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(54) **Drum washer**

(57) Disclosed is a drum washer of a less vibratory and less noisy structure. The washer is provided with a washing tub 3 supported by suspension means 9 in a housing 1, a combination wash/spin drum 5 housed in the washing tub 3 and driven by a drive motor 21 about a horizontal axis X, and a liquor balancer 45 mounted on the inner peripheral surface of the drum 5 over the entire length in its circumferential direction. The liquor balancer 45 is composed of three to eight independent balancing chambers I, II, III, ... extending in the circumferential direction of the wash/spin drum 5 and having baffle boards 63 disposed in each balancing chamber to define therein liquid channels 65, and an unpartitioned annular auxiliary chamber 55 with which the balancing chambers I, II, III, ... communicate through their holes 57. The holes 57 each have a diameter large enough to allow free flowing of liquid of the liquor balancer into and out of the balancing chambers I, II, III, ... and the annular auxiliary chamber 55, and the liquid flows through the channels 65 defined by the baffle boards 47 and the holes 57.

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a low-noise drum washer with an improved liquor balancer mechanism.

2. Description of the Prior Art

Drum washers usually have such a construction as shown in Fig. 1, in which a washing tub 103 supported by suspension means 101 in a washer housing 111 has a combination wash/spin drum 105 mounted in the washing tub 103 for rotation about a horizontal axis X and laundry 109 is put in and out of the inside drum 105 through an access door 107 supported on the forward face of the housing 111.

The combination wash/spin drum 105 rotates about the horizontal axis X, and when the drum 105 is stopped from rotation at the end of the washing cycle, the laundry 109 immediately drops down therein by gravity as shown.

Hence, in the subsequent spin-dry cycle the wash/spin drum 105 is rapidly spun, the wet laundry 103 stays in cluster at one position in the drum 105 and hence causes a great deflection of the center of gravity of the drum 105, seriously unbalancing its rapid spinning and creating severe vibrations of the washing tub 103 in its entirety. Accordingly, the conventional washer is very noisy while in the spin/dry cycle. To avoid this, it is customary in the art that an annular liquor balancer 113 with liquid sealed therein is wound around the combination wash/spin drum 105 as indicated by the broken lines.

The liquor balancer 113 functions to correct the imbalance by the clustering of the laundry 109 and hence reduce the vibrations of the washing tub 103 when the number of revolutions of the wash/spin drum 105 exceeds the point of resonance or a predetermined threshold value. But at the start of rotation of the drum 105 at a speed below the point of resonance, the liquid in the balancer 113 flows down to its lower portion just under the clustering laundry 109, with the result that the imbalance by the clustering of laundry 109 increases, not decreases. Besides, during the low-speed driving of the drum 105, the liquid flows in the liquor balancer 113 and hence contributes to the generation of noise.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a drum washer adapted to suppress the generation of vibrations and noise and to enhance the laundry agitating efficiency in the washing and drying cycles.

To attain the above objective, the drum washer of the present invention comprises: a washer housing; a washing tub supported by suspension means in the

washer housing; a combination wash/spin drum housed in the washing tub in a manner to be driven by a drive motor about a horizontal axis; an annular liquor balancer disposed on the inner peripheral surface of the combination wash/spin drum over the entire length thereof in its circumferential direction and composed of a plurality of independent balancing chambers extending in the circumferential direction of the combination wash/spin drum and an unpartitioned annular auxiliary chamber extending along the plurality of balancing chambers which communicate therewith through their holes; and a liquid contained in the liquor balancer and freely flowing in and out of the balancing chambers and the auxiliary chamber during the rotation of the combination wash/spin drum in a washing cycle.

According to an aspect of the present invention, the liquor balancer is composed of three to eight independent balancing chambers extending in the circumferential direction of the combination wash/spin drum and an unpartitioned annular auxiliary chamber extending along the three to eight balancing chambers which communicate therewith through their holes, each of said holes being made at the center of each of the balancing chambers in the circumferential direction thereof and having a diameter of at least 5 mm.

According to another aspect of the present invention, the liquor balancer is placed at a drying air outlet.

According to another aspect of the present invention, the unpartitioned annular auxiliary chamber has a cross sectional area larger than that of each of said holes.

According to another aspect of the present invention, the plurality of independent balancing chambers each has baffle boards placed therein and defining liquid channels 5 mm or more wide.

According to another aspect of the present invention, the liquor balancer has agitator baffles protrusively provided on its inside peripheral wall. Combination wash/spin drum has its peripheral panel secured to the outer peripheral wall of said liquor balancer and its front panel secured to one side wall of said liquor balancer.

According to another aspect of the present invention, the agitator baffles provided in the liquor balancer are displaced a predetermined angle apart from baffles protrusively provided on the peripheral panel of the combination wash/spin drum in the circumferential direction thereof.

According to another aspect of the present invention, the combination wash/spin drum has its peripheral panel secured to the outer peripheral wall of the liquor balancer and its front panel secured to one side wall of the liquor balancer.

According to still another aspect of the present invention, the liquor balancer is disposed at each of at least two places in the combination wash/spin drum, and independent balancing chambers of the one of two liquor balancers are displaced a predetermined angle apart from independent balancing chambers of the other liquor balancer in the circumferential direction

thereof.

With such a drum washer of the present invention, in the washing cycle in which the wash/spin drum is driven at low speed, the liquid in the respective balancing chambers of the liquor balancer tends to flow downward under the action of gravity but the flow of the liquid is blocked by the baffle boards, so that the noise by the flow is effectively suppressed even when the rotational speed of the wash/spin drum is below a point of resonance or predetermined threshold value. Moreover, substantially the same amount of liquid is contained in each of the respective balancing chambers and the inner and outer balancing chambers are displaced apart in the circumferential direction thereof, so that the liquid in the liquor balancer mechanism is distributed more uniformly and the sound of the liquid flowing back and forth becomes continuous, permitting reduction of noise generation.

When the rotational speed of the wash/spin drum exceeds the point of resonance in the spin-dry cycle, the liquid in the balancer mechanism gathers on the side opposite to the cluster of laundry under the action of centrifugal force--this serves to balance the rapidly spinning drum and hence suppress vibrations.

The agitator baffles on the liquor balancer ensures effective agitation of laundry.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic diagram showing a conventional drum washer;

Fig. 2 is a schematic diagram illustrating a drum washer according to an embodiment of the present invention;

Fig. 3 is a perspective view, partly cut away, of a fluid balancer;

Fig. 4 is a sectional view taken on the line A-A in Fig. 3;

Fig. 5 is a schematic diagram showing a communicating hole of a balancing chamber;

Fig. 6 is a sectional view taken on the line B-B in Fig. 5;

Fig. 7 is an enlarged diagram showing a part denoted by C in Fig. 2;

Fig. 8 is a schematic diagram showing the positions of agitator baffles;

Fig. 9 is a schematic diagram showing an assumed distribution of liquid in the liquor balancer at the start of a washing or rinsing cycles;

Fig. 10 is a schematic diagram showing the distribution of liquid in the liquor balancer after a 60-degree rotation of the wash/spin drum;

Fig. 11 is a schematic diagram showing the distribution of liquid in the liquor balancer after another 60-degree rotation of the wash/spin drum;

Fig. 12 is a schematic diagram showing the distribution of liquid in the liquor balancer in a spin-dry cycle;

Fig. 13 is a schematic diagram illustrating another

embodiment of the present invention in which liquor balancers similar to that in the Fig. 2 embodiment is placed immediately inside front and rear panels of the wash/spin drum;

Figs. 14(A) and (B) are schematic diagrams for explaining the liquor balancers disposed with their balancing chambers displaced apart in the circumferential direction thereof in Fig. 13;

Fig. 15 is a schematic diagram showing a double-structured liquor balancer mechanism in which balancing chambers of inner and outer balancers are displaced apart in the circumferential direction thereof; and

Fig. 16 is a perspective view of the liquor balancer shown in Fig. 15.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to Figs. 2 through 12, a concrete example of the present invention will be described below.

