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(54) **Perfected hydraulic circuit for optimisation of decalcification in particular for domestic dishwashers and relative control method**

(57) In a domestic dishwasher, a method of control of a perfected hydraulic decalcification circuit comprising a decalcifier (1) formed by a tank (3) for the ion exchange resins and a tank (5) for the resins regeneration salt, a valve (10) for feeding into the resins tank (3) hard

mains water intended for washing the dishes and a pair of upper (14u) and lower (14d) filters which define an area of the resins tank for containing the resins, wherein the feed valve (10) of said hydraulic decalcification circuit is made to operate with a flow rate between 2 litres/minute and 2.5 litres/minute.

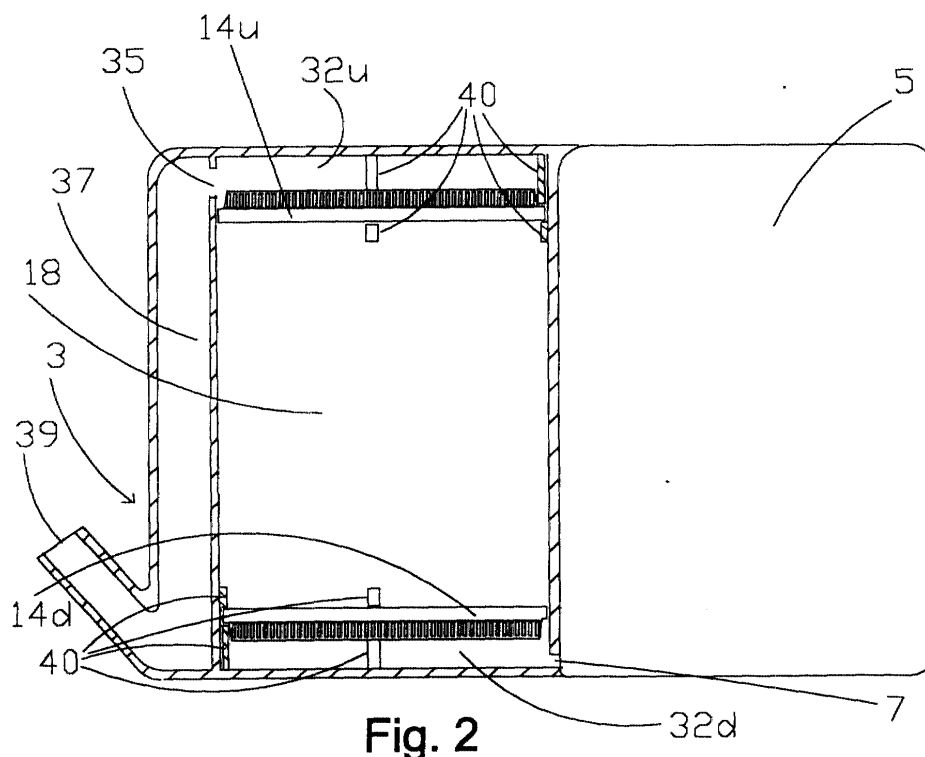


Fig. 2

Description

[0001] The present invention provides a perfected hydraulic circuit for optimisation of decalcification, in particular for domestic dishwashers.

[0002] The hydraulic circuit for decalcification of the water to be fed into the washing tub of a dishwasher comprises, as is known, a decalcifier formed by a tank for the ion exchange resins and a tank for the regeneration salt, and a valve controlled by a timer for feeding hard mains water to the decalcifier via a regeneration compartment.

[0003] The resins tank in turn has internally a lower filter and an upper filter which define an area of the tank intended to contain the ion exchange resins used for softening the washing water, a section for entrance of the hard mains water upstream of the filters and downstream of the filters a section for exit of the softened water towards the washing tub.

[0004] A hydraulic decalcification circuit of a domestic dishwasher for twelve place settings has to handle a feed of water of approximately 4 litres per washing phase (prewash, hot wash, first cold rinse, second cold rinse, hot rinse) and notoriously is capable of softening up to 100°F of incoming hardness using a volume of 800-900 cm³ of resins with a flow rate of the feed valve of approximately 4 litres/minute.

