Dec. 22, 1959 H. E. KARIG 2,918,068

DISHWASHER

Filed Jan. 17, 1955 3 Sheets-Sheet 1

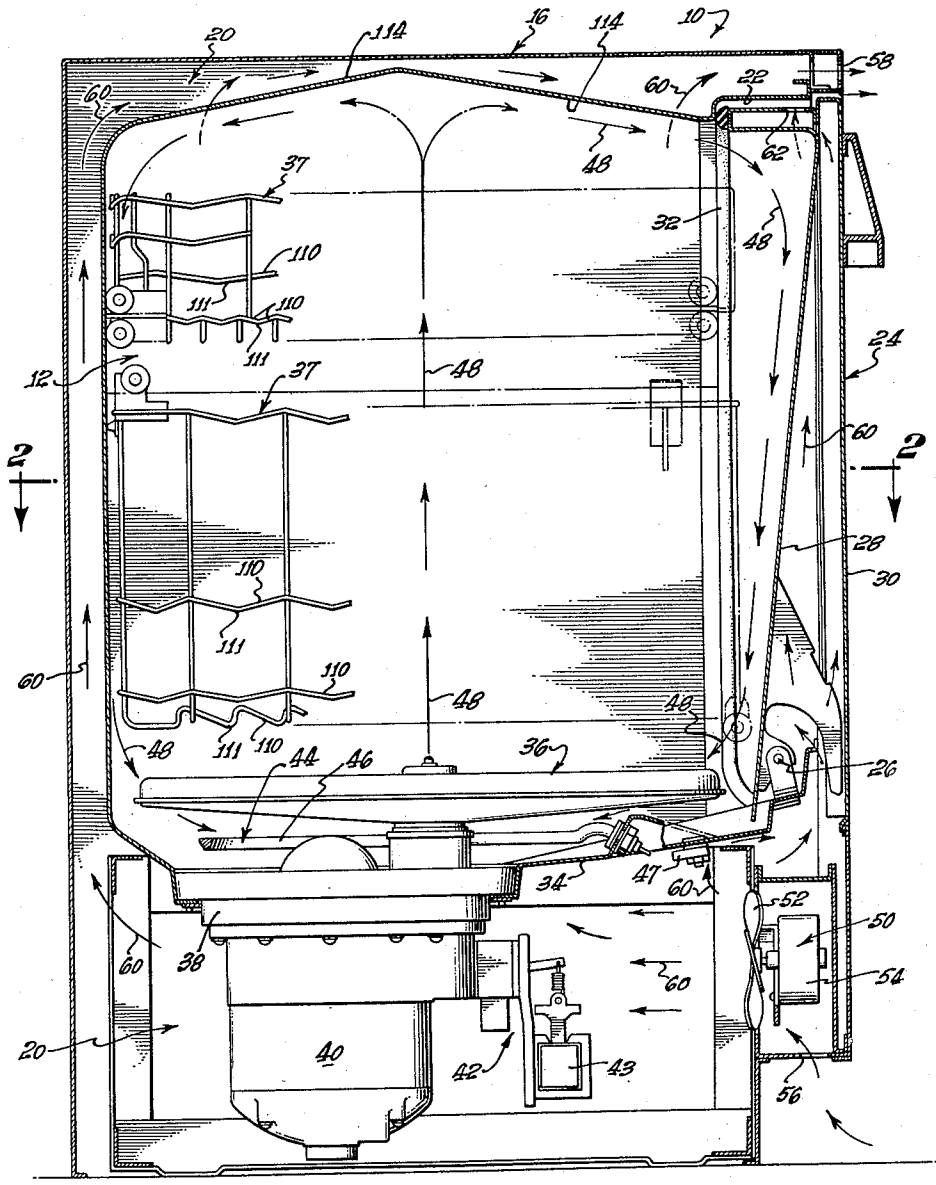


FIG. 1.

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By His ATTORNEYS.

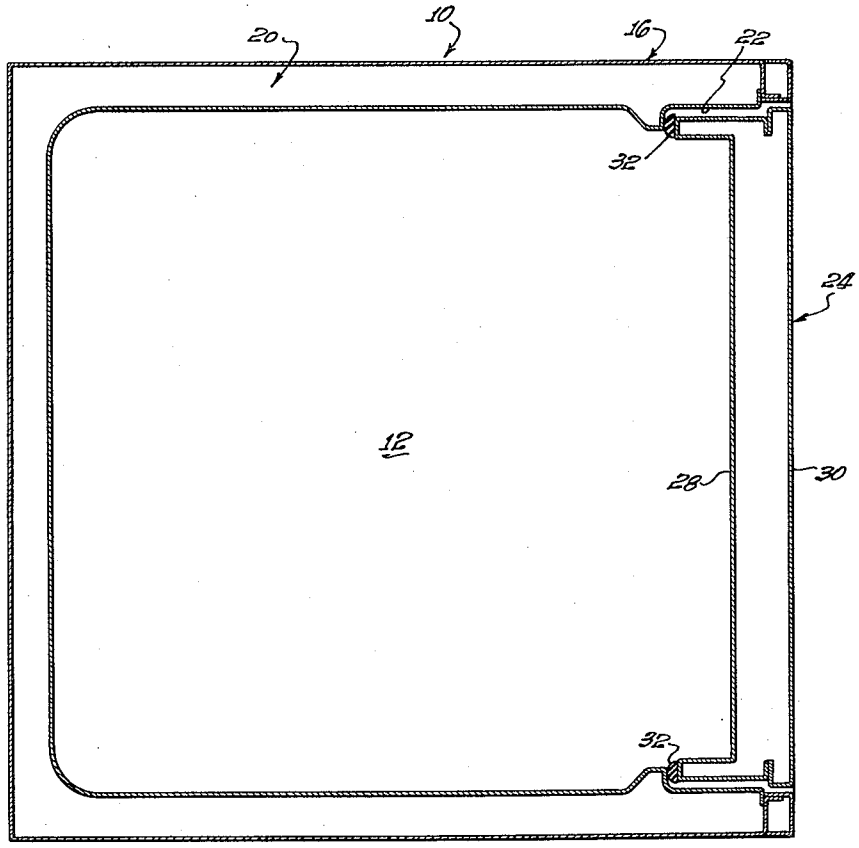
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DISHWASHER

