Oct. 3, 1961 L. GELFAND ET AL 3,002,731

APPARATUS FOR ULTRASONIC CLEANING

Filed Nov. 15, 1956 3 Sheets-Sheet 1

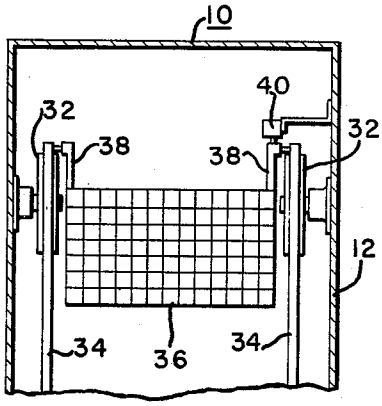


Fig. 2

Fig. 1

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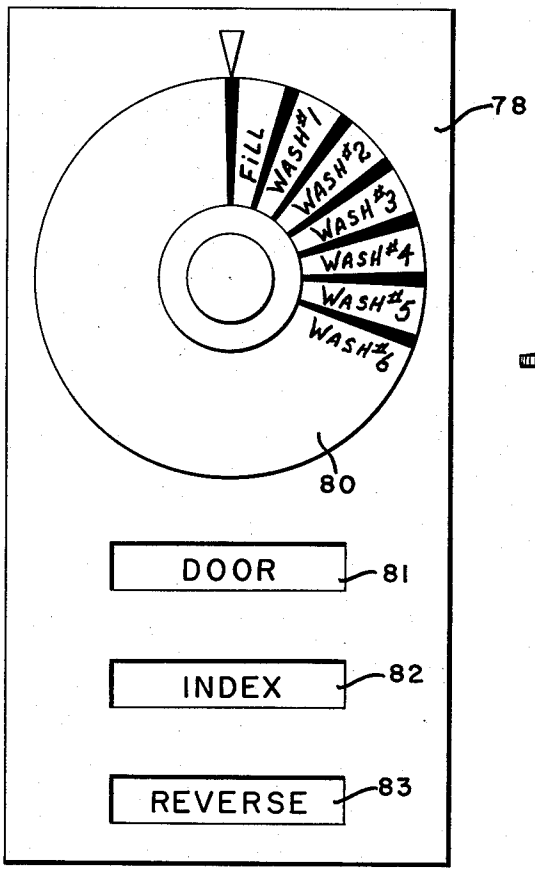


Fig. 3

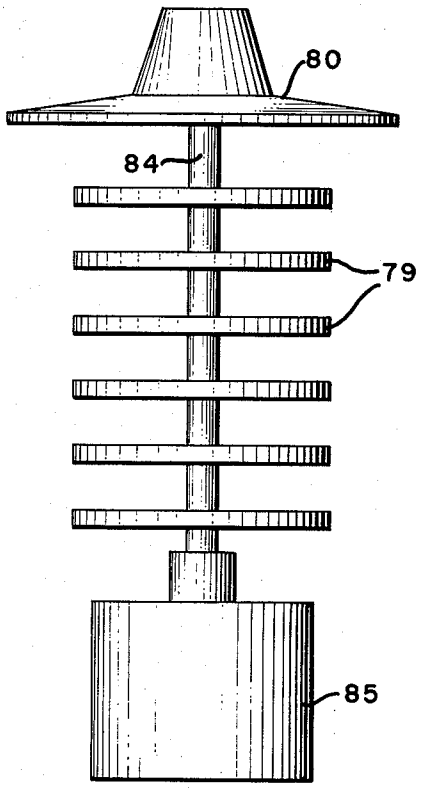


Fig. 4

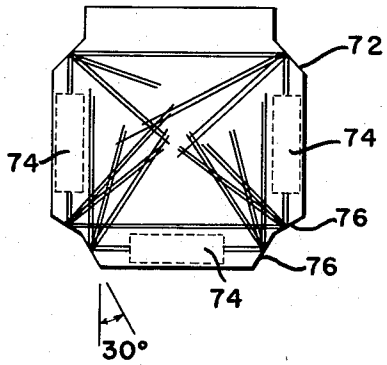


Fig. 5

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APPARATUS FOR ULTRASONIC CLEANING