Reference numeral 1 denotes a washer housing, wherein there are placed an outer washing tub 3, an inner combination wash/spin drum 5 and a drying air circulation path 7.

The washing tub 3 is supported by a plurality of suspensions 9 mounted on the bottom of the washer housing 1. Reference numeral 11 denotes a feed valve located above the washing tub 3 to feed therein washing liquor, and 13 a drain valve connected to the bottom of the washing tub 3 to drain therefrom the liquor away.

The combination wash/spin drum 5 has a number of perforations 15 made in its peripheral panel 5a and is rotatably mounted on a shaft 17 along the afore-mentioned horizontal axis X. Mounted on the front panel of the washer housing 1 is an access door 19 for gaining access to the interior of the combination wash/spin drum 5 to put therein and out therefrom the laundry.

The shaft 17 is driven by a drive motor 21, which has its motor pulley 25 connected by a belt 27 to a drive pulley 23 of the shaft 17.

The drive motor 21 is fixedly mounted on the underside of the washing tub 3 and placed under the control of a controller 31 through ON-OFF control of each control switch 29.

The drying air circulation path 7 is defined by a duct 33 and has a blower 35, a dehumidifier 37 and a heater 39 disposed therein. A first port 33a of the air channel 7 communicates with an air inlet 41 of the combination wash/spin drum 5, whereas a second port 33b communicates with an air outlet 43 of the drum 5. The air outlet 43 is so shaped as to serve also as an opening through which washing is taken in and out of the drum 5 when the door 19 is opened.

The blower 35 is placed near the second port 33b of the air channel 7 to force, as indicated by the arrow, air circulation into the dehumidifier 37 by a fan that is driven by a motor M.

The dehumidifier 37 is positioned at substantially an intermediate portion of the drying air circulation path 7 to remove moisture from the drying air during its passage through the dehumidifier 37.

The heater 39 is placed near the first port 33a of the air circulation path 7 and held by a controller (not shown) at a predetermined temperature to heat the circulating air.

Reference numeral 45 denotes inner and outer annular liquor balancers formed as a unitary structure and mounted on the inside of the combination wash/spin drum 5 over the entire length of its circumference in the vicinity of the air outlet 43 for the circulating air cooled by the passage through wet garments in the drum 5. Such a double-structure liquor balancer 45 is a molding of a synthetic resin material and hence is lightweight, and it is also designed to support a front panel 5b of the combination wash/spin drum 5.

Since the inner and outer liquor balancers 45 are identical in construction, only the outer one of them will be described below, their corresponding parts being identified by the same reference numerals.

As shown in Fig. 3, the liquor balancer 45 is an annular structure formed by a duct of a rectangular cross section and has six balancing chambers I, II, III, IV, V and VI defined by partitions 47 disposed at 60-degree angular intervals. It is desirable that the number of balancing chambers be in the range from three to eight.

As depicted in Fig. 4, the balancing chambers I, II, III, IV, V and VI are each an independent chamber defined by inner and outer peripheral walls 49 and 51, right and left side walls 53 and 54 and the partitions 47. The liquor balancer 45 has salt water or similar liquid sealed therein. Juxtaposed with the liquor balancer 45 at the left-hand side thereof in Fig. 7 is an annular but unpartitioned auxiliary balancing chamber (hereinafter referred to simply as an auxiliary chamber) 55, with which the balancing chambers I, II, III, IV, V and VI communicate through their through holes 57. The outer peripheral wall 51 of each balancing chamber is fixedly secured by a screw 59 to the peripheral panel 5a of the combination wash/spin drum 5 as shown in Fig. 7. Further, the front panel 5b of the combination wash/spin drum 5 is secured by screws 61 to the outer side wall of the auxiliary chamber 55 that forms the left-hand side wall of the liquid balancer 45--this avoids the necessity of welding the peripheral and front panels 5a and 5b of the wash/spin drum 5 together. It is also possible, however, to install the liquor balancer 45 in the drum 5 along the front panel 5b after welding the peripheral and front panels 5a and 5b together.

Each communicating hole 57 is, as shown in Fig. 5, a round hole bored through the left-hand side wall 54 adjacent the outer peripheral wall 51 on a center line Y at the center of each balancing chamber in its circumferential direction. The diameter of the hole 57 is set at a minimum of 5 mm. Incidentally, the hole 57 need not always be round but it may also be square, rectangular,

elongated or polygonal, for instance, as long as its diameter is 5 mm at the smallest.

In each of the balancing chambers I, II, III, IV, V and VI there are disposed a pair of baffle boards 63 standing opposite across the hole 57. As depicted in Fig. 6, the baffle boards 63 and the side wall 54 of each balancing chamber define therebetween liquid channels 65 of an at least 5 mm width, which permit free passage there-through of the liquid in the respective balancing chambers.

The auxiliary chamber 55 is larger in cross section than the communicating hole 57 of each balancing chamber and is formed by joining a structural of a horizontally U-shaped cross section to one of the side walls forming the independent balancing chambers I, II, III, IV, V and VI.

On the inner peripheral wall of the liquor balancer 45 there are protrusively provided at predetermined regular intervals a plurality of baffles 67 for agitating garments within the drum 5. As shown in Fig. 8, the baffles 67 are displaced a predetermined angular distance apart from a plurality of agitator baffles 69 also protrusively provided on the inside surface of the peripheral panel 5a of the combination wash/spin drum 5.

Next, a description will be given, with reference to Figs. 9 through 12, of the operation of the drum washer according to this embodiment. As the combination wash/spin drum 5 rotates at low speed in the direction of arrow in washing and rinsing cycles as shown in Fig. 9, the liquid in the balancing chamber I flows out therefrom through its communicating hole 57 and down into the lowermost balancing chambers V and VI through their holes 57, and until the drum 5 turns 60 degrees, the liquid in the chamber I overflows into the underlying chambers VI and V by an amount indicated by crosshatching in Fig. 10. Thus, the amount of liquid in the balancing chamber V in the state of Fig. 9 is small but gradually increases with the liquid overflowing the other balancing chambers as depicted in Fig. 10. The amount of liquid in the balancing chamber VI is larger than prescribed in the state of Fig. 9 but equals the amount of liquid in the chamber V in the state of Fig. 10. Similarly, until the wash/spin drum 5 further turns 60 degrees to reach the state of Fig. 11, the liquid in the balancing chamber III overflows into the balancing chambers IV and V. Since such a sequence of processes accompanies the low-speed rotation of the wash/spin drum 5 in the washing or rinsing cycle, no particular steps are needed therefor. Hence, these processes are performed one after another during the washing and rinsing steps, so that the amounts of liquid in the six balancing chambers I, II, III, IV, V and VI become nearly equal as shown in Fig. 11. In this state, the amount of liquid in the auxiliary chamber 55 is not zero but so small that the noise of the liquid moving back and forth in the chamber 55 by the rotation of the wash/spin drum 5 is significantly lower than in the prior art.