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FIG. 2.



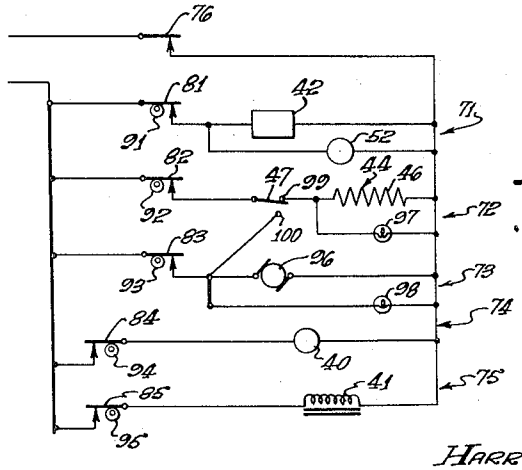


FIG. 3.

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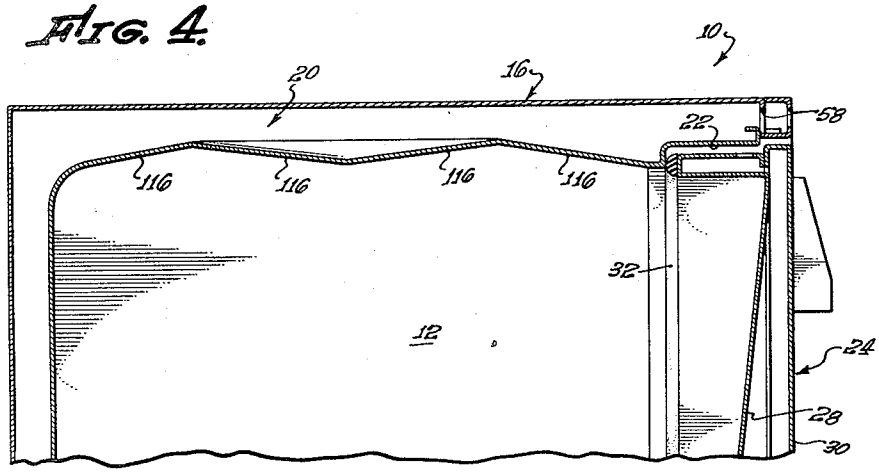
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Dec. 22, 1959 H. E. KARIG 2,918,068

DISHWASHER

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FIG. 4.



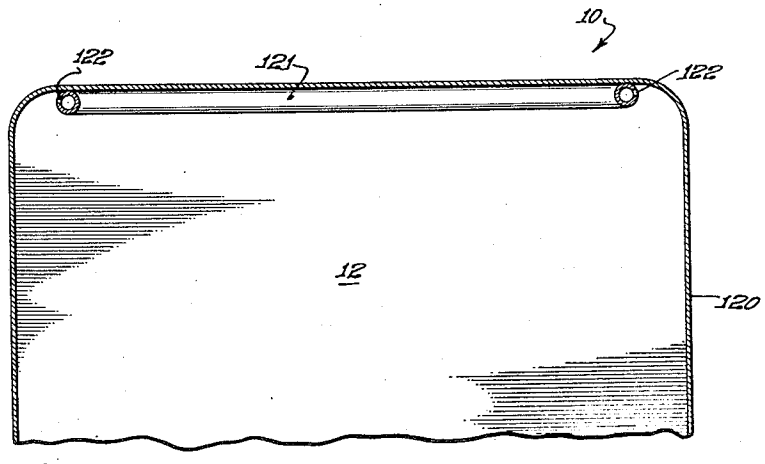


FIG. 5.

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United States Patent Office

2,918,068

Patented Dec. 22, 1959

2,918,068

DISHWASHER

Horace E. Karig, Pasadena, Calif., assignor to Waste King Corporation, Los Angeles, Calif., a corporation of California

Application January 17, 1955, Serial No. 482,239

8 Claims. (Cl. 134—99)

The present invention relates in general to dishwashing and, more particularly, to a novel method of and apparatus for drying dishes after washing and rinsing, the term "dishes" including dinnerware, tableware, glassware, and other objects.

Primary objects of the invention are to provide a method of and apparatus for drying dishes which avoids contamination of the dishes by foreign matter in the air and which avoids the discharge of moisture into the room or other area in which the apparatus is disposed.

More particularly, a primary object is to dry the dishes without exposure to the atmosphere surrounding the apparatus so that the degree of sterility and cleanliness attained during washing and rinsing of the dishes is maintained throughout the drying thereof. In conventional dishwashers, the dishes are dried either by merely opening the door of the dishwasher to expose the dishes to the atmoshpere, or by propelling the ambient air through the dishwasher and over the dishes therein to dry them. In either event, the degree of sterility and cleanliness attained during washing and rinsing is not maintained during the drying operation due to the fact that the dishes are contaminated by bacteria, dust, and the like, in the ambient air brought into contact therewith. Such disadvantages of prior dishwashers and prior practice are avoided by the present invention, which is an important feature thereof.

