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(54) **A METHOD FOR RINSING FABRIC IN A WASHING MACHINE AND WASHING MACHINE USING SUCH METHOD**

(57) A method for rinsing clothes in a washing machine having a wash chamber rotating about a horizontal axis in a wash tub (14) comprises the step of adding water to the tub (14) and spraying rinse water by recirculating it onto the clothes while spinning the wash chamber (12) at a speed to effect a centrifugal force on said fabric so that it will not tumble within the wash chamber. During said step the rinse water is sprayed for a time lower than or equal to 30 s and at a flow rate, measured as l/min that is comprised between 0,2 and 1,7 times the dry load of fabric in the wash chamber measured as kg.

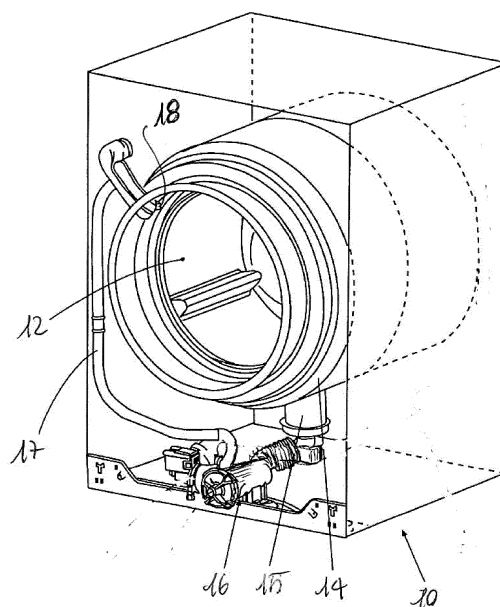


Fig. 1

Description

[0001] The present invention relates to a method for rinsing fabric in a washing machine having a wash chamber rotating about a horizontal axis in a wash tub, comprising the step of adding water to the tub and spraying rinse water by recirculating it onto the fabric while spinning the wash chamber at a speed to effect a centrifugal force on said fabric so that it will not tumble within the wash chamber.

[0002] Such method of rinsing a load of clothes is disclosed by EP1983088.

[0003] European market for washing machines is developing towards low water consumption, high rated capacities especially in cotton cycles (large load in small drum - drum sizes have increased by only 50 % in past 15 years while rated load capacities increased by 150 %) and very low energy consumption. Market is at a limit where energy reduction - while keeping good cleaning performance - can only be reached with rigorous methods such as extremely low water level in main wash combined with recirculation of the wash liquor and very long wash cycles (from 3 to 6 hours for cotton cycles).

[0004] The situation of washing machines designed about 15 years ago presented the following general features:

- ample drum volume / wash load ratios (no more than 5 kg of dry laundry in 48 l washer drum)
- generous water amounts (e.g. 14 liters and more in the main wash for a 5 kg cotton wash load)
- very few machines with recirculation systems in the market and with a use of recirculation mainly to improve wash performance, not for reducing water and energy consumption.

[0005] Detergent and soil were well separated from the laundry and accumulated in the lower part of the tub (so-called sump). Large portion of the detergent and soil was already drained off at the end of the main wash, then further rinsed out during the rinse and spin phases after main wash.

[0006] The present situation is characterized by issues arising from low water amounts, large wash loads, recirculation of wash water are redistribution and re-deposition onto the laundry of all detergent ingredients, even insoluble detergent components such as zeolites (water-hardness adsorbents) and dirt.

[0007] Such substances get distributed and re-absorbed very evenly in the laundry, creating persistent incrustation with the final result that laundry feels stiff and looks yellowed / grayed after wash, and dots and accumulations of insoluble detergent ingredients (e.g. white zeolite spots) are also visible on colored laundry. Moreover, the above detergent ingredients create so called frothing, i.e. an excessive foam creation as wash liquor is poured onto load and into free water repeatedly during recirculation. This frothing can cause bad wash perform-

ance as the "foam bath" reduces mechanical motion / friction of wash load and air bubbles restrict physico-chemical access of surfactants / enzymes to soils in laundry, over foaming, foam leaking out through detergent dispenser and unsuccessful rinsing if foaming persists during intermediate spinning and rinse cycles. As a final result of the above problems, detergent and dirt stay on load and laundry feels soapy, with perceivably crepitating foam residues in laundry after wash.

