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(54) **Method of operating a water-circulating household appliance**

(57) Herein a method of operating a water-circulating household appliance 2 is disclosed. The water-circulating household appliance 2 comprises an electric motor 4 and a washing liquid circuit 6, the washing liquid circuit comprising a pump 8 for circulating washing liquid through the washing liquid circuit. A portion of the washing liquid circuit is arranged in thermal communication

with the electric motor. For heating the washing liquid, the method comprises a step of driving the electric motor, over a time period longer than 1 minute, with a higher electrical power input than required for circulating the washing liquid through the washing liquid circuit with the pump rotating in the primary direction of rotation. Also disclosed is a water-circulating household appliance 2.

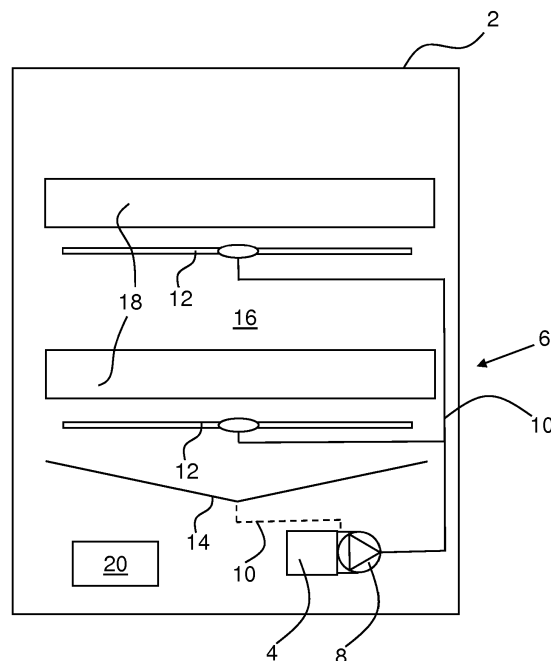


Fig. 1

## Description

### TECHNICAL FIELD

**[0001]** The present invention relates to a method of operating a water-circulating household appliance such as e.g. a dishwasher or a washing machine, and to a water-circulating household appliance as such.

### BACKGROUND

**[0002]** WO 2000/028878 discloses a circulating pump for a water-circulating household appliance, such as a dishwasher or washing machine, which is provided with a wash tub and an electric heating device for heating the wash-water, as well as a pump housing which is flange-mounted on the motor housing of the pump and has suction and pressure stubs for the liquid to be circulated and heated in the circular flow. The heating device is removably mounted on the pump housing in the water circuit of the pump. The combination of heating device and pump and the positioning of same in the water circuit of said pump, preferably in the pump housing, permits rapid and loss-free transfer of heat to the circulating wash-water.

**[0003]** GB 1002532 discloses a dishwashing machine comprising a rotary spray head disposed beneath a rack for holding dishes, tanks below the head for washing and rinsing liquids, respectively, a pump located between the tanks, and a valve operable to connect the required tank to the pump for the washing or rinsing operation. In using the machine the valve is first set to interconnect the tanks, and water is introduced by a hose into one of the tanks to a level slightly above a pipe interconnecting the tanks. An immersion heater in one of the tanks is then energized to heat the water in both tanks, and subsequently the pump motor and the motor for rotating the spray head are started. The soiled liquid returns to one of the tanks through a filter. The heater may be omitted if the tanks are to be filled initially with hot water.

**[0004]** Thus, various ways of providing a warm washing liquid in a household appliance utilizing warm washing liquid are known.

### SUMMARY

**[0005]** It is an object of the present invention to arrange for an alternative way of providing a warm washing liquid in a water-circulating household appliance.

**[0006]** According to an aspect of the invention, the object is achieved by a method of operating a water-circulating household appliance, the water-circulating household appliance comprising an electric motor and a washing liquid circuit, the washing liquid circuit comprising a pump for circulating washing liquid through the washing liquid circuit. A portion of the washing liquid circuit is arranged in thermal communication with the electric motor. The electric motor has a first direction of rotation and a

second direction of rotation and is arranged to drive the pump. The pump has a primary direction of rotation corresponding to the first direction of rotation of the electric motor. The method comprises a step of driving the electric motor, over a time period longer than 1 minute, with a higher electrical power input than required for circulating the washing liquid through the washing liquid circuit with the pump rotating in the primary direction of rotation.