[0005] The greatest disadvantages of a known hydraulic decalcification circuit lie in the under-utilisation of the resins, linked both to the operating regime of the feed valve and to the configuration of the area for containing the resins and the relative filters.

[0006] In particular the low values of the height/radius ratio of the area for containing the resins and the passage surface/total surface ratio of the filters contribute to defining preferential paths through the resins for the flow of water to be softened, with the result that some portions of resins are used up rapidly while others remain virtually unused.

[0007] The consumption of salt for the regeneration of ion exchange resins is moreover linked to the quantity of resins used, and for this reason may be heavily penalised by low decalcification efficiency of the resins themselves.

[0008] In a known hydraulic decalcification circuit the risk of clogging of the filters, particularly of the upper filter, by the smaller resin particles, the risk of removal of the resins through the slots of the filters and the noise of the decalcification system during actuation of the feed valve cannot be ignored.

[0009] The object of the present invention is therefore that of providing an optimised hydraulic decalcification circuit in particular for domestic dishwashers, which overcomes the disadvantages suffered by traditional hydraulic decalcification circuits.

[0010] In particular one object of the present invention is that of providing a hydraulic decalcification circuit, which optimises exploitation of the ion exchange resins

and consequently also consumption of the regeneration salt.

[0011] A hydraulic decalcification circuit is required which, compared to a traditional one, uses a smaller volume of resins, achieving the same degree of softening of the washing water.

[0012] In other words a hydraulic decalcification circuit is required which, compared to a traditional one, with the same volumes of resin used, achieves a better degree of softening of the washing water.

[0013] Another object of the present invention is that of making the decalcification system silent and avoiding also clogging of the filters and removal of the resin from the resins tank.

[0014] These objects are achieved by adopting, in a domestic dishwasher, a method of control of a perfected hydraulic decalcification circuit comprising a decalcifier formed by a tank for the ion exchange resins and a tank for the resins regeneration salt, a valve for feeding into the resins tank hard mains water intended for washing the dishes, and a pair of upper and lower filters which define an area of the resins tank for containing the resins, characterised in that the feed valve is made to operate with a flow rate between 2 litres/minute and 2.5 litres/minute, while the hydraulic decalcification circuit is perfected by setting the height of the area for containing the resins at between 120 mm and 130 mm, and the passage surface/overall surface ratio of the filters higher than 20%.

[0015] The best performances are obtained by associating with said hydraulic circuit a method for control of the same wherein: the feeds of washing water to the washing tub for performing a washing phase are performed dynamically, that is to say partly with the circulation pump stopped and partly with the circulation pump in motion. Regeneration of the resins is divided into two parts with a brief phase of intermediate rinsing and slowly, with a flow rate equal to or below 100 cm³/minute, and the final rinsing of the resins is performed in two parts or with a brief feed jet before actual rinsing.

[0016] With the hydraulic decalcification circuit and the method of control of the same provided by the present invention it is possible to optimise decalcification thanks to improved exploitation of the resins, of the chemical kinetics of the ion exchange, of the chemical kinetics of regeneration of the ion exchange resins and of the rinsing of the ion exchange resins.

[0017] The optimal flow rate range for the feed valve takes account of the fact that the chemical kinetics of the ion exchange is favoured for a low flow rate of water, but experimentally we have found that an excessive reduction in the flow rate penalises exchange efficiency due to the creation of preferential flows inside the resins tank.

[0018] The decrease in the flow rate of the feed valve compared to the solutions traditionally adopted only marginally affects the time of performance of an overall washing cycle.

[0019] In a domestic dishwasher the complete operation cycle lasts approximately 50 minutes and each phase requires a feed of water of approximately 4 litres: by exploiting a dynamic feed for the washing water, wherein the first two litres of water are fed with the pump which actuates the washing nozzles at a standstill, and the remaining two litres of water with the pump already in action, it is calculated that, with the present invention, the lengthening of the time of performance of the entire washing cycle is only 3-5% compared to a traditional system operating with the same type of dynamic feed but with a flow rate of the feed valve of 4 litres/minute.