Furthermore, since the liquid in each of the independent balancing chambers I, II, III, IV, V and VI flows

through the liquid channels 65 defined by the baffle boards 63, the noise of the liquid beating against the partitions 47 during the rotation of the drum 5 can be held lower than in the case of no baffle boards being used. This was experimentally demonstrated. The noise level was 62 dB when measured with no baffle boards but it went down to 52 dB when the baffles boards were used. Besides, the baffles 67 serve to agitate the laundry well even in the liquor balancer 45.

Now, a description will be given of the total amount of liquid that is contained in the six balancing chambers I, II, III, IV, V and VI and the auxiliary chamber 55. Let it be assumed that the liquor balancer 45 is stable in such a state as shown in Fig. 11 in which the balancing chambers I, II, III, IV, V and VI contain substantially the same amounts of liquid. The total amount of liquid is chosen such that when the diametrically opposite balancing chambers, for example, III and VI in this instance are at the same horizontal level, the same amount of liquid as those in the chambers III and IV, wherein the liquid levels are flush with the holes 57, is held in every one of the other balancing chambers as well and that the liquid level in the auxiliary chamber 55 is flush with the liquid levels in the balancing chambers V and IV.

It is desirable, therefore, that the total amount of liquid to be contained in the liquor balancer 45 basically correspond to the capacity of three of the balancing chambers I to IV plus a 1/6 capacity of the auxiliary chamber 55. In this instance, the amount of liquid may be adjusted to some extent, if necessary, since the rotation of the drum 5 will cause a certain amount of flow of liquid between the balancing chambers V and IV and the auxiliary chamber 55 in such a state as shown in Fig. 11. However, the above-mentioned right amount of liquid need not considerably changed but an adjustment within 10% is usually enough.

In the spin-drying cycle, centrifugal force gradually acts on the liquid in the liquor balancer 45 as the rotational speed of the combination wash/spin drum 5 increases, and during high-speed rotation at about 800 rpm the liquid in the liquor balancer 45 is pressed against the outer peripheral wall of the balancer 45 as depicted in Fig. 12. That is to say, since laundry 71 in the drum 5 is not uniformly distributed during the spin-dry process, the center of whirling is displaced from the center S of the balancer 45 to a point O under the action of external force F by the laundry 71 and the drum 5 rotates with a radius r1 about the point O as shown. As a result, the liquid in the balancer 45 shifts in a direction opposite to the offset center of gravity of the laundry 71 and hence compensates for the imbalance caused by the deviation of the laundry 71, effectively suppressing noisy vibrations of the drum 5. In the transition of the liquor balancer 45 to the state of Fig. 12 from the state of Fig. 11 in which the liquid is distributed uniformly in all the balancing chambers I through IV at the start of the spin-dry cycle, the liquid in the respective chambers is pressed by centrifugal force to the outer peripheral wall 51 of the balancer 45, so that the influence of gravity is

negligible, allowing a required amount of liquid to freely flow into or out of any balancing chambers through the holes 65 and the auxiliary chamber 55 irrespective of the positions of the balancing chambers.

Next, when the washer enters the drying mode after the spin-dry cycle, drying air heated by the heater 39 is fed through the air inlet 41 into the combination wash/spin drum 5 to dry the laundry 71. The air having passed through the garments in the drum 5 is blown out therefrom and into the air circulation path 7 via the air outlet 43. The moisture-laden air is blown by the blower 35 into the dehumidifier 37 to remove moisture from the air, after which the drying air is heated by the heater 39 and then recirculated into the wash/spin drum 5 through the air inlet 41. Since the liquor balancer 45 is located at the air outlet side, it is not exposed to high temperatures in the drying process; hence, the use of synthetic resin for the liquor balancer 45 does not give rise to any problems. Further, even if on the inside periphery of the liquor balancer 45, the laundry 71 is agitated by the agitator baffles 67. This provides for enhanced efficiency in drying the laundry, coupled with the agitation by the baffles 69 on the side of the washer/spin drum 5 which are displaced from the baffles 67.

Figs. 13 and 14 illustrate another embodiment of the present invention, in which a liquor balancer is placed at each of positions immediately inside the front and rear panels of the combination wash/spin drum 5. As is the case with the embodiment described above, the liquor balancer 45 comprises six independent balancing chambers I through IV defined by partitions 43 and extending over the entire length of the combination wash/spin drum 5 in its circumferential direction and an unpartitioned annular auxiliary chamber 55 with which the balancing chambers communicate through their holes 57. The liquor balancers 45 are disposed so that the front balancing chambers I to IV are displaced around 30 degrees apart from the rear chambers I to IV in the circumferential direction of the drum 5.

Figs. 15 and 16 illustrate still another embodiment of the present invention, which employs the same double-structured liquor balancer mechanism as in the embodiment described previously with reference to Figs. 2 through 12. The double-structured liquor balancer mechanism comprises outer and inner annular liquor balancers 45. The outer balancer 45 is made up of six independent balancing chambers I through IV separated by partitions 43 and extending over the entire length of the wash/spin drum 5 in its circumferential direction and an unpartitioned annular auxiliary chamber 55 with which the balancing chambers I through IV communicate through their holes 57. Similarly, the inner liquor balancer 45 is made up of six independent balancing chambers I through IV separated by partitions 43a and an unpartitioned annular auxiliary chamber 55 which communicates with the balancing chambers I through IV communicate through their holes 57 and is formed integrally with and communicates with the auxiliary chamber 55 of the outer balancer 45. In this embod-

iment the inner balancing chambers I to IV are displaced approximately 30 degrees apart from the outer chambers I to IV in the circumferential direction of the drum 5.

With the arrangements of the embodiments of Figs. 13 through 16, uniform distribution of the liquid in the liquor balancer mechanism is further promoted in the direction of rotation of the drum 5, so that the sound of the liquid flowing back and forth during low-speed driving of the drum 5 as in the washing and rinsing cycles becomes continuous and hence low--this permits cancellation of noise.

Additionally, at the start of the spin-dry cycle the influence of the liquid can be lessened and the spinning of the drum 5 can be started smoothly.

As described above, the present invention effectively suppresses vibrations of the washing tub and noise of the liquid and, at the same time, enhances the laundry agitating efficiency during the washing and drying processes.

Moreover, the mechanical strength of the wash/spin drum 5 can be increased by fixedly securing its front panel to the liquor balancer mechanism.

It is a matter of course that the embodiments described above should be construed as being illustrative of the present invention and that various modifications and variations may be effected without departing from the scope of the technical concepts of the invention.