**[0007]** Since the electric motor is driven with a higher electrical power input than required for circulating the washing liquid through the washing liquid circuit with the pump rotating in the primary direction of rotation, over a time period longer than 1 minute, the electric motor intentionally is driven with low efficiency, i.e. more electric power is input than required for simple pumping of washing liquid, excess electric energy input to the electric motor is transformed to heat in the windings of the electric motor. Moreover, since a portion of the washing liquid circuit is arranged in thermal communication with the electric motor, the heat is transferred to the washing liquid in this portion of the washing liquid circuit. As a result, the above mentioned object is achieved.

**[0008]** It has been realized by the inventors that a heating element may be altogether omitted in a water-circulating household appliance, such as a dishwasher or a washing machine, wherein a portion of the washing liquid circuit is arranged in thermal communication with the electric motor and the electric motor is driven in accordance with the above defined method. Thus, reducing costs of the relevant household appliance. Moreover, since a compartment for the heater may be omitted in the washing liquid circuit, for instance if the thermal communication is arranged between a housing of the pump and the electric motor, the total washing liquid volume in the water-circulating household appliance may be reduced. Thus, water may be saved and the amount of washing liquid requiring heating may be reduced, which saves energy.

**[0009]** Thus, the present invention revolves around the idea of intentionally driving the electric motor with low efficiency and utilizing excess heat from driving the electric motor to heat the washing liquid.

**[0010]** The water-circulating household appliance may for instance be a dishwasher or a washing machine. The washing liquid circuit may for instance comprise, beside the pump, conduits for the washing liquid, a trough for collecting washing liquid, a washing liquid tank or reservoir, a washing arm or other means of distributing the washing liquid to elements being cleaned in the water-circulating household appliance. The washing liquid may be water or water with an added detergent, other cleaning agent, or other additive. Various different washing liquids may be used during one full washing operation of elements in the water-circulating household appliance.

**[0011]** The portion of the washing liquid circuit arranged in thermal communication with the electric motor may for instance be a housing of the pump, a washing liquid inlet to the pump extending through a rotor axle of

the electric motor, a length of conduit extending around at least a portion of the electric motor, a washing liquid tank or reservoir of the water-circulating household appliance against which, or inside which, the electric motor is arranged, or any other similar arrangement.

**[0012]** The primary direction of rotation of the pump is the direction of rotation, in which the pump is designed to be rotated in order to provide an efficient pumping of the washing liquid. The step of driving the electric motor, over a time period longer than 1 minute, with a higher electrical power input than required for circulating the washing liquid through the washing liquid circuit with the pump rotating in the primary direction of rotation, provides an intentional low efficiency during pumping the washing liquid. The low efficiency may be created mechanically or dynamically in connection with the pump, or electrically in connection with the electric motor. The excessive electric power input generates heat in the windings of the electric motor, which is transferred to the washing liquid in the portion of the washing liquid circuit arranged in thermal communication with the electric motor. Depending on the desired temperature of the washing liquid and on the power rating of the electric motor, the time period longer than 1 minute may be longer than 10 minutes, longer than 20 minutes, or longer than 30 minutes.

**[0013]** According to embodiments, the step of driving the electric motor may comprise a step of rotating the electric motor in the second direction of rotation to rotate the pump in a direction opposite to the primary direction of rotation. In this manner the pump is driven with low efficiency and electrical power is transferred into heat in the electric motor.

**[0014]** The pump may be for instance a centrifugal pump. A centrifugal pump has a central fluid inlet and a peripheral fluid outlet. An impeller of the centrifugal pump is provided with blades, which pump the fluid from the central inlet to the peripheral outlet. A centrifugal pump is commonly designed with curved blades thus, providing a primary direction of rotation of the centrifugal pump, in which primary direction of rotation the pump is most efficient. In the opposite direction of rotation fluid may also be pumped however, with lower efficiency. That is, in the opposite direction of rotation a higher number of revolutions per time unit and/or a higher momentum is required to create a desired flow rate of fluid at the outlet of the pump. Such higher number of revolutions and/or higher momentum will require a higher electrical input, which generates heat in the electric motor.