Considering the invention more specifically, the foregoing primary object of the invention is attained by drying the dishes in a closed dish chamber into which no ambient air is introduced after washing and rinsing, thereby permitting the maintenance of a high degree of sterility and cleanliness during the drying operation.

Still more specifically, an important object of the present invention is to wash, rinse and subsequently dry the dishes in a closed dish chamber to which substantially no ambient air is admitted during the washing, rinsing and drying operations so that the degree of sterility and cleanliness attained during the washing and rinsing operations is maintained into and throughout the drying operation.

The foregoing objects of the present invention are attained by circulating the air in the dish chamber first over the dishes therein and then over the inner surfaces of the walls of the chamber, while maintaining the temperature of the chamber walls below the temperature of the air circulating in the chamber, so that any moisture evaporated from the dishes in the chamber is conveyed to the inner surfaces of the chamber walls by the air circulating in the chamber to be condensed thereon, the air dried by condensation on the chamber walls in this manner being again circulated over the dishes to evaporate further moisture therefrom. Thus, the air in the dish chamber is continuously recirculated until all of the moisture has been evaporated from the dishes, such moisture being condensed on the chamber walls and subsequently draining to the bottom of the chamber, from whence it is drained off in any suitable manner. Thus,

the invention permits maintaining the dishes in the same condition of sterility and cleanliness as produced by the washing and rinsing operations, which is an important feature.

As hereinbefore indicated, another primary object of the invention is to prevent the discharge of vapor from the dishes during drying into the room or other area in which the dishwasher is disposed. Thus, moisture condensation on windows, walls, and other surfaces, in the room in which the dishwasher is disposed, is avoided, which is an important feature. This feature of the invention is inherently attained by drying the dishes in the manner hereinbefore set forth, all of the moisture evaporated from the dishes being condensed within the dish chamber and being drained off to a suitable point of disposal, such as a sewer line, to prevent condensation within the room in which the dishwasher is located.

Another object of the invention is to provide means for circulating the air in the dish chamber during drying which includes air heating means for maintaining the air in the chamber at an elevated temperature and for circulating the air through the chamber by convection, the heating means being centrally located at the bottom of the chamber so that the heated air is circulated upwardly through the center of the chamber and then outwardly and downwardly over the chamber walls back to the heating means. As the air is moved upwardly through the center of the chamber by convection, it evaporates moisture from the dishes and, as the air is thereafter moved outwardly and downwardly along the walls of the chamber by convection, it is dried by condensation of moisture therefrom onto the inner surfaces of the chamber walls, the air thus being capable of evaporating additional moisture from the dishes as it again flows upwardly therethrough.

Another object is to provide a method of and apparatus for drying dishes wherein the heating of the air in the dish chamber is terminated after a predetermined time interval, whereupon the air convection in the chamber is maintained by the heat stored in the dishes themselves until such time as the drying operation is completed. In other words, during the initial portion of the drying operation wherein heat is supplied to the air in the chamber by the heating means to produce the hereinbefore discussed circulation by convection, the dishes are heated to an elevated temperature and, after termination of the heating by the heating means, the heat stored in the dishes is transferred to the air circulating in the chamber each time such air passes over the dishes to continue the circulation in the chamber by convection. Thus, the heating means needs to be energized for only a portion of the drying operation, which is an important feature.

Another object in connection with certain embodiments of the present invention is to maintain the chamber walls at a temperature below the temperature of the air circulating in the chamber by exposing the outer surfaces of the chamber walls to the ambient air. Under all but the most unusual atmospheric conditions, the temperature of the ambient air will be well below the temperature of the air circulating in the dish chamber so that the chamber walls will be maintained at a temperature sufficiently below the temperature of the air circulating in the chamber to produce the desired condensation of moisture on the inner surfaces of the chamber walls.

In many instances, adequate cooling of the walls of the closed chamber containing the dishes is attained merely by exposing the exterior surfaces of such walls to the ambient air in the room or other area in which the dishwasher is disposed. In other words, adequate cooling under such conditions is frequently attained by radiation from the chamber walls, by thermal convection of

the ambient air thereover, and by normal air circulation in the room or other area.

However, I prefer to employ forced air circulation over the exterior surfaces of the chamber walls and, to this end, an important object of the invention is to provide a dishwasher wherein the closed chamber containing the dishes is enclosed by an outer housing through which ambient air is propelled.

More particularly, an object is to provide a dishwasher having an outer housing formed by outer walls which are spaced outwardly from the walls of the dish chamber, hereinafter referred to also as inner walls, to provide between such inner and outer walls a space which surrounds the dish chamber, ambient air being propelled through such space by a fan, or the like, to maintain the temperature of the inner walls below the temperature of the air circulating in the chamber. A related object is to provide a dishwasher wherein the space through which the ambient air is propelled completely surrounds the closed chamber containing the dishes. More specifically, an object in this connection is to provide a door for access to the closed chamber which is defined by certain of said inner and outer walls, such inner and outer walls also being spaced apart to permit propelling ambient air therebetween.