Claims

1. A drum washer comprising:

a washer housing;
a washing tub supported by suspension means in said washer housing;
a combination wash/spin drum housed in said washing tub in a manner to be driven by a drive motor about a horizontal axis;
a liquor balancer disposed on the peripheral surface of said combination wash/spin drum over the entire length thereof in its circumferential direction, said liquor balancer being composed of a plurality of independent balancing chambers extending in the circumferential direction of said combination wash/spin drum and an unpartitioned annular auxiliary chamber extending along said plurality of balancing chambers which communicate therewith through their holes; and
a liquid contained in said liquor balancer and freely flowing in and out of said balancing chambers and said auxiliary chamber during the rotation of said combination wash/spin drum in a washing cycle.

2. The drum washer as claimed in claim 1 wherein said liquor balancer is composed of three to eight

independent balancing chambers extending in the circumferential direction of said combination wash/spin drum and an unpartitioned annular auxiliary chamber extending along said three to eight balancing chambers which communicate therewith through their holes, each of said holes being made at the center of each of said balancing chambers in the circumferential direction thereof and having a diameter of at least 5 mm.

3. The drum washer as claimed in claim 1 wherein said unpartitioned annular auxiliary chamber has a cross sectional area larger than that of each of said holes.

4. The drum washer as claimed in claim 1 wherein said plurality of independent balancing chambers each has baffle boards placed therein and defining liquid channels 5 mm or more wide.

5. The drum washer as claimed in claim 1 wherein said combination wash/spin drum has its peripheral panel secured to the outer peripheral wall of said liquor balancer and its front panel secured to one side wall of said liquor balancer.

6. The drum washer as claimed in a claim 1 wherein said liquor balancer has agitator baffles protrusively provided on its inside peripheral wall.

7. The drum washer as claimed in claim 6 wherein said agitator baffles are displaced a predetermined angle apart from baffles protrusively provided on the peripheral panel of said combination wash/spin drum.

8. The drum washer as claimed in claim 1 wherein said liquor balancer is placed at a drying air outlet.

9. The drum washer as claimed in claim 1 wherein said liquor balancer is disposed at each of at least two places in said combination wash/spin drum, said independent balancing chambers of the one of two liquor balancers being displaced a predetermined angle apart from independent balancing chambers of the other liquor balancer in the circumferential direction thereof.