**[0015]** According to embodiments, the step of driving the electric motor may comprise a step of causing an excessive electrical loss in the electric motor exceeding a normal electrical loss in the electric motor associated with rotating the pump in the primary direction for circulating the washing liquid through the washing liquid circuit.

**[0016]** According to embodiments, the step of causing the excessive electrical loss may comprise a step of re-

peatedly starting and stopping the rotation of the electric motor a number of times during each of a number of consecutive 1 minute time periods. Starting and stopping the electric motor in this manner provides an inefficient operation of the electric motor generating heat in the electric motor.

**[0017]** According to embodiments, the step of causing an excessive electrical loss may comprise a step of sending a DC voltage into at least one set of windings of the electric motor. Sending a DC voltage into a winding of the electric motor will not contribute to the rotation of the electric motor but will generate heat in the set of windings. Herein the term DC voltage includes a constant polarity voltage such as e.g. a PWM, Pulse Width Modulation, voltage. A PWM voltage may be used for controlling the electric power supplied to the set of windings of the electric motor.

**[0018]** According to embodiments, the step of causing the excessive electrical loss may comprise a step of sending an out of phase AC voltage through at least one set of windings of the electric motor. In this manner the AC voltage sent into the a least one set of windings will work against the AC voltage of the remaining sets of windings of the electric motor thus, causing an inefficient and heat generating operation of the electric motor. In this context the electric motor for instance may be a brushless motor comprising at least three sets of windings.

**[0019]** According to embodiments, the method may comprise a step of measuring a temperature of the washing liquid. In this manner it may be decided whether the washing liquid has reached a desired temperature.

**[0020]** According to embodiments, the method may comprise a step of rotating the electric motor in the first direction of rotation and rotating the pump in the primary direction of rotation. In this manner the washing liquid may be circulated in the water-circulating household appliance in an energy efficient manner once the washing liquid has reached a desired temperature.

**[0021]** According to a further aspect of the invention, the above mentioned object is achieved by a water-circulating household appliance comprising an electric motor and a washing liquid circuit, the washing liquid circuit comprising a pump driven by the electric motor and arranged to circulate washing liquid through the washing liquid circuit. A portion of the washing liquid circuit is arranged in thermal communication with the electric motor. The water-circulating household appliance is arranged to perform the method according to any one of the aspects and/or embodiments discussed herein.

**[0022]** Further features of, and advantages with, the present invention will become apparent when studying the appended claims and the following detailed description.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0023]** Various aspects of the invention, including its particular features and advantages, will be readily under-

stood from the example embodiments discussed in the following detailed description and the accompanying drawings, in which:

Fig. 1 illustrates a water-circulating household appliance according to embodiments, and

Fig. 2 illustrates a method of operating a water-circulating household appliance.

#### DETAILED DESCRIPTION

**[0024]** Aspects of the present invention will now be described more fully. Like numbers refer to like elements throughout. Well-known functions or constructions will not necessarily be described in detail for brevity and/or clarity.

**[0025]** Fig. 1 illustrates a water-circulating household appliance 2 according to embodiments. The water-circulating household appliance 2 is illustrated in the form of a dishwasher. The water-circulating household appliance 2 comprises an electric motor 4 and a washing liquid circuit 6. The electric motor 4 may be e.g. a brushless electric motor, a synchronous electric motor, or an asynchronous electric motor. The washing liquid circuit 6 comprising a pump 8 for circulating washing liquid through the washing liquid circuit 6. The pump 8 may be a centrifugal pump. In these embodiments the washing liquid circuit 6 further comprises conduits 10, rotating arms 12 provided with nozzles, and a trough 14. The pump 8 pumps the washing liquid to the rotating arms 12, wherein the washing liquid is distributed in a washing compartment 16. In the washing compartment 16 two trays 18 are provided for holding dishes to be washed. The washing liquid distributed in the washing compartment 16 is collected in the trough 14, from where it is led back to the pump 8.