[0008] To avoid this, foam must be broken down by adding water or the machine must interrupt all motion until foam has settled. This behavior has proven to be very hard to control, requiring time, energy and more water. Even if there is no excessive foam, it is very difficult to effectively rinse out soil and detergent. They are embedded into the load during main wash. Separation of detergent, soil and insoluble such as zeolite from the laundry must be accomplished during rinse and spin phases alone. Contrary to the situation of 15 years ago, main wash is not contributing to this process any longer, and consumers complain about eczemas from detergent residues. While fabrics made from synthetic fibers are relatively easy to rinse out, especially cotton fabrics absorb large amounts of detergent and soil and are particularly difficult to rinse out.

[0009] In order to solve the above problems, appliance producers have designed special antifoam routines. When foaming is detected, for instance via a pressure sensor, the drum rotation is set to slower motion or is stopped completely until foam has settled. More advanced methods include adding fresh water in one or several intervals to beat down the foam and dilute the wash liquor. A disadvantage of this known method is an increased overall washing time and a higher amount of water.

[0010] Another known solution is to design washing machines which offer the possibility of selecting several extra rinses. This means falling back to 1970s state of the art with for instance five long rinses and from 120 to 160 l of total water consumption. A common method of measuring the rinsing efficiency of a wash cycle is the so called "alkalinity method". After the wash cycle is finished, the laundry is taken out of the washer and its remaining moisture content is measured by weighing it on a precise scale and subtracting the dry load weight in an environment with standard air humidity and temperature from this value. Then the wet wash load is spun out in standard spin extractors, using a standard-defined wash load and standard-defined loading schemes for the washer and the spin extractors. The liquor spun out by the spin extractors is collected and titrated with a hydrochloric acid solution of defined concentration. The volume of hydrochloric acid required to reach a pH value of 4.5 is measured, multiplied by the remaining moisture content and a standard factor. The resulting value is internationally known in the technical field of washing machines as "alkalinity" of the spun-out water-detergent solution in equivalents of milligrams of sodium hydroxide

(mg NaOH).

[0011] Typical state-of-the art alkalinities of the residual water in the laundry for a full all-cotton wash load are as follows:

- without optimization: 240 mg NaOH
- with traditional optimization: 2 to 3 rinses with 4 to 6 min tumbling duration, medium rotation speed of intermediate spins (e.g. 900 rpm), optimized distribution of water amounts and rinse durations while saving water and time: 160 to 200 mg NaOH. This is still perceptibly turbid.
- cycles working with extreme amounts of water, very high spinning-speed and long intermediate spins, 5 rinse cycles and long rinsing times: 35 to 50 mg NaOH. This means residual water appears transparent, clear, and "clean".

[0012] An object of the present invention is to provide a method of the type mentioned at the beginning of the description according to which a low alkalinity of the rinsing water is reached without increasing the overall washing time and the water consumption.

[0013] The above object is reached thanks to the features listed in the appended claims.

[0014] According to the invention, by rinsing the load with water recirculated for a predetermined short time (i.e. shorter than 50 sec), while maintaining it in a satellized configuration of the load, it is possible to achieve excellent rinse result of 30 to 45 mg NaOH consistently with 90 to 100 l of water for 80 % of rated capacity all-cotton load in washers with recirculation system with a dedicated recirculation pump.

[0015] The pumping rate (measured as l/min) is preferably comprised between 0,2 and 1,7, more preferably between 0,3 and 1,5 of the fabric dry load (measured in kg). For a dry load of 5 kg the flow rate of the recirculation pump is therefore comprised between 1,5 and 7,5 l/min, with a total volume of water loaded in the tub comprised between 5 and 8 liters, more preferably within 6,5 and 7 liters.