[0020] Given a small lengthening of the washing time, destined in any case to be reduced further thanks to the use of improved detergents which minimise the quantity of feed water required for each washing phase, the present invention achieves improved performances compared to a traditional decalcification system: by using a volume of 800-900 cm³ of virgin or newly regenerated resins, our system achieves softening of the water from 100°F to 1°F while a traditional decalcification system achieves softening of the water on average from 100°F to 4°F; in other words, in order to soften the water from 100°F to 4°F, for our system a volume of 600 cm³ of resins is sufficient.

[0021] The decalcification system of the present invention is suitable for being used also for softening extremely hard water with acceptable volumes of resins, for example water having hardness equal to 140°F with 900 cm³ of resin, which to date was unthinkable unless the volume of resins used and the consumption of salt for regeneration of the resins was considerably increased.

[0022] The saving in resins allows also a reduction in the overall dimensions of the decalcifier, achieving greater facility of assembly and improved accessibility for maintenance work.

[0023] The possibility of reducing the volume of resins allows simultaneously a reduction in the risk of clogging of the filters and the risk of removal of the resins from the relative tank, while the lower flow rate of feed water through the resins tank is reflected in quieter operation of the hydraulic circuit comprising in particular the decalcifier and the feed valve.

[0024] An equally important advantageous aspect of the present invention is represented by the fact that the reduction in the flow rate of the feed valve makes the same feed of water more accurate, due to the slower water flow to the washing tub and to the devices for measuring the feed.

[0025] The present invention will be made clearer on reading a preferred embodiment thereof, which refers to the accompanying drawings in which:

Fig. 1 shows a domestic dishwasher wherein the position of the hydraulic decalcification circuit is indicated;

Fig. 2 shows a partially sectioned enlargement of the decalcifier of a preferred embodiment of the present invention;

Fig. 3 shows in a plan view the inner side of a filter in the resins tank of a preferred embodiment of the present invention;

Fig. 4 shows a view of a sectioned side elevation of the filter of Fig. 3.

[0026] Fig. 1 illustrates a traditional dishwasher formed by a box-like casing 2 with a front door 4 which can be opened for loading the dishes into the washing tub 16 with, at the top, a push-button panel 6 and a knob 8 for switching the machine on/off and for setting the washing cycle.

[0027] With reference also to Fig. 2, the hydraulic decalcification circuit comprises a decalcifier 1 formed by a tank for the ion exchange resins 3 and a tank for the regeneration salt 5 communicating via a conduit formed at the lower base of the decalcifier 1. This conduit can be opened by a regeneration solenoid valve not shown and, through its end section 7, feeds the brine taken from the salt tank 5 to the resins tank 3.

[0028] The hydraulic decalcification circuit also comprises a feed valve 10 which feeds hard mains water to a regeneration compartment 12 and from there to the resins tank 3 via a section of the conduit for connection between the tanks 3 and 5 downstream of the regeneration solenoid valve.

[0029] Inside the cylindrically shaped resins tank 3 a pair of upper 14u and lower 14d filters define an area for containing the resins 18.

[0030] In the side wall of the chamber 32u of the resins tank 3, enclosed between the upper cover 13 of the resins tank 3 and the upper filter 14u, an opening 35 is formed which feeds a conduit 37 descending along the side wall of the resins tank 3 and communicating with the washing tub 16 through a mouth 39.

[0031] The configuration of the resins tank 3 is restricted by the maximum height which can be exploited for its positioning below the washing tub 14, which in a standard dishwasher for eight or twelve place settings is equal at most to 154 mm.

[0032] Experimentally we have however ascertained that the efficiency of the decalcifier is optimised by choosing, on a par with the volume of resins to be used and hence on a par with the volume of the resins tank 3, the configuration which maximises the height/radius ratio of the area 18 for containing the resins. In view of this, taking into account the fact that the resins are subject to a change in volume and must be able to fluctuate freely in the containing area 18, and that the chamber 32u between the cover of the resins tank 3 and the upper filter 14u and also the corresponding lower one 32d must have a minimum height to avoid the creation of preferential flows between the feed point 7 in the tank 3

and the point of outflow 35 from the tank 3, the area 18 for containing a volume of 600 cm³ of resins has been formed with a height/radius ratio equal to 3 and a height of 120 mm.