**[0026]** The electric motor 4 is arranged to drive the pump 8. The electric motor 4 has a first direction of rotation and a second direction of rotation. The pump 8 has a primary direction of rotation corresponding to the first direction of rotation of the electric motor 4. The pump 8 has a secondary, or opposite, direction of rotation corresponding to the second direction of rotation of the electric motor 4.

**[0027]** A portion of the washing liquid circuit 6 is arranged in thermal communication with the electric motor 4. In these embodiments a housing of the pump 8 in the washing liquid circuit 6 is arranged in thermal communication when the electric motor 4.

**[0028]** The water-circulating household appliance 2 is arranged to perform a method according to any one of the aspects and/or embodiments discussed herein. Inter alia, for this purpose the water-circulating household appliance 2 comprises a control unit 20. The control unit 20 is arranged to control at least one washing operation of the water-circulating household appliance 2, including control of the manner in which the electric motor 4 is driven. A user of the water-circulating household appli-

ance 2 may select a washing program in the control unit 20 via a non-shown control panel. A washing program may comprise one or more different washing operations such as pre-rinsing, washing with detergent, and after-rinsing.

**[0029]** A heating element for heating in the washing liquid may be omitted in the water-circulating household appliance 2 since a portion of the washing liquid circuit 6 is arranged in thermal communication with the electric motor 4 and the electric motor 4 is driven in accordance with aspects and/or embodiments of the method discussed herein. The water supplied to the water-circulating household appliance 2 may be warm water thus, requiring less heating than if cold water were to be supplied. Mentioned purely as an example, circulating the washing liquid through the water-circulating household appliance 2 may require 60 - 90 W of electrical power. In an ordinary electric motor as used in a water-circulating household appliance, the power consumption may be 200-300 W or more when the electric motor is driven in accordance with aspects and/or embodiments of the method discussed herein. The excess electric power will be transformed into heat in the windings of the electric motor and thus, will be utilized to heat the washing liquid. Of course a more powerful electric motor may be used to increase the electric power consumption and thus, to increase the heat available for heating the washing liquid.

**[0030]** Fig. 2 illustrates a method of operating a water-circulating household appliance. The water-circulating household appliance comprises an electric motor and a washing liquid circuit. The washing liquid circuit comprising a pump for circulating washing liquid through the washing liquid circuit. A portion of the washing liquid circuit is arranged in thermal communication with the electric motor. The electric motor has a first direction of rotation and a second direction of rotation and is arranged to drive the pump. The pump has a primary direction of rotation corresponding to the first direction of rotation of the electric motor.

**[0031]** The water-circulating household appliance may be a water-circulating household appliance 2 as discussed in connection with Fig. 1.

**[0032]** The method comprises a step of driving 30 the electric motor, over a time period longer than 1 minute, with a higher electrical power input than required for circulating the washing liquid through the washing liquid circuit with the pump rotating in the primary direction of rotation.

**[0033]** The step of driving 30 the electric motor may comprise a step of rotating 32 the electric motor in the second direction of rotation to rotate the pump in a direction opposite to the primary direction of rotation.

**[0034]** The step of driving 30 the electric motor may comprise a step of causing 34 an excessive electrical loss in the electric motor exceeding a normal electrical loss in the electric motor associated with rotating the pump in the primary direction for circulating the washing liquid through the washing liquid circuit.

[0035] The step of causing 34 the excessive electrical loss may comprise a step of repeatedly starting and stopping 36 the rotation of the electric motor a number of times during each of a number of consecutive 1 minute time periods.

[0036] The step of causing 34 an excessive electrical loss may comprise a step of sending 38 a DC voltage into at least one set of windings of the electric motor.

[0037] The step of causing 34 an excessive electrical loss may comprise a step of sending 40 an out of phase AC voltage through at least one set of windings of the electric motor.

[0038] The method may comprise a step of measuring 42 a temperature of the washing liquid. In this manner it may be decided whether the washing liquid has reached a desired temperature and the electric motor may be driven with high efficiency again. The temperature of the washing liquid may be measured directly with a temperature sensor in the washing liquid, or indirectly on the outside of e.g. a conduit or a housing of the pump.

