent that even a relatively small distance between the center of the bottom plate and the transmission element ($R = 10$ mm) provides a relatively large movement in the middle section of the bottom plate. If a larger movement is desired, the rotation center of the bottom plate may be moved from the center of the transmission element, that is R may be increased.

In the embodiment shown in fig. 3a and 3b the support wheels 13a and 13c are inclined relative to the wheeling path on the cavity bottom 18. In its prolongation the shafts of the support wheels 13a-13c passes through the rotation center of the bottom plate. The prolongation of the shaft of the support wheel 13b furthermore passes through the rotation center of the transmission element.

The following numerical example may serve as an example of a possible dimensioning of the transmission coupling:

$$R = 10 \text{ mm}$$

$$r = 105 \text{ mm}$$

$$r_a = r_c = 100.4 \text{ mm}$$

$$r_b = 115 \text{ mm}$$

$$V_m = 2.47 \text{ revolutions/min}$$

in which V_m denotes the rotation speed of motor shaft.

If it is assumed that the support wheels on the transmission element run without gliding on the cavity bottom 18, the periphery speed on the wheel shafts for the support wheels 13a, 13b, 13c are:

$$V_{pa} = V_m \cdot 2 \cdot 3.14 \cdot r_a = 25.9 \text{ mm/s} \quad (1)$$

$$V_{pb} = V_m \cdot 2 \cdot 3.14 \cdot r_b = 29.7 \text{ mm/s} \quad (2)$$

$$V_{pc} = V_m \cdot 2 \cdot 3.14 \cdot r_c = 25.9 \text{ mm/s} \quad (3)$$

If it is assumed that the support wheels on the transmission element runs without gliding on the bottom plate 5 and that the support wheel 13b also runs on the cavity bottom 18, the following is valid. The contact point of the bottom plate against the support wheel 13b has a double wheel speed, that is $29.7 \cdot 2 = 59.4$ mm/s. The rotation speed of the bottom plate $V_b = 2 \cdot V_m \cdot r_b/r = 5.40$, that is the doubled rotation speed of the motor shaft weighed with the rotation radii. The ratio of the rotation speed of the bottom plate and the rotation speed of the transmission element or the rotation speed of the motor shaft becomes $K = V_b/V_m = 5.40/2.47 = 2.19$. Accordingly, the rotation speed of the bottom plate will drive the wheels 13a and 13c

faster than stated by the digits in (1) and (3) above.

From the above it is apparent that at least one wheel must glide against at least one surface. This is obtained by choosing a material for one or two of the wheels so that it has a low friction coefficient.

In our example the support wheel 13b essentially will run without sliding against the cavity bottom 18 or the bottom plate 5 due to the fact that the prolongation of the wheel shaft for this wheel passes through both the center lines A-A and B-B, respectively. The support wheels 13a and 13c are subjected to breaking by the inclination relative to the cavity bottom 18 but the higher speed of the support wheel 13b struggles to increase the speed of the wheels 13a and 13c via the bottom plate 5. In the case that the wheels 13a and 13c should be manufactured in a material having a negligible friction coefficient the speed of the bottom plate would be somewhat more than twice the speed of the wheel shaft, that is $V_b = 2.0 \cdot (r_b/r) \cdot V_m$ if the wheel 13b has a non-negligible friction coefficient. The materials chosen in our experimental embodiment resulted in that $R = V_b/V_m = 1.97$, that is a small sliding also occurred at the wheel 13b.

The figures 4a and 4b show a second alternative embodiment of the transmission coupling. Components having correspondance in fig. 3 have been given the same reference numerals. As in fig. 3a the bottom plate has only been indicated in fig. 4b by dashed lines. Two of the three branches are here provided with two support wheels each 13a', 13a'' and 13c', 13c'', respectively. One of the support wheels 13a' or 13c', respectively, is thereby intended to cooperate with the cavity bottom 18, while the other support wheel 13a' or 13c', respectively, is intended to cooperate with the bottom plate. The prolongation of the rotation shafts of the support wheels 17a', 17a'', 17b, 17c' and 17c'' is so arranged that the prolongation of the rotation shafts 17a'', 17b, 17c'' belonging to support wheels cooperating with the bottom plate 5 pass through the rotation center of the bottom plate, while the prolongation of the rotation shafts 17a', 17b, 17c' belonging to support wheels cooperating with the cavity bottom pass through the rotation center of the transmission element. Due to this arrangement a transmission coupling essentially free of slippage is obtained in which an integral multiple switching of the rotation speed is avoided, that is a change of the rotation speed with an integral multiple, for example a doubling or tripling.

Fig 5 shows a third embodiment of the driving of the bottom plate 5. In this case the guide pin of the transmission element and the recess of the bottom plate have been replaced by a circular ring-shaped raising 20 applied on the underside of the bottom plate in its peripheral section. The ring shaped raising 20 in cooperation with the support

wheels 13a-c guide the position of the bottom plate 5 at the same time as it is rotated.