[0016] The above preferred values apply to usual drums of washing machines having a diameter from 470 to 500 mm and a total volume from 50 to 65 l.

[0017] The applicant has discovered the above surprising results by carrying out several tests based on combinations of conservative and extreme wash cycle parameter settings in a cotton wash cycle, then looking for the optimum composite of short and long rinse cycles, small and large water amounts, and optimum drum movement. From previous experience the applicant did not expect to get down below 48 mg NaOH but it was surprised to find that some of the settings gave a breakthrough result. These settings succeeded not only in one washer model but in many different models with different drum volumes ranging from 50 l to 65 l. This range of drum volumes is typical of today's EU wash market.

[0018] The above surprising result in term of low final

alkalinity of the rinsing water seems mainly due to the centrifugal recirculation of the rinsing water for a strictly limited time in order to avoid stirring up of soil/detergent from the sump of the tub.

5 **[0019]** The applicant has also discovered that good final result can be obtained by combining the above centrifugal recirculation, preferably repeated two or more times, with a final tumbling rinse whose duration is preferably longer than 7 minutes and with a water amount which is preferably comprised between 0,7 and 1 of the total water amount used in the washing phase. The applicant has discovered another beneficial ancillary step of performing short tumbling rinses with a reduced amount of water (i.e. the only water loaded before centrifugal recirculation) in order to quickly release concentrated superficial soil/detergent combined with longer rinses in which the wash load is flooded with higher amount of water in order to rinse out deep-bound soil/detergent.

20 **[0020]** Further advantages and features of a method of rinsing the load in a washing machine according to the invention will become clear from the following detailed description, provided as non-limiting example, with reference to the attached drawings in which:

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- figure 1 is a perspective view of a washing machine according to the invention,
 - figure 2 is a diagram of total washing cycle and rinsing cycle according to the invention, where water consumption and drum speed are reported vs. time,
 - 30 - figure 3 is an enlarged view of a portion of diagram of figure 2, and
 - figure 4 is an enlarged view of another portion of diagram of figure 2.

35 **[0021]** With reference to the drawings, a washing machine 10 comprises a rotating drum 12 mounted in a tub 14. A pump 16 is provided for spraying water from the lowest part of the tub 14 (i.e. the sump 15) in a recirculation pattern through a conduit 17 towards a spraying nozzle 18. The washing machine 10 comprises a control unit (not shown) which drives all the components of the machine according to a certain predetermined program and according to a selection of such program by a user through a user interface (not shown).

40 **[0022]** With reference to a wash cycle for cotton fabrics, according to one embodiment of the invention such cycle comprises the following combination:

- 50
- water amount in the main wash: from 18.5 to 22.5 liters depending on drum volume;
 - after main wash, a traditional multistep intermediate spin is performed with maximum rotation speed plateau of 800 to 1200 rpm, preferably 960 rpm;
 - 55 - from 6 to 7.5 liters of fresh water for rinsing are injected in the tub 14 at the end of the above intermediate spin while spinning with a lightly satellized load, e.g. at 100 rpm rotation speed in a washer drum with

470 to 500 mm drum diameter. By "satellized" we mean that the load is attached to the drum wrapper through centrifugal force such that it cannot perform any tumbling / falling movement. By "lightly satellized" we mean that no strong compression force is exerted to the wash load, load items are loosely stacked on each other inside the drum wrapper. Duration of plateau depends on flow rate of freshwater inlet valve. 100 seconds duration is suitable if inlet valve has 5.5 l/min flow rate. The fresh water is brought directly into the load by activating the recirculation pump for a short time, preferably 30 s after end of filling for 8 l/min pumping rate. This short recirculation phase is indicated with reference R in the drawings. During this short recirculation phase the drum rotation at "light satellization" speed is still maintained. Longer recirculation than 50 s (in case of 8 l/min pumping rate) should be avoided. The applicant has discovered that best result in terms of alkalinity can be obtained if the recirculation time is shorter than 35 s, preferably shorter than or equal to 30 s. The applicant found that longer recirculation worsens the rinsing efficiency as it takes sedimented soil and detergent from the bottom of the basket / tub back into the laundry. The method of loading fresh water into the tub while load is satellized and bringing the water directly onto the load during satellization is called in the following "centrifugal fill" (CF in the drawings). The main advantage of performing this centrifugal fill is that fresh water is centrifugally pressed through the fabric layers of the wash load, releasing large amounts of detergent and soil. It is important to notice that in figure 2 the 2nd, 4th and 5th addition of water in the tub (upper part of figure 2) is made by a first step during the centrifugal fill CF and by a second step W where water is added during the subsequent tumbling rinse.