Another object of the invention is to provide a dishwasher wherein the walls of the closed chamber containing the dishes are cooled by means of a liquid, preferably water from the normal household or other cold water supply, applied to the chamber walls either externally or internally thereof. If the chamber walls art cooled by water applied externally thereto, the moisture evaporated from the dishes in the manner hereinbefore discussed is condensed on the inner surfaces of such walls in the same manner as for the cases mentioned in which the chamber walls are cooled by the ambient air. For the case in which the water is applied to the chamber walls internally thereof, the cooling water is preferably spread over the interior surfaces of such walls in relatively thin sheets, whereupon the moisture evaporated from the dishes condenses either on the interior surfaces of the chamber walls, or directly on the water sheets, the cooling water being drained off along with the condensate.

Another object is to facilitate drying of the dishes by minimizing the amount of water which must be evaporated and subsequently condensed in the manner hereinbefore described. More particularly, an object of the invention is to minimize the amount of water from the final rinse which hangs up on various components of the dishwasher, such as the racks for supporting the dishes, the upper wall of the chamber containing the dishes, and the like. More particularly, an object in this connection is to minimize water hang up on the dish racks by eliminating, or substantially eliminating, horizontal elements from the dish racks, a related object being to make the dish racks of "zig zag" construction so that all, or substantially all, elements thereof are sloping or vertical. With this construction, the dish racks are provided with numerous apices to which water droplets may drain and fall off, thereby minimizing the number of water droplets retained by the dish racks for subsequent evaporation. In connection with the upper wall of the dish chamber, an object is to make such upper wall with a sloping surface, or sloping surfaces, to minimize water droplet hang up. Other objects in this connection are to minimize horizontal surfaces on which water droplets can hang up throughout the entire interior of the dish chamber.

Another object of the invention is to provide a dishwasher the operating cycle of which is timer controlled so that the washing, rinsing and drying operations are carried out automatically, it being understood, however, that certain features of the invention may be embodied in manually operated or semiautomatic dishwashers as well.

Another object is to provide a timer-controlled dishwasher having a thermostat or thermostat means which responds to the temperature within the dish chamber, and having means controlled by the thermostat for interrupting operation of the timer until the temperature of the water utilized for the final rinsing of the dishes is up to a preselected value, the hereinbefore discussed heating means for circulating the air in the dish chamber during drying also being utilized to heat the water employed during the washing and rinsing operations. After the temperature of the water utilized for the final rinse is up to the preselected value, the timer is re-energized and thereafter again controls the operating cycle, the control of the operating cycle being taken away from the timer only when it is necessary to heat the final rinse water up to the preselected value. This feature of the invention provides a sterilizing rinse regardless of the temperature of the water available to the dishwasher, and is important to the drying operation since it insures that the dishes are heated to the preselected temperature of the final rinse water before the drying operation is initiated, thereby expediting the drying operation.

An important object of the invention is to utilize a single thermostat for regulating both the temperature of the washing and rinsing water during the washing and rinsing operations and for regulating the temperature of the air utilized to dry the dishes during the drying operation. More particularly, an object is to utilize a single thermostat for limiting the temperature of the washing and rinsing water to one preselected value and for limiting the temperature of the air utilized to dry the dishes to a higher preselected value. Considering how the foregoing is accomplished, the thermostat is located in a sump at the bottom of the dish chamber below the normal water level therein. Thus, the thermostat limits the water temperature to the preselected value for which the thermostat is designed. During the drying operation, the thermostat limits the air temperature at the bottom of the dish chamber to the same preselected value, but the air in the dish chamber at the level of the dishes therein will be at a higher value due to the fact that the heated air rises in the dish chamber. For example, if the thermostat limits the temperature of the washing and rinsing water to 160° F., and limits the temperature of the air at the bottom of the dish chamber to 160° F. during drying, the temperature of the air in the upper portions of the dish chamber in the vicinity of the dishes will be at a higher preselected value, e.g., 180° F. to 190° F. Thus, the same thermostat is utilized to maintain the temperature of the washing and rinsing water at one preselected value and is utilized to maintain the drying air temperature in the vicinity of the dishes at a higher preselected value, which is an important feature of the invention.

The foregoing objects, advantages and features of the present invention, together with various other objects, advantages and features thereof which will become apparent, may be attained with the exemplary embodiments of the invention illustrated in the accompanying drawings and described in detail hereinafter. Referring to the drawings:

Fig. 1 is a vertical sectional view of one embodiment of the present invention;

Fig. 2 is a horizontal sectional view taken along the broken line 2—2 of Fig. 1;

Fig. 3 is a simplified diagrammatic view of a control circuit for the invention;

Fig. 4 is a vertical sectional view of an alternative dish chamber construction; and

Fig. 5 is a vertical sectional view of an alternative dish chamber cooling means.

Referring particularly to Figs. 1 and 2 of the drawings, the embodiment of the invention illustrated therein is

designated generally by the numeral 10 and includes an inner, closed, dish chamber 12 having upper, lower and side walls. The dish chamber 12 is enclosed by an outer housing or cabinet 16 the walls of which are spaced outwardly from the walls of the dish chamber to provide a space 20 completely surrounding the dish chamber. A doorway 22 provides access to the interior of the chamber 12, this doorway being closed by a door 24 shown as hinged to the structure of the dishwasher 10 at 26. Interconnected walls 28 and 30 of the dish chamber 12 and the cabinet 16 form the door 24, the walls 28 and 30 being spaced apart to make the space 20 coextensive with the door so that the space 20 completely surrounds the dish chamber 12 as hereinbefore indicated. The door 24 is shown as carrying a sealing strip 32 which is engageable with the dish chamber 12 along at least the sides and the top of the doorway 22 so as to provide means for sealing the dish chamber against the escape of water during washing and rinsing operations to be described. In the particular construction illustrated, the lower edge of the wall 28 extends downwardly into a sump 34 forming the lower wall of the dish chamber so that a water seal is provided along the lower edge of the door 24 to prevent the escape of water during the washing and rinsing operations. Except for the doorway 22, which is sealed in the manner hereinbefore described, and some means, not shown, for introducing water into the dishwasher, the dish chamber 12 is completely closed.