[0039] The method may comprise a step of rotating 44 the electric motor in the first direction of rotation and rotating the pump in the primary direction of rotation. In this manner the washing liquid may be circulated in the water-circulating household appliance in an energy efficient manner once the washing liquid has reached a desired temperature.

[0040] This invention should not be construed as limited to the embodiments set forth herein. A person skilled in the art will realize that different features of the embodiments disclosed herein may be combined to create embodiments other than those described herein, without departing from the scope of the present invention, as defined by the appended claims.

[0041] As used herein, the term "comprising" or "comprises" is open-ended, and includes one or more stated features, elements, steps, components or functions but does not preclude the presence or addition of one or more other features, elements, steps, components, functions or groups thereof.

## Claims

1. A method of operating a water-circulating household appliance, the water-circulating household appliance comprising an electric motor and a washing liquid circuit, the washing liquid circuit comprising a pump for circulating washing liquid through the washing liquid circuit, a portion of the washing liquid circuit being arranged in thermal communication with the electric motor, wherein the electric motor has a first direction of rotation and a second direction of rotation and is arranged to drive the pump, and wherein the pump has a primary direction of rotation corresponding to the first direction of rotation of the electric motor, **characterized in that** the method comprises a step of driving (30) the electric motor,

over a time period longer than 1 minute, with a higher electrical power input than required for circulating the washing liquid through the washing liquid circuit with the pump rotating in the primary direction of rotation.

2. The method according to claim 1, wherein the step of driving (30) the electric motor comprises a step of rotating (32) the electric motor in the second direction of rotation to rotate the pump in a direction opposite to the primary direction of rotation.

3. The method according to claim 1 or 2, wherein the step of driving (30) the electric motor comprises a step of causing (34) an excessive electrical loss in the electric motor exceeding a normal electrical loss in the electric motor associated with rotating the pump in the primary direction for circulating the washing liquid through the washing liquid circuit.

4. The method according to claim 3, wherein the step of causing (34) the excessive electrical loss comprises a step of repeatedly starting and stopping (36) the rotation of the electric motor a number of times during each of a number of consecutive 1 minute time periods.

5. The method according to claim 3, wherein the step of causing an excessive (34) electrical loss comprises a step of sending (38) a DC voltage into at least one set of windings of the electric motor.

6. The method according to claim 3, wherein the step of causing (34) the excessive electrical loss comprises a step of sending (40) an out of phase AC voltage through at least one set of windings of the electric motor.

7. The method according to any one of the preceding claims, comprising a step of measuring (42) a temperature of the washing liquid.

8. The method according to any one of the preceding claims, comprising a step of rotating (44) the electric motor in the first direction of rotation and rotating the pump in the primary direction of rotation.

9. A water-circulating household appliance (2) comprising an electric motor (4) and a washing liquid circuit (6), the washing liquid circuit (6) comprising a pump (8) driven by the electric motor (4) and arranged to circulate washing liquid through the washing liquid circuit (6), a portion of the washing liquid circuit (6) being arranged in thermal communication with the electric motor (4),

**characterized in that** the water-circulating household appliance (2) is arranged to perform the method according to any one of the preceding claims.