[0023] Figure 3 shows the water inlet and spin speed profile versus time as described in the above preliminary rinse step.

[0024] Several (preferably two) time-saving short rinses and spins (called "interval rinse" and indicated with reference A in the drawings) are carried out. Each interval rinse has a tumbling duration of 1 to 5 minutes (preferably 3 minutes), short motor-on / motor-off times in reversing with slow rotation to achieve good distribution of water and laundry (preferably tumbling 4 seconds clockwise at 35 rpm, 4 seconds no movement, 4 seconds counterclockwise at 35 rpm, 4 seconds no movement and so on) followed by a short spin peak (called "interval peak" and indicated in the drawings with reference B) of 800 to 1200 rpm, preferably 960 rpm. At the end of each spin peak B, after water is pumped out of the tub, a centrifugal fill CF is performed.

[0025] A longer rinse cycle (7 to 12 min duration, preferably 8 min, called "basic rinse" and indicated with reference C in the drawings) is performed after some of the

above interval peak B. One of such basic tumbling rinses C is shown in figure 4, and its preferred duration is comprised between 3 and 8 minutes. In addition to the 6 to 7.5 liters of fresh water injected while spinning at approx. 100 rpm, a moderate amount of fresh water (0.7 to 0.8 times the water amount of the main wash) is injected after the laundry satellization is ended. Again, a tumbling (reversing) rhythm is performed with short on/off times and slow rotation to achieve good mixing of water and wash load (preferably 4 seconds clockwise at 35 rpm, 4 seconds no movement, 4 seconds counterclockwise at 35 rpm, 4 seconds no movement). At the end of the spin peak B, a centrifugal fill is performed.

[0026] The last phase of the overall rinsing process according to the invention is a very long tumbling phase of a last rinse E, with duration of at least 10 minutes, preferably 12 min. In addition to the 6 to 7.5 liters of fresh water loaded while spinning at approx. 100 rpm, again a moderate amount of fresh water is loaded after the laundry satellization is ended. This water amount in final rinse should be higher than in the other long rinse cycles C in order to efficiently soak the load, obtain good dilution of the detergent and soil bound in the fabrics and release these impurities from the fabrics. This water amount should be around 0.85 times the water amount of the main wash. A tumbling (reversing) rhythm with short on/off times and slow rotation is carried out to achieve good distribution of water and laundry but preferably longer / higher than in the other rinse cycles C (preferably 8 seconds clockwise at 40 rpm, 8 seconds no movement, 8 seconds counterclockwise at 40 rpm, 4 seconds no movement). At the end a traditional final spinning F is carried out to extract as much liquor as possible from the wash load.

[0027] According to a further feature of the invention, through the user interface it is possible to activate an "intensive rinse" or "extra rinse" program corresponding to the rinsing and spinning parameters described above. If this strong rinsing is not needed and the option is not selected by the user, a shorter cycle consuming less water and energy will be performed.

Claims

1. Method for rinsing fabric in a washing machine (10) having a wash chamber (12) rotating about a horizontal axis in a wash tub (14), comprising the step of adding water to the tub (14) and spraying rinse water by recirculating it onto the fabric while spinning the wash chamber (12) at a speed to effect a centrifugal force on said fabric so that it will not tumble within the wash chamber (12), **characterized in that** during said step (CF) the rinse water is sprayed for a time lower than 50 s.
2. Method according to claim 1, wherein recirculated water is sprayed at a flow rate measured as l/min

that is comprised between 0.2 and 1.7, more preferably between 0.3 and 1.5 times the dry load of fabric in the wash chamber (12) measured as kg.