Claims

1. An oven, preferably a microwave oven, comprising an oven cavity, a rotatable bottom plate provided in the oven cavity for rotation of a load applied on the bottom plate, a drive motor for rotation of the bottom plate, and a transmission coupling between the drive motor shaft and the rotatable plate, characterized in that the rotation center of the bottom plate is arranged to be moved relative to the oven cavity essentially in the rotation plane of the bottom plate at the same time as the bottom plate is rotated.
2. An oven as claimed in claim 1, characterized in that the rotation center of the bottom plate is arranged to be moved along a circular path.
3. An oven as claimed in any of preceding claims, the bottom plate bearing on a transmission coupling provided with support wheels for transmission of a rotation movement from the drive motor shaft to a rotation movement of the bottom plate via one or several support wheels, characterized in that the rotation center of the bottom plate is displaced relative to the rotation center of the transmission coupling to obtain a simultaneous displacement and rotation of the bottom plate in its rotation plane.
4. An oven as claimed in claim 3, the transmission coupling comprising a transmission element having a central section and at least three from the same emanating branches provided with at least one support wheel in the end of each branch for cooperation with the cavity bottom of the oven and the bottom plate, and rotation movement transmission between the transmission element and the bottom plate, characterized in guide means acting, between the transmission element and the bottom plate to guide the movement of the bottom plate.
5. An oven as claimed in claim 4, characterized in that the guide means act essentially in the center of the bottom plate.
6. An oven as claimed in claim 5, characterized in that the guide means consist of a guide pin combined with a recess, the guide pin being provided on the transmission element and the recess in the rotation center of the bottom plate or vice versa.

7. An oven as claimed in claim 5, characterized in that the guide means act in the peripheral section of the bottom plate.
8. An oven as claimed in claim 7, characterized in that the guide means consist of an essentially circular ring-shaped raising provided on the underside of the bottom plate and which cooperate with at least one of the support wheels of the transmission element.
9. An oven as claimed in any of the claims 4-8, characterized in that a number of the branches of the transmission element are provided with two support wheels, one of the support wheels being arranged to bear on the bottom plate, the other support wheel being arranged to bear on the bottom of the oven cavity.
10. An oven as claimed in any of the preceding claims, characterized in that the ratio of the rotation speed V_b of the bottom plate and the rotation speed V_m of the drive motor shaft has a value deviating from 2.00.

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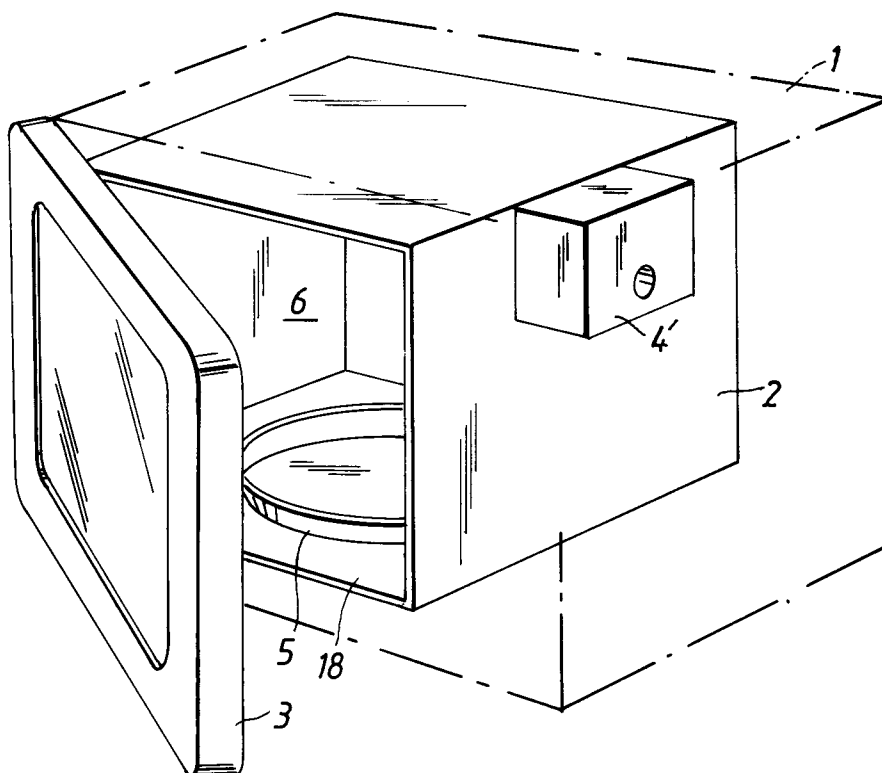