FIG.1
PRIOR ART

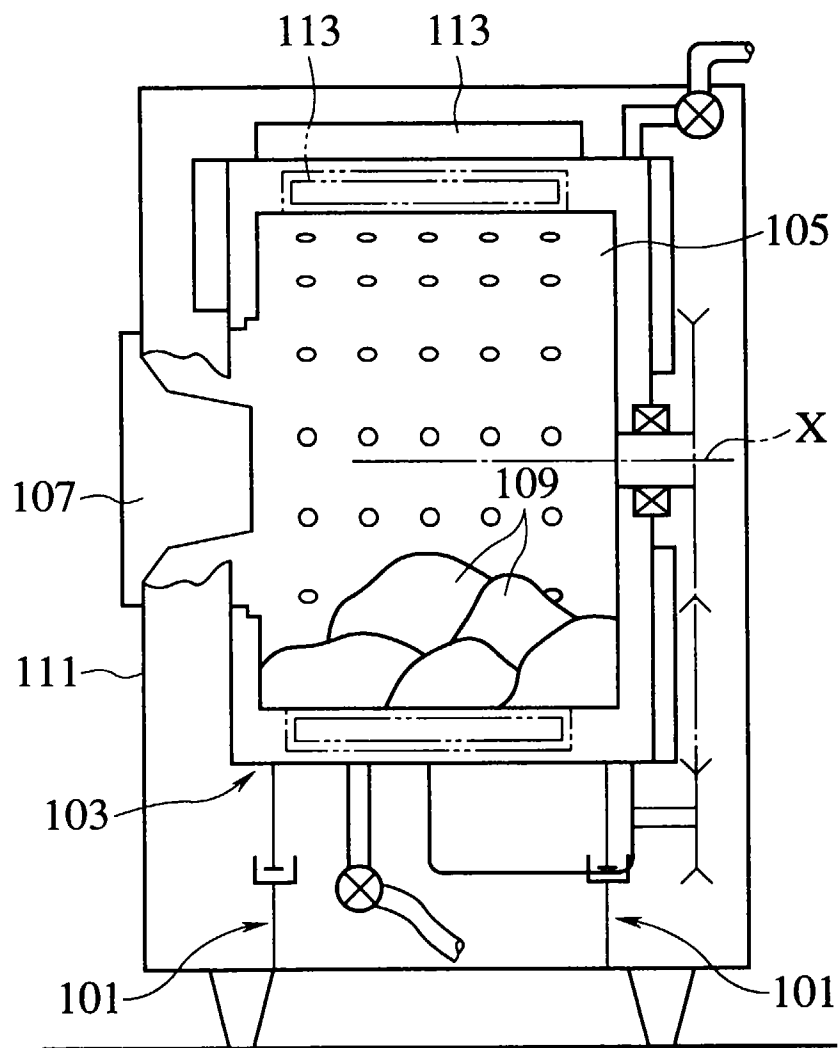


FIG.2

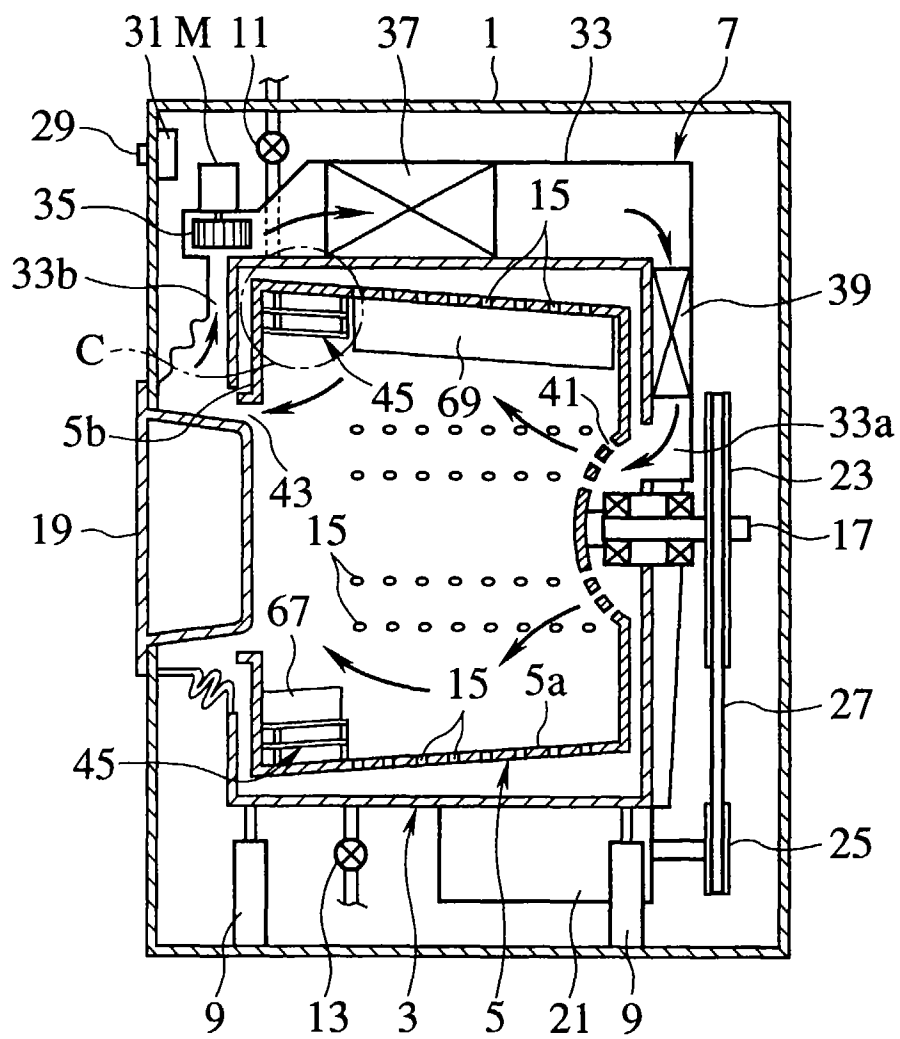


FIG.3

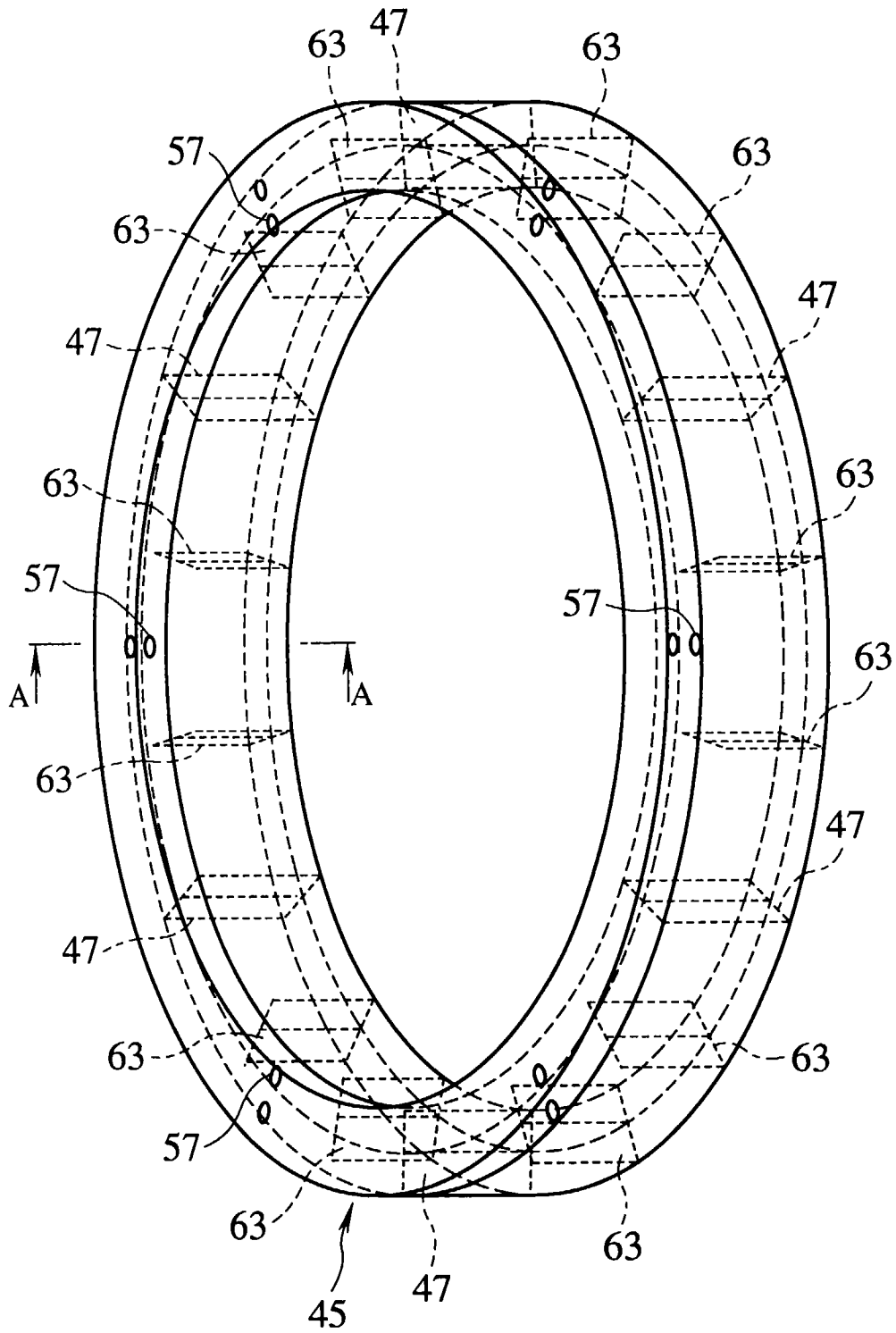


FIG.4

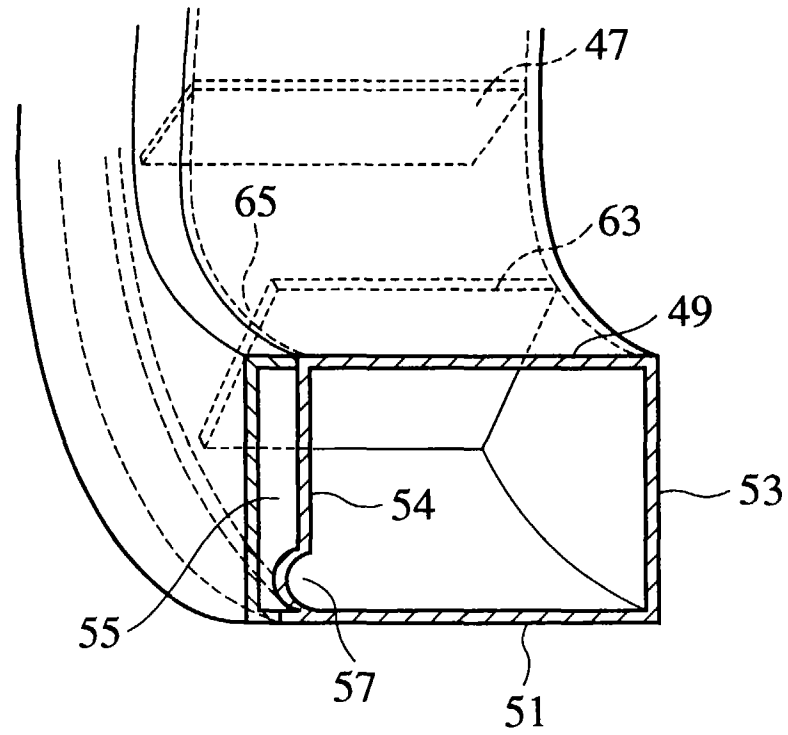