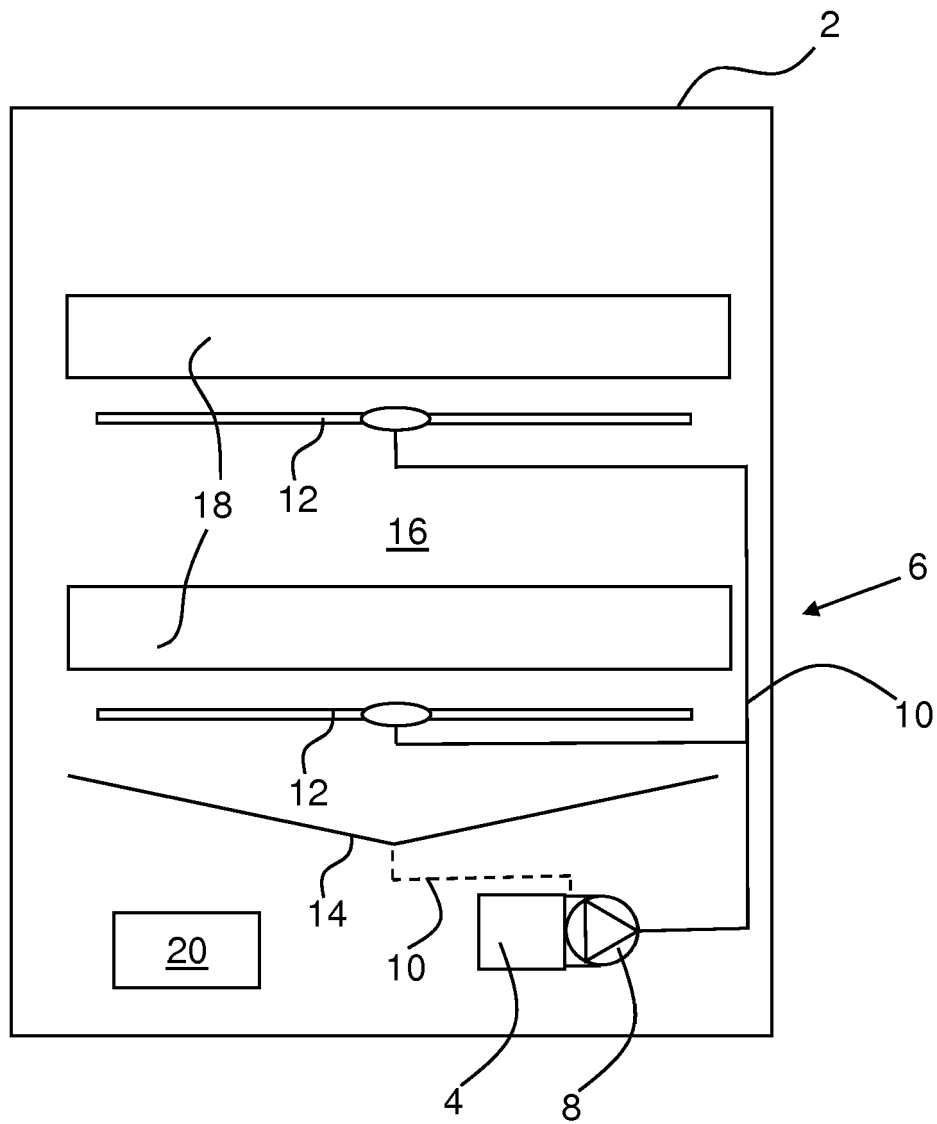


Fig. 1

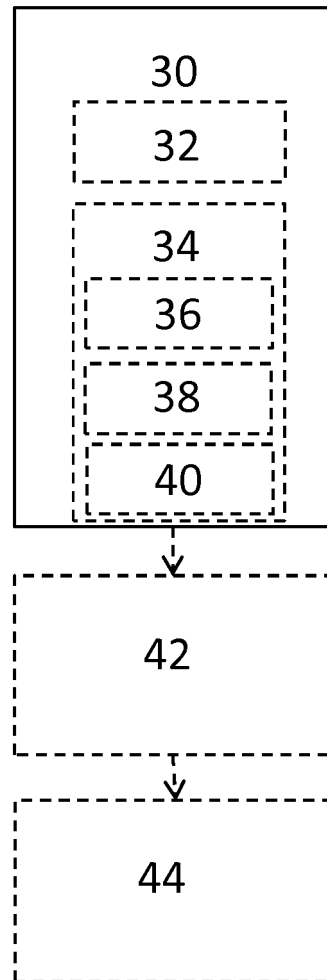


Fig. 2



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Application Number  
EP 13 19 4996

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| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                          |                                                  |                                                          |
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| Place of search<br>Munich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                          | Date of completion of the search<br>7 April 2014 | Examiner<br>Weinberg, Ekkehard                           |
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EPO FORM 1503 03.82 (P04C01)



**ANNEX TO THE EUROPEAN SEARCH REPORT  
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EP 13 19 4996

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
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