Located within the dish chamber 12 adjacent the bottom thereof is a washing-fluid impelling means 36, the washing fluid preferably being water with or without such additives as detergents, water softeners, and the like, as is well known in the art. In the particular construction illustrated, the impelling means 36 takes the form of a rotary spraying device for spraying the washing fluid upwardly throughout the interior of the dish chamber 12 and over any dishes therein to be washed and/or rinsed, the dishes being suitably supported in the chamber 12, as on suitable racks 37 which are shown fragmentarily. The impelling means 36 may take the form of a spraying device of the reaction type, or it may take the form of a positively driven spraying device, or the like. In the particular construction illustrated, the impelling means 36 is a reaction-type spraying device which is supplied with washing fluid by a pump 38 communicating with the sump 34, the pump being driven by an electric motor 40 disposed below the dish chamber 12 in a portion of the space 20 between the chamber 12 and the cabinet 16. The washing fluid may be introduced into the chamber 12 in any suitable manner, not shown, as by way of a valve, not shown, controlled by a solenoid 41, Fig. 3. The water may be drained from the dish chamber 12 in any suitable manner by a draining means 42, Figs. 1 and 3, the draining means being shown in Fig. 1 as including a solenoid 43 for actuating a drain valve, not shown.

Centrally located at the bottom of the dish chamber 12 is a heating means 44 shown as comprising an electrical heating element 46 carried by the sump 34 and controlled by a thermostat 47 carried by the sump at the bottom of the dish chamber, the thermostat being so located relative to the heating element 46 that direct radiation from the heating element to the thermostat is minimized. The heating means 44, in addition to performing a heating function in connection with the washing and rinsing water and the drying air, also serves as a means for circulating the drying air within the dish chamber 12 throughout this chamber by convection in a pattern somewhat as indicated by the arrows 48. In other words, the air heated by the heating means 44 rises centrally of the dish chamber 12 and then flows outwardly and downwardly along the inner surfaces of the walls of the dish chamber, to be again heated by the heating means 44 and again caused to rise centrally of the chamber in a continuous flow pattern.

As more fully discussed hereinafter, the air circulating in the dish chamber 12 during the drying operation is relieved of moisture carried thereby by condensation of such moisture on the inner surfaces of the walls of the dish chamber. In order to produce such condensation, the walls of the dish chamber 12 are maintained at a temperature below that of the air circulating in the dish chamber. The walls of the dish chamber 12 may be cooled either with the ambient air, or, as discussed hereinafter, with a liquid such as water from the normal household or other cold water supply. One way of cooling the walls of the dish chamber 12 with ambient air is to merely expose the dish chamber to the ambient air, in which case the cabinet 16 would not be utilized. Under such conditions, cooling of the dish chamber walls would be attained by radiation therefrom into the ambient air, or by conduction to the ambient air, such conduction being enhanced by thermal convection of the ambient air over the external surfaces of the dish chamber walls and by normal air circulation in the room or other area in which the dishwasher is located.

However, as hereinbefore indicated, I prefer to maintain the temperature of the dish chamber walls below the temperature of the drying air circulating in the dish chamber by forced air circulation over the external surfaces of the dish chamber walls. To this end, atmospheric air is circulated throughout the space 20 between the dish chamber 12 and the outer housing or cabinet 16 by an air propelling means 50 shown as including a fan 52 driven by an electric motor 54. The fan 52 draws ambient air in through an inlet 56 in the cabinet 16 and propels such air throughout the space 20 between the chamber 12 and the cabinet, the air escaping from the cabinet through outlet openings 58, all as indicated by the arrows 60. It will be noted that the ambient air propelled by the fan 52 also flows through the door 24, i.e., between the walls 28 and 30 forming the door, such air escaping through openings 62 at the top of the door.

The foregoing completes a general description of the structure and operation of the dishwasher of the invention and the manner in which the dishwasher is timer controlled will now be considered before considering the operation of the dishwasher in detail. Referring to Fig. 3 of the drawings, the control circuit illustrated includes parallel circuits 71, 72, 73, 74 and 75 all controlled by a switch 76, the latter cooperating with the door 24, in a manner not shown, to energize the control circuit only when the door is closed. The circuits 71, 72, 73, 74 and 75 respectively include switches 81, 82, 83, 84 and 85 controlled by diagrammatically-shown cams 91, 92, 93, 94 and 95, the cams being driven by a timer motor 96 in the circuit 73. The circuit 71 includes the draining means 42 and the fan 52 and the cam 91 closes the switch 81 to energize these elements whenever water is to be drained from the dish chamber 12 and throughout the entire drying operation. The circuit 74 includes the pump motor 40, and the cam 94 closes the switch 84 to energize the pump motor during the various washing and rinsing operations. The circuit 75 includes the solenoid 41 and the cam 95 closes the switch 85 to energize the solenoid 41 so as to open the fill valve to admit water to the dish chamber 12 at the proper points in the operating cycle.