FIG.5

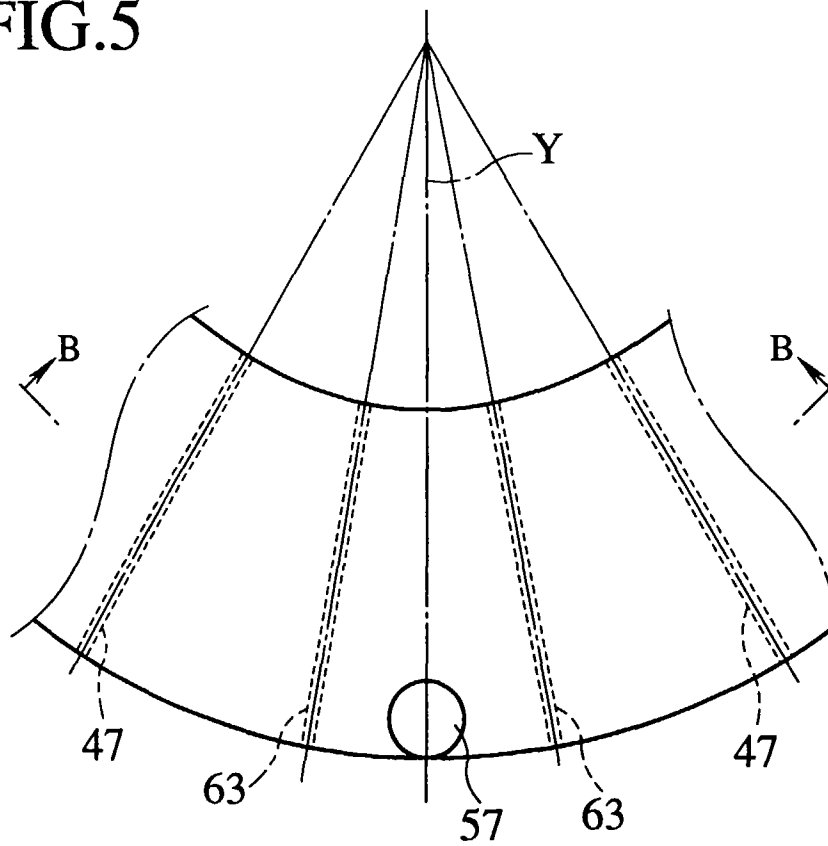


FIG.6

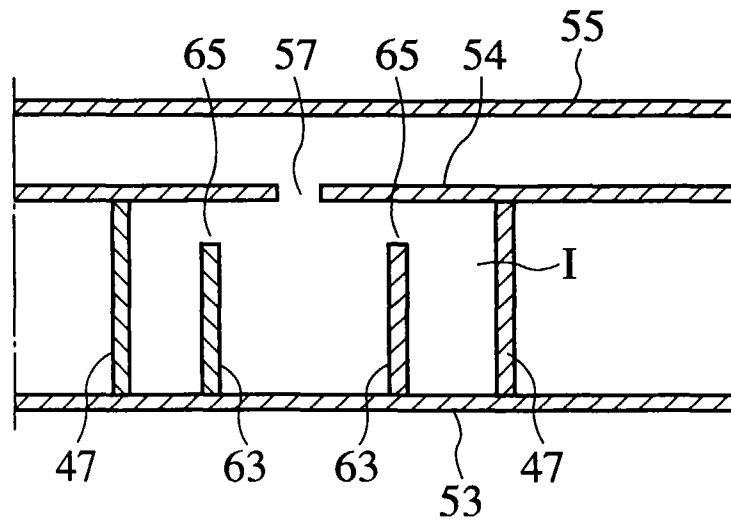


FIG.7

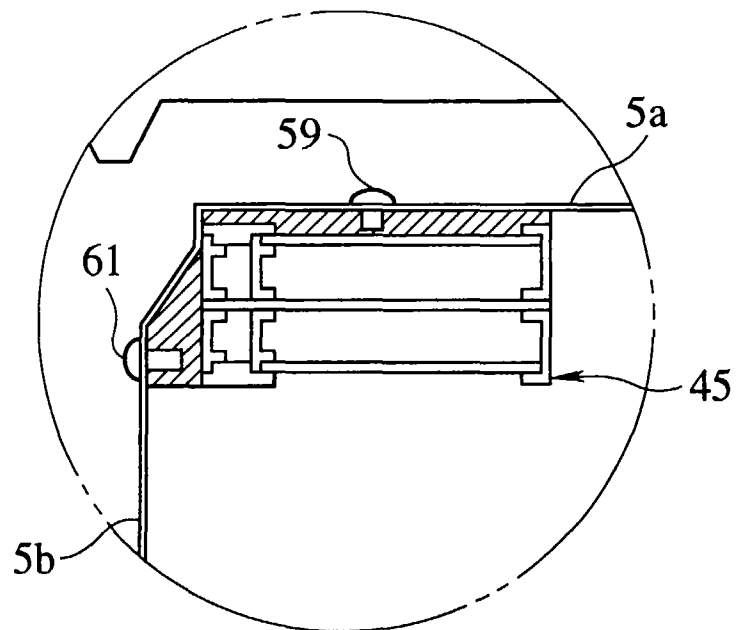


FIG.8

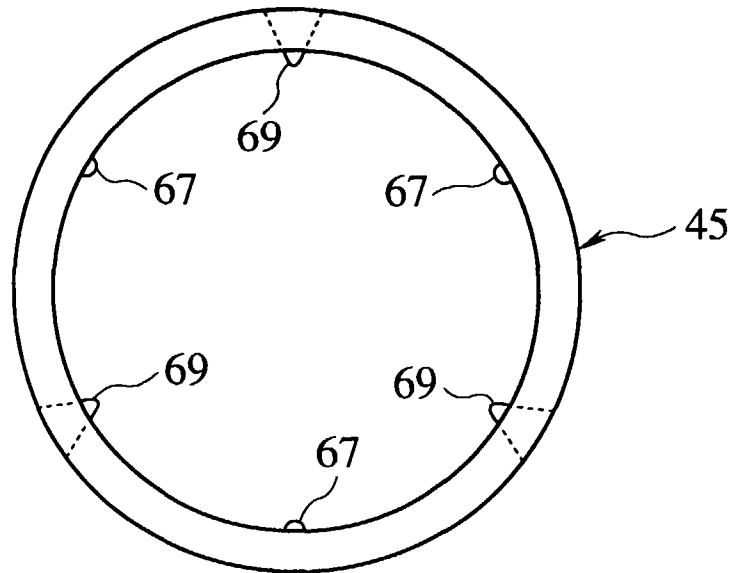