3. Method according to claim 2, wherein the time during which the water is sprayed on the fabric is lower than 40 s. 5

4. Method according to claim 2, wherein the time during which the water is sprayed on the fabric is lower than 35 s, preferably lower than or equal to 30 s. 10

5. Method according to any of the preceding claims, wherein the total amount of water recirculated in the recirculation step is comprised between 5 to 8 liters, preferably between 6,5 to 7 liters. 15

6. Method according to any of the preceding claims, wherein it comprises a final tumbling rinse phase (E) longer than 7 minutes during which the added rinsing water is comprised between 0.5 and 1.2, more preferably between 0.7 and 1 of the total amount of water used during the washing phase. 20

7. Method according to any of the preceding claims, wherein the step of spraying water on the fabric is repeated several times with intermediate tumbling phases (A, C) followed by spinning phases (B) for water extraction. 25

8. Method according to claim 7, wherein each of said intermediate tumbling phases (C) has a duration comprised between 3 minutes and 8 minutes. 30

9. Method according to claim 8, wherein said intermediate tumbling phases (C) are shorter than 4 minutes. 35

10. Washing machine (10) comprising a wash chamber (12) rotating about a horizontal axis in a wash tub (14) and a recirculation system (15, 16, 17, 18) for spraying water onto fabric loaded in the wash chamber (12), **characterized in that** it comprises a control circuit configured to carry out a method according to any of the preceding claims. 40

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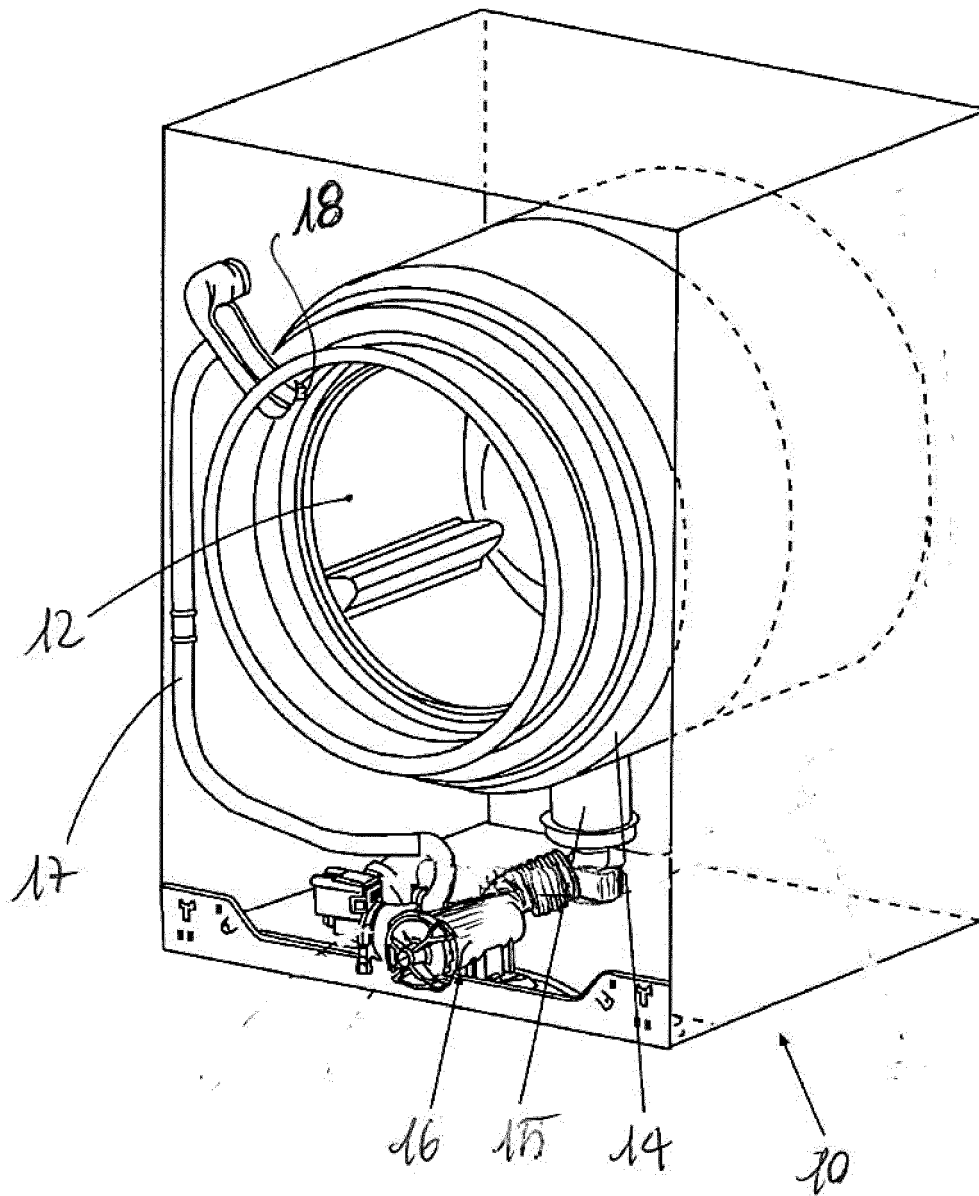