Considering the circuits 72 and 73, the circuit 72 includes the thermostat 47 and the heating element 46, as well as a signal light 97 in parallel with the heating element. The circuit 73 includes the timer motor 96, as well as a signal light 98 in parallel therewith. The thermostat 47 includes a switch element engageable with a contact 99 or a contact 100, the parallel circuit 72 being completed through the thermostat and the switch 82 when the contact 99 is engaged, and the parallel circuit 73 being energized through the thermostat when the contact 100 is engaged, the contact 100 being connected to the circuit 73 between the timer motor 96 and the switch 83 to energize the timer motor when the switch 83 is open.

Considering the operation of the dishwasher **10**, the dishes to be washed are placed on the racks **37** in the dish chamber **12** and the door **24** is closed, thereby closing the switch **76** to energize the control circuit. The timer, comprising the timer motor **96** and the cams and switches controlled thereby, then causes the dishwasher to perform a series of washing and rinsing operations, including a preliminary rinse prior to washing if desired, in a manner which need not be discussed in detail herein, the various elements performing their intended functions in a manner which will be apparent. Only the final rinsing operation and the drying operation, and the relationship therebetween, will be considered in detail herein.

After filling the sump **34** for the final rinsing operation, which may be the only rinsing operation, the cam **93** opens the switch **83** to de-energize the timer motor **96**, which remains de-energized until the temperature of the final rinse water has been increased, if necessary to the preselected value, e.g., 160° F., by the heating element **46**. The cam **92** closes the switch **82** at this point in the operating cycle and the thermostat **47** engages the contact **99**. At this point in the operating cycle, the cam **91** opens the switch **81** to deenergize the draining means **42** and the fan **52**, the cam **95** opens the switch **85** to de-energize the fill solenoid **41**, and the cam **94** opens the switch **84** to de-energize the pump motor **40**. As soon as the heating element **46** has heated the water in the dish chamber **12** up to the preselected value, the thermostat **47** disengages the contact **99** to interrupt the circuit through the heating element, and engages the contact **100** to re-energize the timer motor **96**, even though the switch **83** is open. At this point, the cam **94** closes the switch **84** to energize the pump motor **40**. A slight rotation of the cam **93** by the timer motor **96** recloses the switch **83** to insure continued operation of the timer motor **96** even though the thermostat **47** subsequently interrupts the circuit therethrough, the switch **83** normally controlling the timer motor **96** being closed throughout the entire operating cycle, except for the interruption discussed during the interval while the temperature of the final rinse water is being increased to the preselected value.

By delaying the operating cycle in the foregoing manner to insure that the final rinse water is up to the desired preselected value, thorough preheating of the dishes by the final rinse water is insured to expedite subsequent drying thereof, which is an important feature of the invention.

Considering now the drying operation, after the final rinse has been completed, the cam **94** opens the switch **84** to de-energize the pump motor **40** and the cam **91** closes the switch **81** to energize the draining means **42** and the fan motor **52**, the latter circulating air through the space **20** between the dish chamber **12** and the cabinet **16** as hereinbefore discussed. The cam **95** holds the switch **85** controlling the fill solenoid **41** open, and the cam **93** maintains the switch **83** closed, as hereinbefore discussed, to energize the timer motor **96**. During an initial portion of the drying operation, the cam **92** closes the switch **82** to maintain the heating element **46** in operation under the control of the thermostat **47**, which limits the air temperature at the bottom of the dish chamber **12** to the preselected value for which the thermostat is designed, the air in the dish chamber in the vicinity of the dishes being at a substantially higher temperature for the reasons hereinbefore discussed.

During the initial portion of the drying cycle, which may be of the order of magnitude of one-third the length of the complete drying cycle, the heating means **44** is in operation, as indicated above, and, under the control of the thermostat **47**, maintains the air within the dish chamber **12** in the vicinity of the racks **37** at a predetermined value, such as 180° F. to 190° F., for example, by maintaining the temperature of the air at the bottom of the dish chamber at a lower temperature, such as 160° F. The heating of the air in the chamber **12** by the heating means **44** causes the air to circulate by convection approximately as indicated by the arrows **48** and as hereinbefore described. The air in the chamber **12**, in passing upwardly through the dishes therein, evaporates water therefrom and carries such water upwardly to the top of the chamber. At the same time, the fan **52**, which is in operation throughout the entire drying cycle, propels atmospheric air through the space **20** surrounding the chamber **12**, the atmospheric air, under all normal conditions, being at a temperature very considerably lower than the temperature of the air within the chamber **12**. As a consequence, the atmospheric air propelled through the space **20** maintains the chamber walls at a temperature lower than the air temperature within the chamber so that, as the air within the chamber flows outwardly and downwardly along the chamber walls, the moisture previously evaporated from the dishes within the chamber is condensed on the chamber walls, such condensed moisture draining downwardly to the sump **34** and being disposed of by the draining means **42**, which also is in operation continuously during the entire drying cycle. The moisture condensed out of the air moving over the chamber walls in this manner reduces the humidity thereof so that, when the air is reheated by the heating means **44** and again passed upwardly through the dishes, it is capable of absorbing more moisture therefrom, additional moisture again being condensed from the air as it again moves over the chamber walls cooled by circulation of atmospheric air through the space **20**.