FIG.9

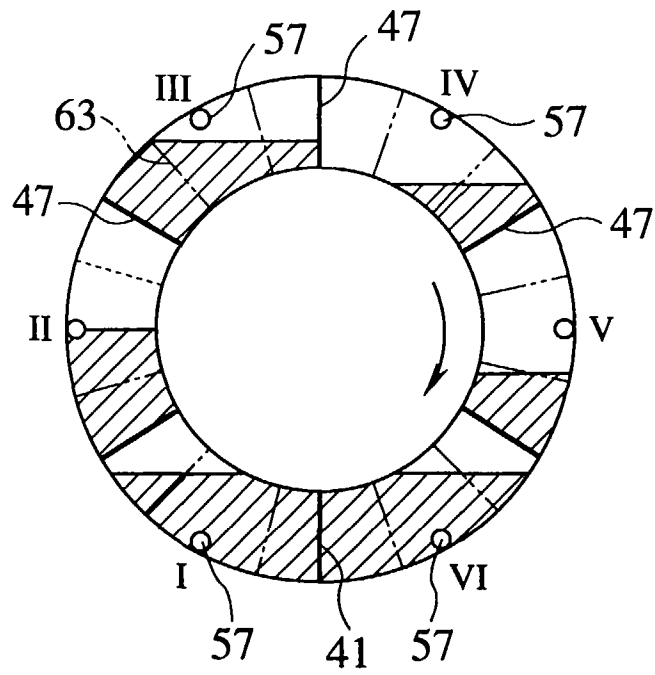


FIG.10

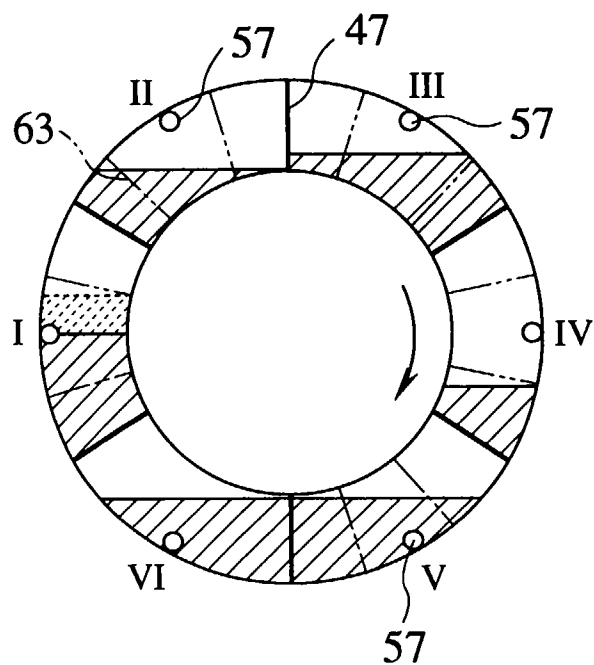


FIG.11

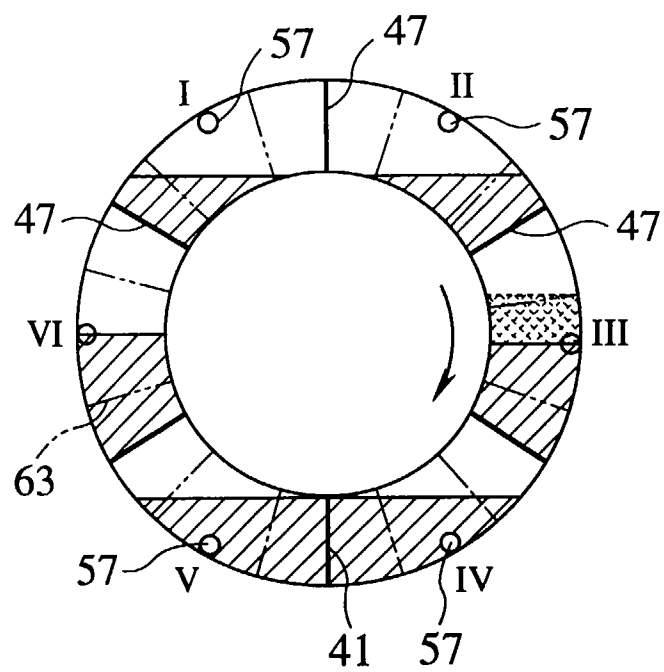


FIG.12

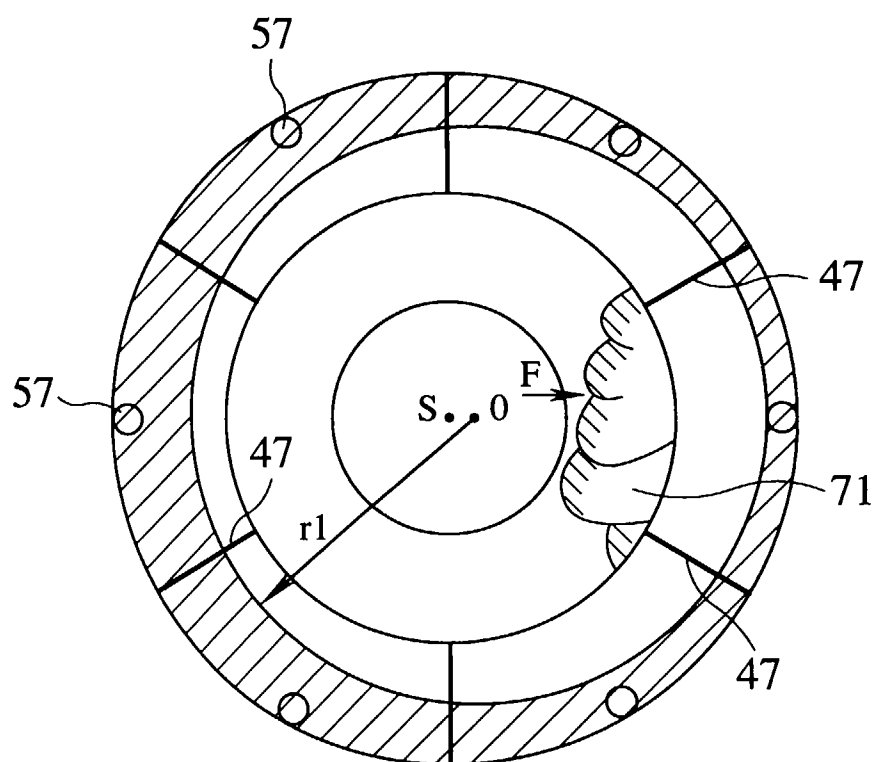


FIG.13