[0033] An even more advantageous ratio can be obtained in the case wherein the openings of feed 7 and of outflow 35 of the resins tank 3 respectively are lengthened for a large circumferential section of the side wall of the resins tank 3. In this case the height of the chambers 32u and 32d can be reduced further without flows with preferential directions being created in the tank 3: the height/radius ratio can be pushed up to 3.25 and the height up to 130 mm.

[0034] Naturally in the case wherein it is necessary to use a greater volume of resins, for example for the decalcification of harder water, the height/radius ratio of the area 18 will decrease, but the height of the area for containing the resins 18 has to remain at least equal to 120 mm and preferably equal to or near the maximum admissible limit of 130 mm.

[0035] In Figs. 3 and 4 the body of the upper filter 14u and lower filter 14d of the resins tank 3 is made in a thermoplastic material and comprises a circular base 15 and a side wall 17 wherein a series of slots are formed for the passage of the water.

[0036] For the resins tank 3 of the present embodiment intended to contain 600 cm³ of resins, the base 15 has a radius of 40 mm and has a series of twenty-four concentric, circular and equidistant slots 19 supported by four diametric ribs 21, while the side wall has eight equidistant vertical slots 23.

[0037] The minimum distance between the rims of each slot 19 and 23 is equal to 0.3 mm so that the passage surface of the filter/total surface of the filter ratio is 23%.

[0038] Maximisation of the passage surface of the filter/total surface of the filter ratio allows a greater percentage of resins to be used, further improving the efficiency of the decalcifier.

[0039] In the case wherein a greater volume of resins is required, for example for softening harder mains water, the number of slots 19 and 23 has to be incremented in such a way that, without changing the minimum distance between the rims of each slot, the aforesaid ratio remains advantageously above 20%.

[0040] Finally, from the edge of the cylindrical wall 17 of the filters 14u and 14d opposite the base 13, a shoulder extends which can be snap-fastened onto a joined profile 40 formed on the internal wall of the resins tank 3 in such a way that the filters 14u and 14d are supported horizontally.

[0041] The method of control of the decalcification circuit is the following.

[0042] We will refer to the standard dishwasher for twelve place settings of the present embodiment, which uses a volume of 600 cm³ of resins for treating 100° F, or alternatively 400 cm³ of resins for treating 70° F, with a total feed of 16 litres divided into four washing phases.

[0043] The feed valve is set to a flow value between 2 and 2.5 litres/minute, while the feeding in each washing phase is dynamic and takes place with the first two litres of water fed into the washing tub with the circulation pump stopped and with the next two litres of water fed with the circulation pump in motion in such a way as to spray the dishes by means of the nozzles of the rotor of the machine.

[0044] Given that the efficiency of decalcification depends also on regeneration and subsequent rinsing of the resins, it is important to control these operations correctly.

[0045] The regeneration should thus be divided into two parts separated by a brief phase of rinsing of the resins.

[0046] In a first case the first part of regeneration can take place during a washing or rinsing phase of the machine-cycle, wherein a sufficient time of contact between the resins and the regeneration water is allowed, then interrupting the circulation pump for the time necessary for brief rinsing and subsequent discharge of the regeneration water from the washing tub. The second part of regeneration can take place during a subsequent phase of the machine-cycle. Alternatively each part of regeneration can be performed at the end of a machine-cycle phase.

[0047] Finally rinsing of the resins should also be divided into two parts or performed with a brief feed jet before actual rinsing.

[0048] Naturally the present description is given merely by way of an example and many changes can be devised without departing from the main idea of the invention, which consists in providing a perfected hydraulic decalcification circuit, controlled in such a way as to optimise efficiency of decalcification.