Fig. 1

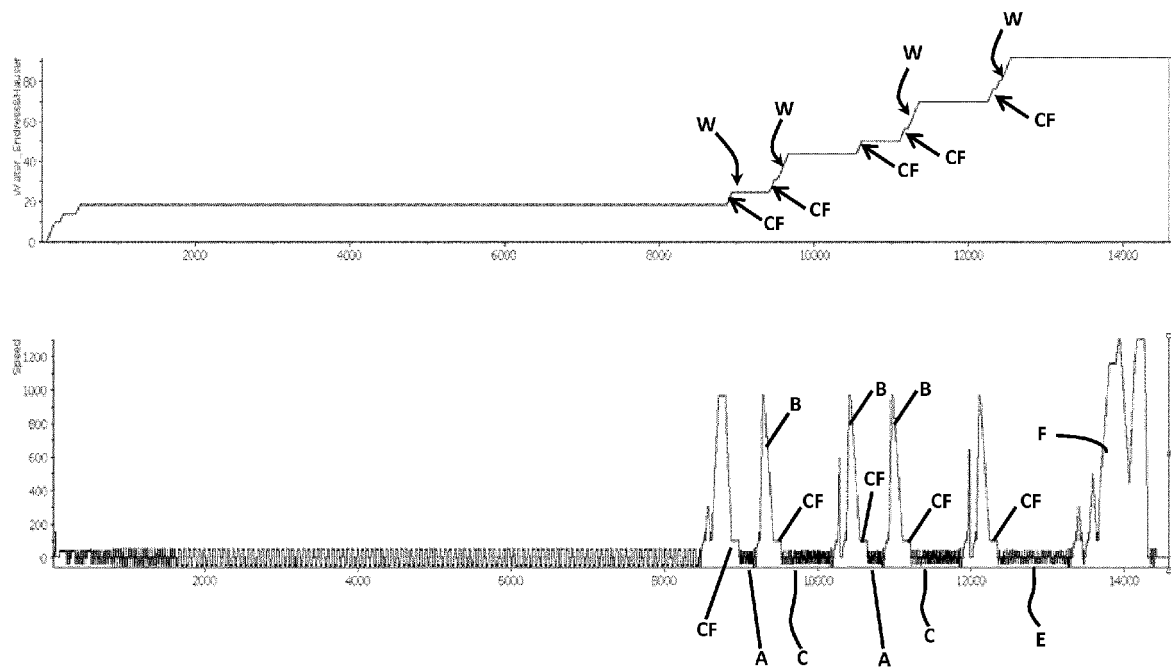


Fig. 2

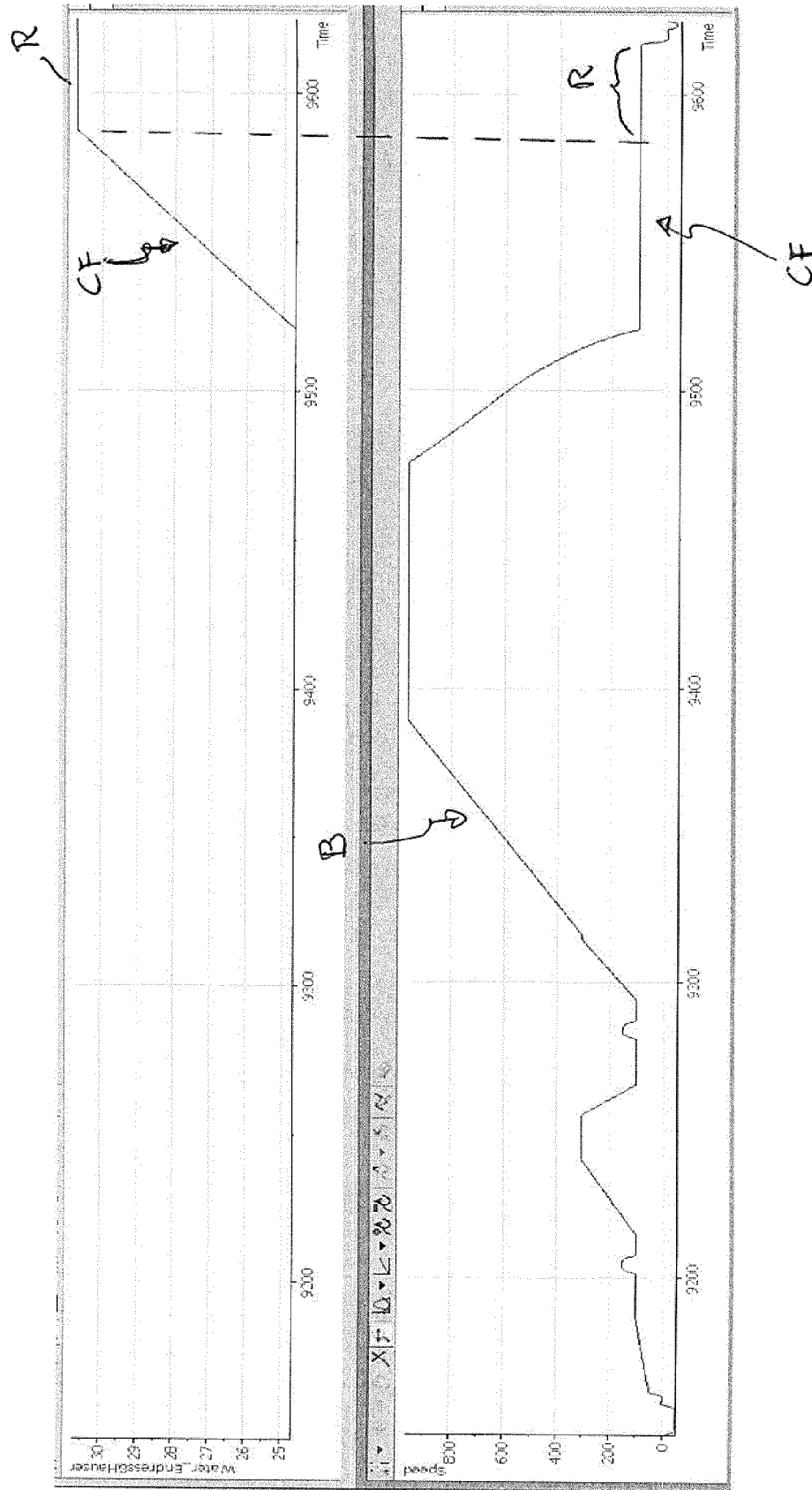


Fig. 3

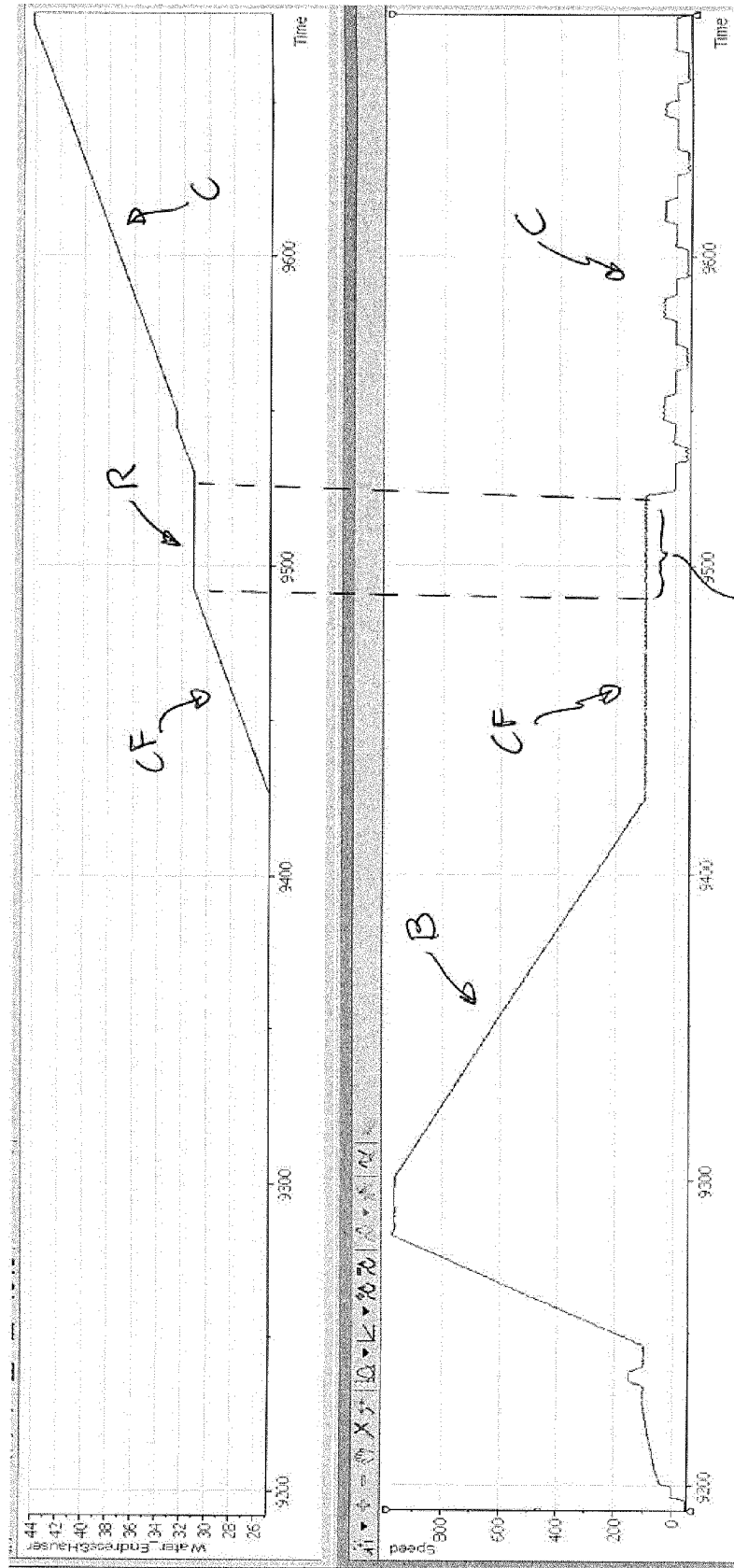


Fig. 4



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Application Number
EP 15 15 7826

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 28 September 2015	Examiner Stroppa, Giovanni
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			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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