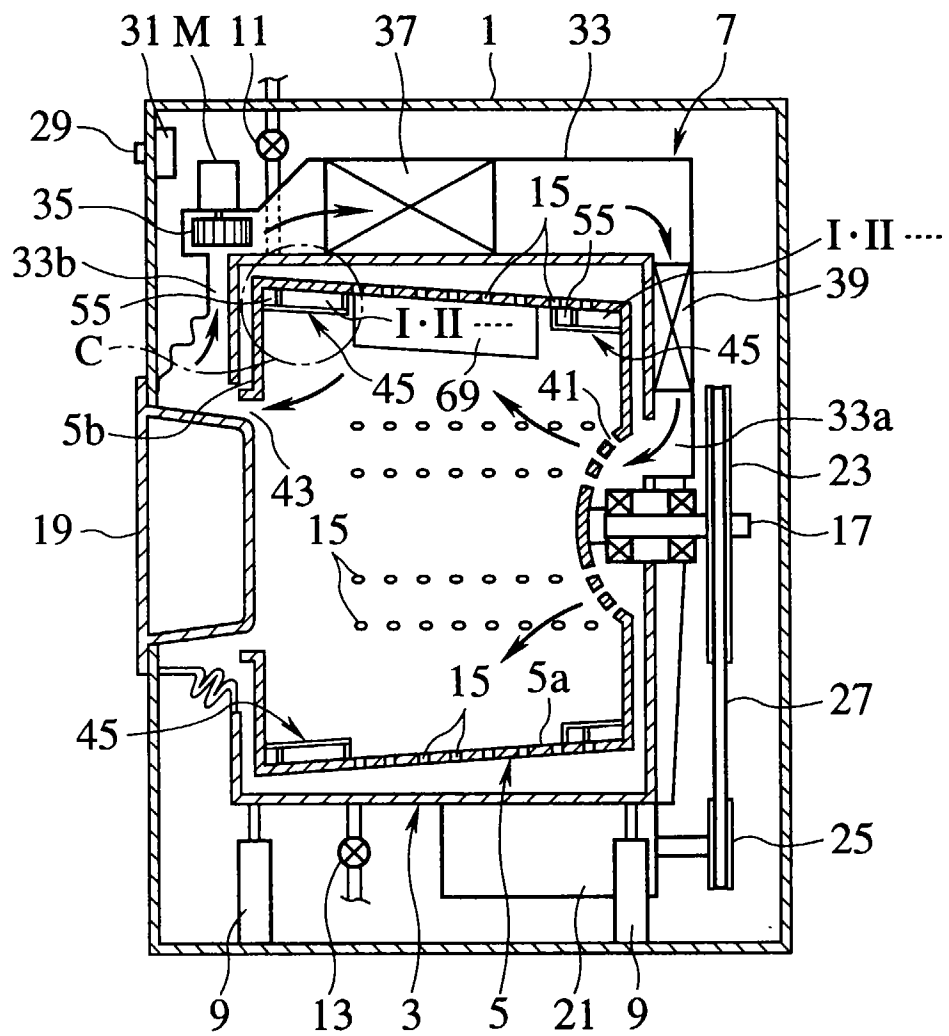


FIG.14A

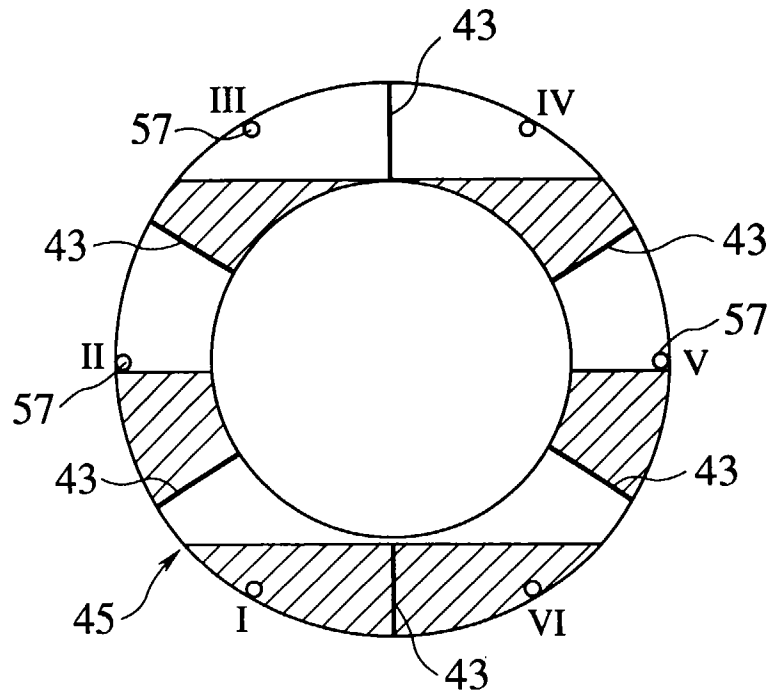


FIG.14B

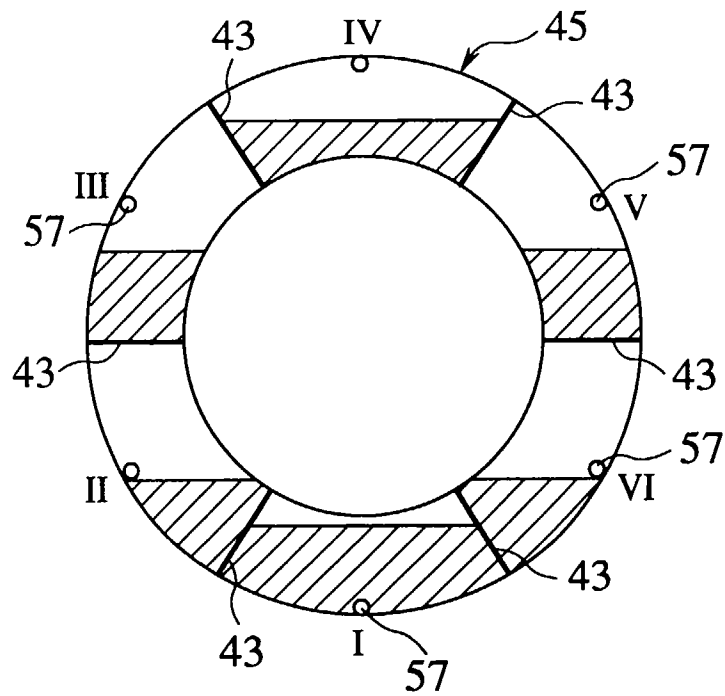


FIG.15

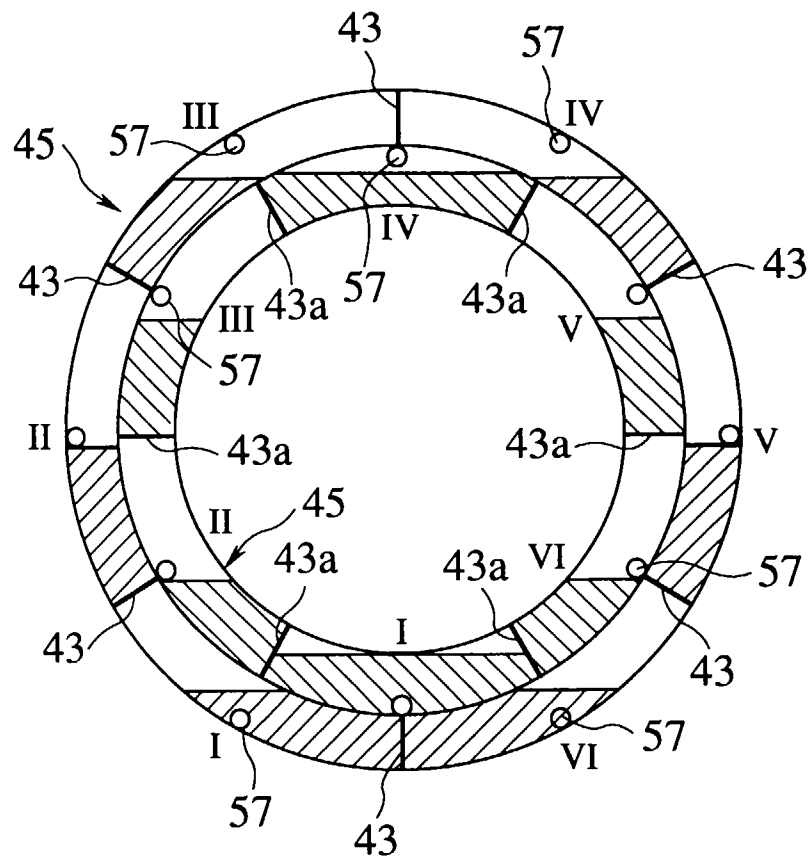


FIG.16