It has been found that the dishes may be dried effectively and in a relatively short period of time by energizing the heating means **44** during only a part of the complete drying cycle, i.e., during the hereinbefore referred to initial portion of the drying cycle. During the final portion of the drying cycle, the heating means **44** may be de-energized, by designing the cam **92** to open the switch **82** at the proper point, whereupon the heat stored in the dishes during the initial portion of the drying cycle maintains the desired air circulation within the chamber **12** by convection, the heat stored in the dishes being transferred to the air to cause the air to continue to circulate in the chamber **12** and evaporate moisture from the dishes in the manner hereinafter discussed. Consequently, it is necessary to energize the heating means **44** during only part of the complete drying cycle, which is an important feature.

It has been found that complete drying of the dishes will take place with the foregoing procedure in a period of time of only about 15 to 20 minutes if atmospheric air is propelled through the space **20** at a rate and under temperature conditions such that the temperature of the chamber walls is maintained at a value of approximately 20° F. below the air temperature in the chamber. In other words, even with a relatively small temperature differential between the chamber walls and the air in the chamber **12**, drying of the dishes in a satisfactorily short period of time is attained. Of course, if a larger temperature differential is maintained, the drying time may be reduced.

The present invention thus attains the principal objects hereinbefore discussed of maintaining the degree of sterility and cleanliness obtained during the washing and rinsing operations, and of avoiding the discharge of moisture into the room or other area in which the dishwasher is located, both of these objects being attained by avoiding drying of the dishes by circulating ambient air from the room thereover. Another important result attained by the drying method of the present invention is that much more effective drying of the dishes is attained as compared to drying by circulating ambient air from the room over the dishes. For example, heating the air in the dish chamber **12** from a temperature of 157° F.

to a temperature of 177° F. provides a drying capacity, i.e., an ability to hold moisture in the vapor phase, of 3½ times the drying capacity of air heated from 80° F. to 125° F. in accordance with prior practice. In other words, the present invention provides a much greater drying capacity with a much smaller drying-air temperature increase, which is an important feature.

As hereinbefore indicated, a feature of the dishwasher of the invention is that the amount of water which must be evaporated from the walls of the dish chamber 12 and from elements therein is minimized by minimizing water droplet hang up. In connection with the dish racks 37, this is accomplished by making all, or substantially all, of the elements forming the racks nonhorizontal. Referring to Fig. 1 of the drawings, it will be seen that the dish racks 37 are made up of vertical and generally horizontal wires, all of the generally horizontal wires being of zig zag shape so as to provide sloping portions 110 down which the water may drain to apices 111. Most of the water droplets fall from the apices 111 and thus do not need to be evaporated from the dish racks 37, which is an important feature. Horizontal surfaces on which water droplets can hang up are eliminated insofar as possible throughout the remaining elements in the dish chamber 12 and throughout the walls of the dish chamber 12 itself. For example, referring to Fig. 1 of the drawings, the upper wall of the dish chamber 12 is more or less dome shaped and includes sloping surfaces 114 extending from the center of the upper wall to the sides of the dish chamber. Referring to Fig. 4 of the drawings, illustrated therein is an alternative upper wall for the dish chamber 12 which attains substantially the same results but which reduces the height of the dish chamber. In Fig. 4 of the drawings, the upper wall of the dish chamber is provided with a plurality of sloping surfaces 116 down which water droplets may drain to the lowest points thereon, thereby minimizing water droplet hang up. Thus, throughout the dish chamber 12, water droplet hang up is minimized to minimize the amount of water which must be evaporated during the drying operation, which is an important feature.

As hereinbefore indicated, while embodiments of the invention wherein the walls of the dish chamber 12 are cooled during the drying operation by the ambient air have been disclosed, the walls of the dish chamber may also be cooled with a liquid, such as water from the normal household or other cold water supply. The dish chamber walls may be cooled by applying cold water externally thereto, or internally thereto, as illustrated in Fig. 5 of the drawings. Referring thereto, illustrated is a dish chamber 120 having at the top thereof a water distributing manifold 121 provided with orifices 122 which are directed toward the side walls of the dish chamber in such a manner as to spread thin sheets of water on the inner surfaces of the side walls of the dish chamber. The water sheets thus maintain the walls of the dish chamber at a considerably lower temperature than the drying air within the dish chamber, and condensation of moisture from the drying air in the dish chamber takes place either on the walls of the dish chamber 120, or directly on the water sheets on the inner surfaces of the walls. The cooling water used in this manner is drained off by the draining means 42, along with the condensate.

Although I have disclosed exemplary embodiments of the invention, it will be understood that various changes, modifications and substitutions may be incorporated in such embodiments without departing from the spirit of the invention as defined by the patent claims hereinafter appearing.

I claim as my invention:

1. In a dishwasher, the combination of: a closed chamber adapted to receive therein dishes to be washed, rinsed and dried and including upright walls having inner and outer surfaces; means for washing dishes in said chamber; means for rinsing dishes in said chamber; and means for drying dishes in said chamber without discharging water vapor into the surrounding atmosphere, said drying means including air recirculating means for recirculating air confined in said chamber first upwardly over dishes therein and then downwardly over said inner surfaces of said upright walls of said chamber, and said drying means including an enclosure spaced outwardly from said chamber and providing between said chamber and said enclosure an air passage bounded by said upright walls of said chamber, said enclosure having an air inlet connecting said air passage to the atmosphere adjacent the bottom of said air passage and having an air outlet connecting said air passage to the atmosphere adjacent the top of said air passage so that said air passage conducts atmospheric air from said inlet upwardly over said outer surfaces of said upright walls of said chamber to said outlet to maintain the temperature of said upright walls of said chamber below the temperature of the air being recirculated in said chamber, whereby moisture evaporated from dishes in said chamber by the air being recirculated therein is conveyed to said inner surfaces of said upright walls of said chamber by the air being recirculated in said chamber to be condensed directly on said inner surfaces of said upright walls.