Claims

1. In a domestic dishwasher, a method of control of a perfected hydraulic decalcification circuit comprising a decalcifier (1) formed by a tank (3) for the ion exchange resins and a tank (5) for the resins regeneration salt, a valve (10) for feeding into the resins tank (3) hard mains water intended for washing the dishes and a pair of upper (14u) and lower (14d) filters which define an area (18) of the resins tank (3) for containing the resins, characterised in that said hydraulic decalcification circuit operates with a dynamic feed in the machine-cycle phases, with resins regeneration performed in two parts separated by a brief phase of rinsing of the resins, and with a resins rinse performed in two parts or with a brief feed jet before actual rinsing, and in that the feed valve (10) of said hydraulic decalcification circuit is made to operate with a flow rate between 2 litres/minute and 2.5 litres/minute.

2. In a domestic dishwasher, a hydraulic decalcification circuit controlled according to the previous claim, characterised in that the height of said area (18) for containing the resins of said hydraulic decalcification circuit is between 120 mm and 130 mm. 5
3. In a domestic dishwasher, a hydraulic decalcification circuit according to the previous claim, wherein upstream of the filters (14u, 14d) at the base of the resins tank (3) a section (7) of inflow of the hard 10
mains water is provided and downstream of the filters (14u, 14d), at the top of the resins tank (3), a section (35) of outflow of the softened water towards the washing tub is provided, characterised in 15
that said section (7) for inflow of the hard mains water and said section (35) for outflow towards the washing tub are in the form of an elongated opening on a circumferential section of the resins tank (3).
4. In a domestic dishwasher, a hydraulic decalcification circuit according to any one of the previous 20
claims, wherein the filters (14u, 14d) are formed by a base (15) with equidistant concentric slots (19) and a side wall (17) provided with equidistant vertical 25
slots (23), characterised in that the passage surface/total surface of the filters (14u, 14d) ratio is at least 20%.

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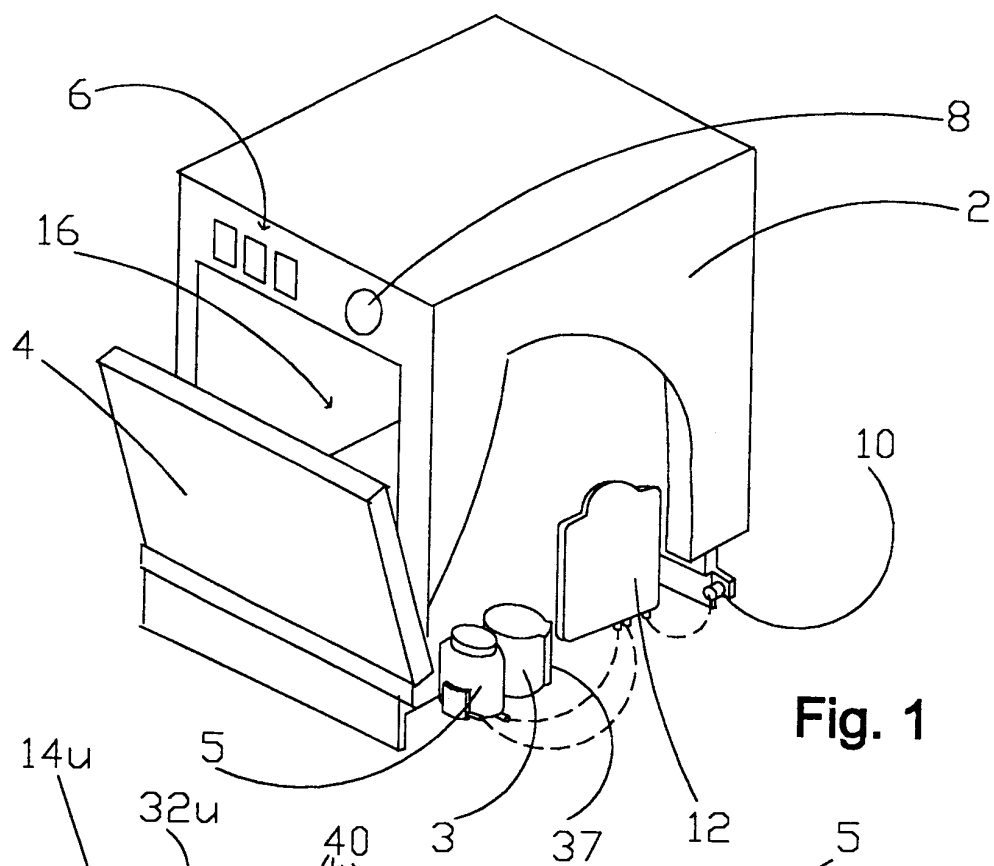