FIG.1

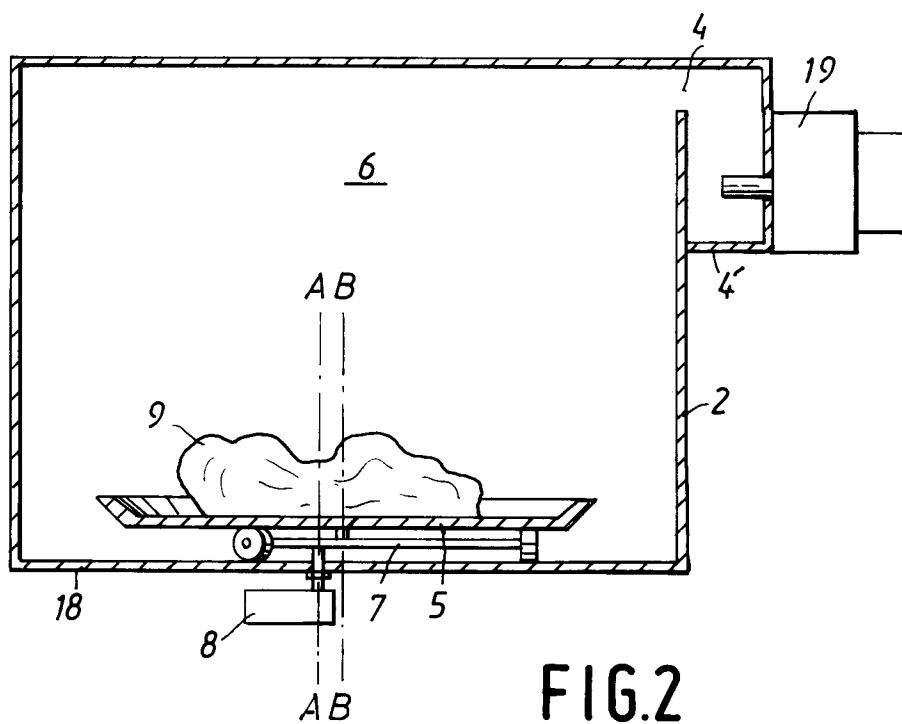


FIG.2

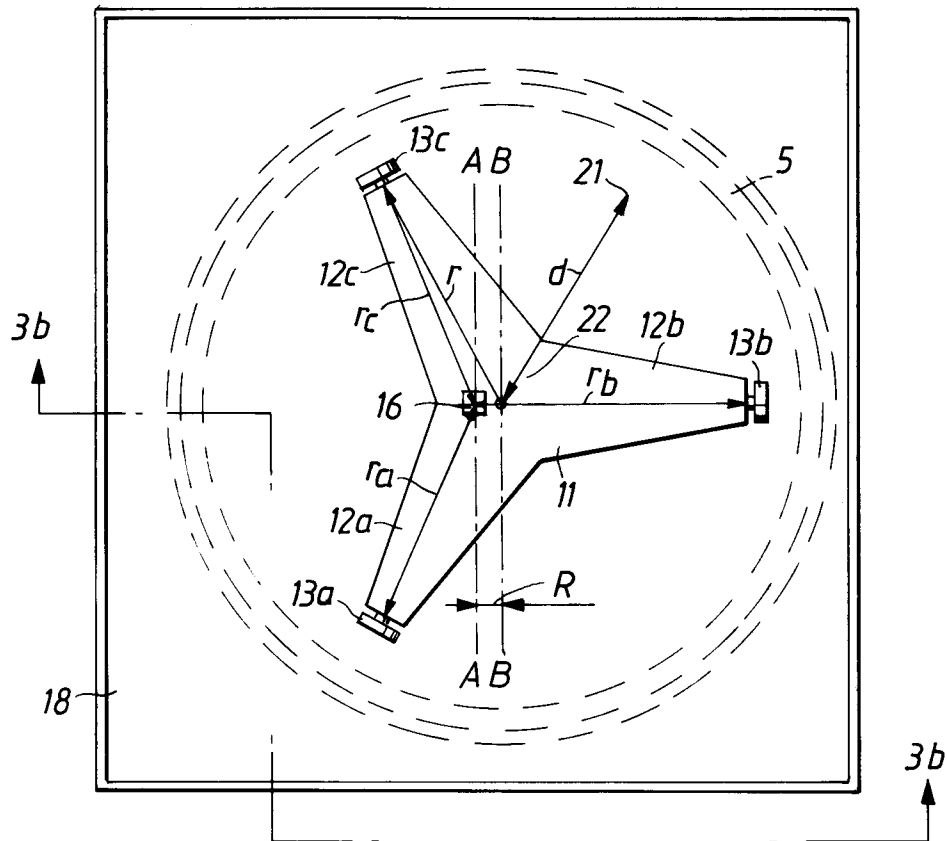


FIG. 3a

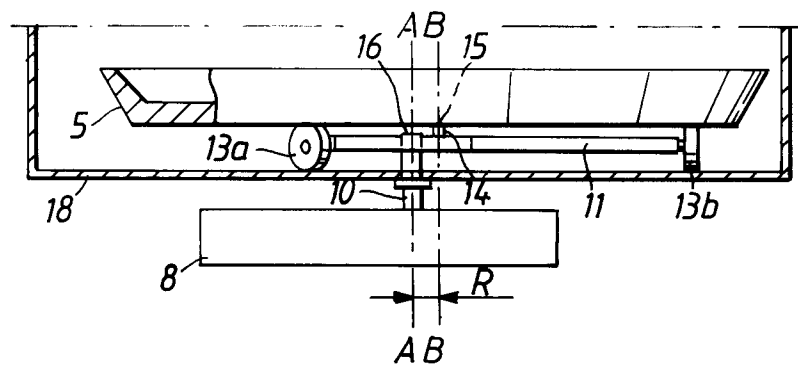


FIG. 3b

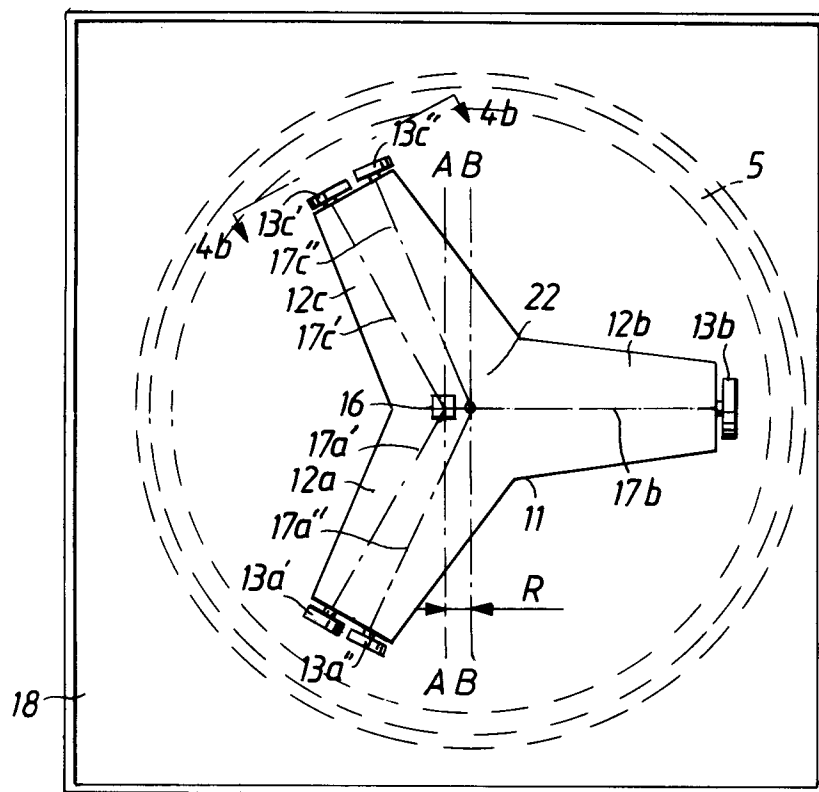


FIG. 4a

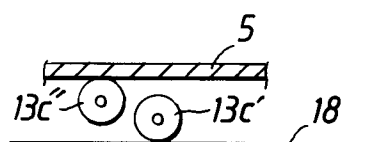


FIG. 4b

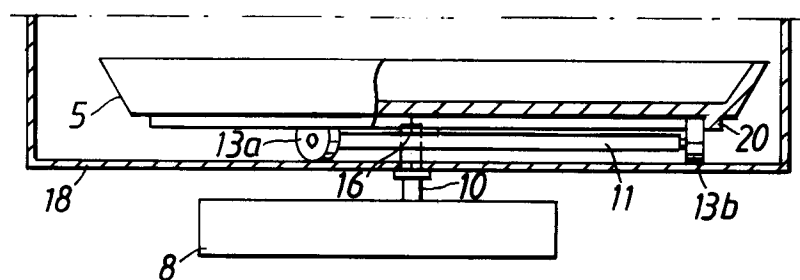


FIG. 5



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Application number

EP 91202240.7

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.)												
A, D	US-A- 4 757 173 (PARK) *whole document*	1-2	H 05 B 6/78												
	- - -														
A	GB-A- 2 122 060 (TOKYO SHIBAURA DENKI K K) *whole document*	1-2													
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The present search report has been drawn up for all claims															
Place of search STOCKHOLM		Date of completion of the search 21-11-1991	Examiner BENGTSOON, R.												
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