2. In a dishwasher having a front, the combination of: a closed chamber adapted to receive therein dishes to be washed, rinsed and dried and including upright walls having inner and outer surfaces; means for washing dishes in said chamber; means for rinsing dishes in said chamber; and means for drying dishes in said chamber without discharging water vapor into the surrounding atmosphere, said drying means including air recirculating means for recirculating air confined in said chamber first upwardly over dishes therein and then downwardly over said inner surfaces of said upright walls of said chamber, and said drying means including an enclosure spaced outwardly from said chamber and providing between said chamber and said enclosure an air passage bounded by said upright walls of said chamber, said enclosure having at the front of said dishwasher an air inlet connecting said air passage to the atmosphere adjacent the bottom of said air passage and having at the front of said dishwasher an air outlet connecting said air passage to the atmosphere adjacent the top of said air passage so that said air passage conducts atmospheric air from said inlet upwardly over said outer surfaces of said upright walls of said chamber to said outlet to maintain the temperature of said upright walls of said chamber below the temperature of the air being recirculated in said chamber, whereby moisture evaporated from dishes in said chamber by the air being recirculated therein is conveyed to said inner surfaces of said upright walls of said chamber by the air being recirculated in said chamber to be condensed directly on said inner surfaces of said upright walls.

3. A dishwasher according to claim 2 wherein one of said upright walls of said chamber is a front wall at the front of said dishwasher and wherein said dishwasher includes a door movable relative to said chamber and said enclosure from a closed position to an open position to provide access to the interior of said chamber, said door having an inner wall which forms said front wall of said chamber and having an outer wall which forms a front wall of said enclosure and which is connected to and spaced from said inner wall of said door, the space between said inner and outer walls of said door forming part of said air passage when said door is in said closed position and conducting atmospheric air from said inlet upwardly to said outlet when said door is in said closed position.

4. In a dishwasher having a front, the combination of: a chamber adapted to receive therein dishes to be washed, rinsed and dried and having at the front thereof a door-

way for access to the interior of said chamber; a door movable relative to said chamber between a closed position wherein it closes said doorway and an open position, said door having an inner wall which forms a front wall of said chamber when said door is in said closed position, said door having an outer wall spaced from and connected to said inner wall thereof, the space between said inner and outer walls of said door having upper and lower ends communicating with the atmosphere when said door is in said closed position so as to conduct atmospheric air over the outer surface of said inner wall of said door to cool said inner wall of said door; means for washing dishes in said chamber; means for rinsing dishes in said chamber; and air recirculating means for recirculating air confined in said chamber first over dishes therein and then over the inner surface of said inner wall of said door when said door is in said closed position, whereby moisture evaporated from dishes in said chamber by the air being recirculated therein is conveyed to said inner surface of said inner wall of said door by the air being recirculated in said chamber to be condensed directly on said inner surface of said inner wall of said door when said inner wall of said door is maintained at a temperature below that of the air being recirculated in said chamber by atmospheric air conducted through the space between said inner and outer walls of said door.

5. A dishwasher according to claim 2 including fan means within said enclosure for circulating atmospheric air through said air passage from said inlet upwardly over said outer surfaces of said upright walls of said chamber to said outlet.

6. In a dishwasher, the combination of: a closed chamber adapted to receive therein dishes to be washed, rinsed and dried and including upright walls having inner and outer surfaces; means for washing dishes in said chamber; means for rinsing dishes in said chamber; and means for drying dishes in said chamber without discharging water vapor into the surrounding atmosphere, said drying means including air recirculating means for recirculating air confined in said chamber first upwardly over dishes therein and then downwardly over said inner surfaces of said upright walls of said chamber, said air recirculating means including air heating means centrally located within said chamber adjacent the bottom thereof for recirculating air confined in said chamber first upwardly over dishes therein and then downwardly over said inner surfaces of said upright walls of said chamber by convection, and said drying means including an enclosure spaced outwardly from said chamber and providing between said chamber and said enclosure an air passage bounded by said upright walls of said chamber, said enclosure having an atmospheric air inlet connecting said air passage to the atmosphere adjacent the bottom of said air passage and having an air outlet connecting said air passage to the atmosphere adjacent the top of said air passage so that said air passage conducts atmospheric air from said inlet upwardly over said outer surfaces of said upright walls of said chamber to said outlet to maintain the temperature of said upright walls of said chamber below the temperature of the air being recirculated in said chamber, whereby moisture evaporated from dishes in said chamber by the air being recirculated therein is conveyed to said inner surfaces of said upright walls of said chamber by the air being recirculated in said chamber to be condensed directly on said inner surfaces of said upright walls.

7. A dishwasher according to claim 6 including control means for said air heating means including thermostat means at the bottom of said chamber for maintaining the air temperature adjacent the top of said chamber at a higher preselected temperature than the air temperature adjacent the bottom thereof when said air recirculating means is in operation during drying of dishes in said chamber.

8. A dishwasher as set forth in claim 6 including timer means for energizing said air heating means to dry dishes in said chamber and for de-energizing said air heating means after a predetermined time interval less than that required to completely dry dishes in said chamber, whereby said air recirculation in said chamber is thereafter maintained by the transfer of heat from dishes in said chamber to the air therein.

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