Fig. 1

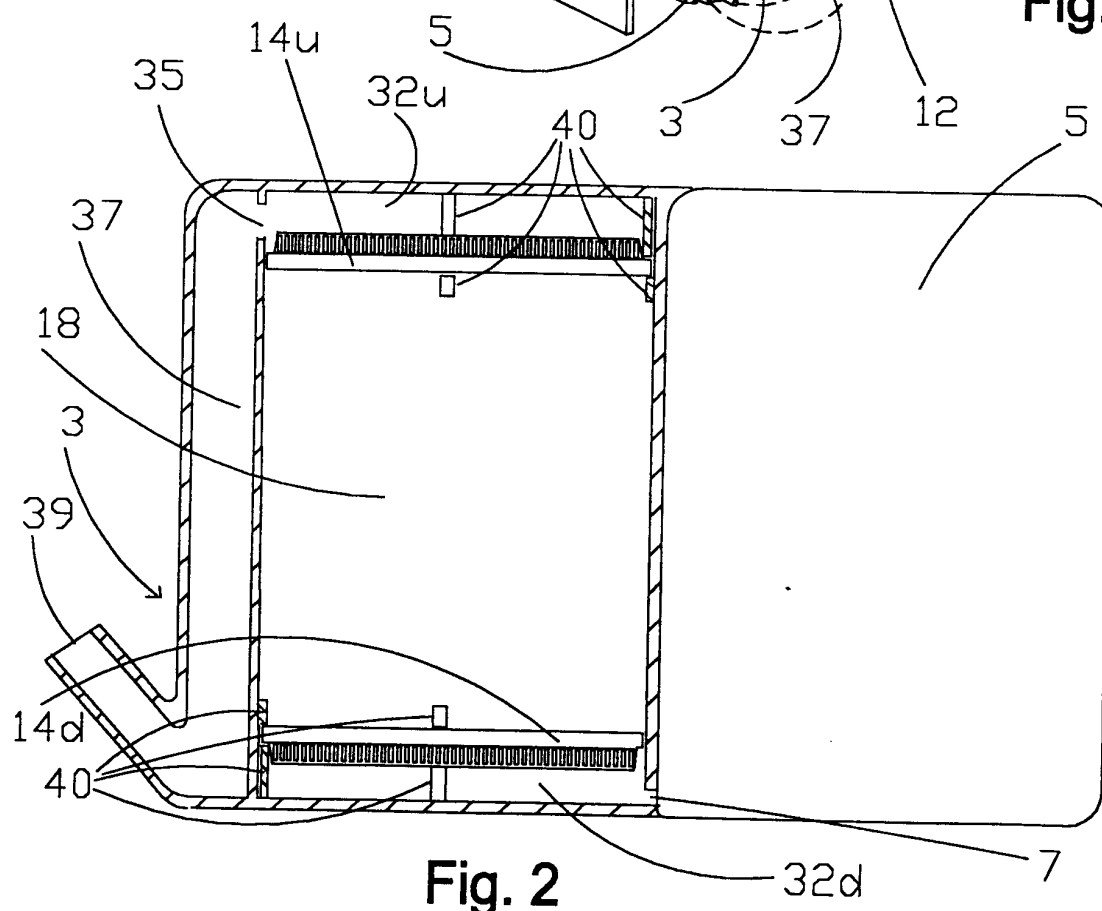


Fig. 2

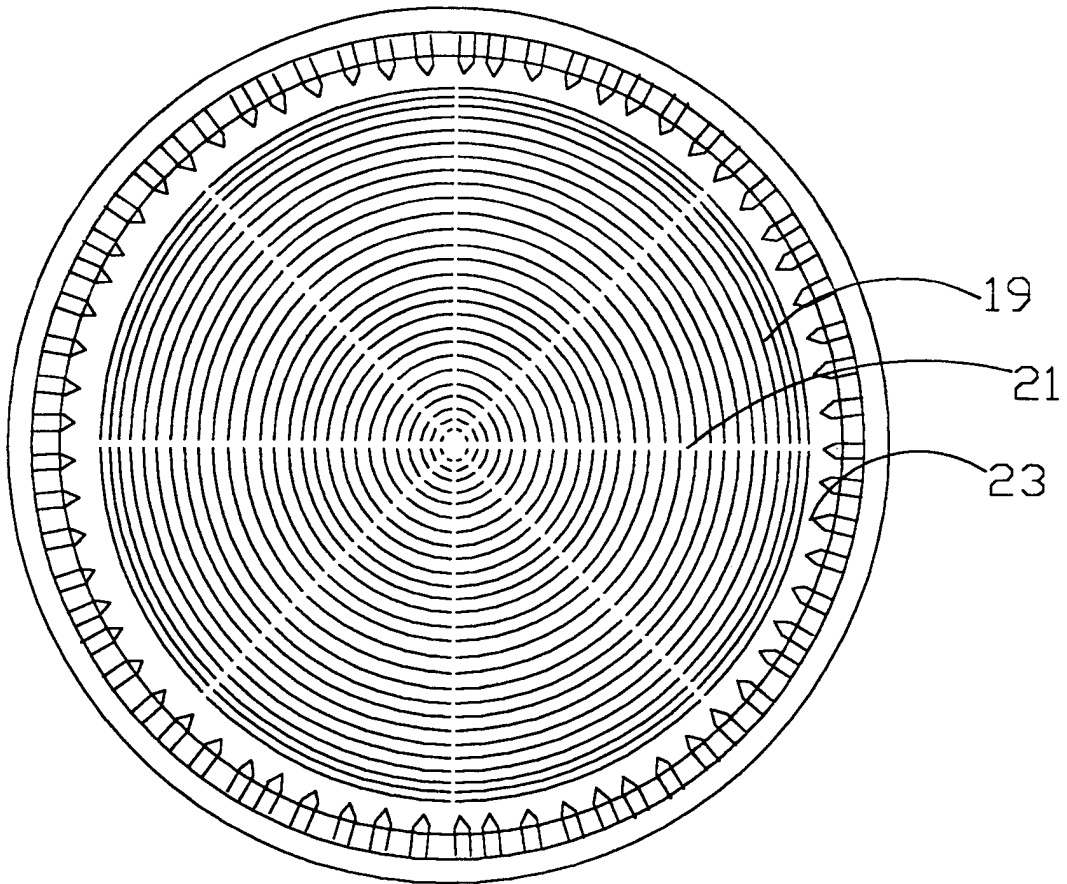


Fig. 3

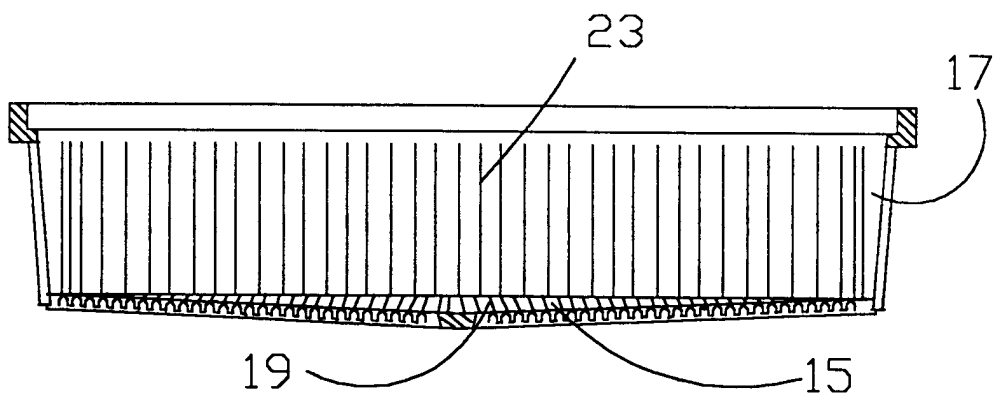


Fig. 4



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 00 12 5278

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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 9 May 2001	Examiner Norman, P
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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