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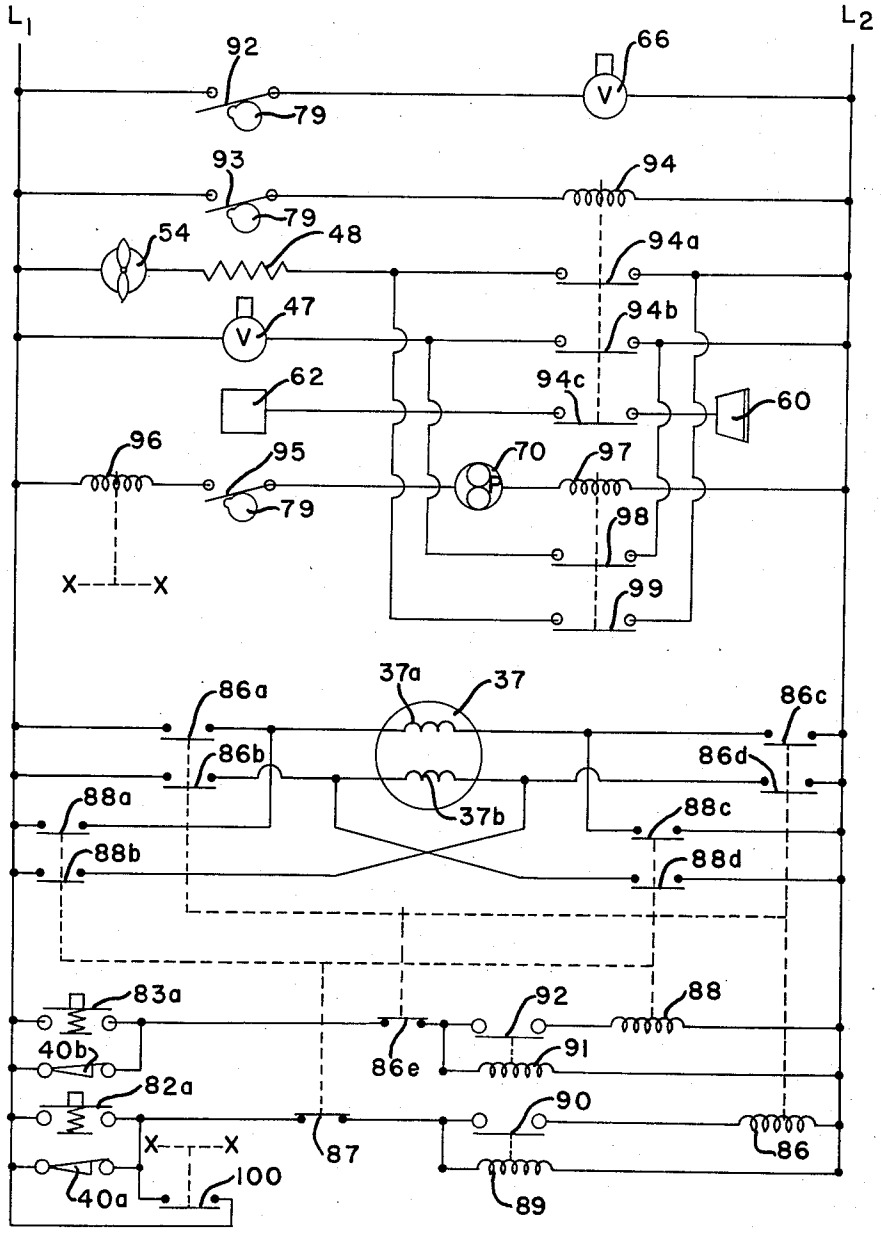


Fig. 6

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APPARATUS FOR ULTRASONIC CLEANING

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3 Claims. (Cl. 259—1)

This invention relates to a domestic appliance and more particularly to a dishwasher of the ultrasonic type wherein high frequency energy is employed to wash the dishes.

An object of the invention is to provide a dish washing machine wherein the dishes to be cleaned are disposed within a washing solution, and wherein high frequency energy is applied to the washing solution.

Still another object is to provide a washing machine including a washing section, a rinsing section, and a drying section, and having means for conveying the articles to be washed progressively through the aforesaid sections.

Another object is to provide an ultrasonic dishwasher having a plurality of article carrying baskets supported by conveyor means, the movement of the conveyor means being controlled by indexing means associated with dishwasher.

A further object is to provide an ultrasonic dishwasher including a plurality of dish carrying baskets, the dishwasher including means for simultaneously washing, rinsing, and drying different baskets of the plurality of baskets employed.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of the present invention is clearly shown.

In the drawings:

FIGURE 1 is a side view with parts broken away of the dishwasher of this invention;

FIGURE 2 is a side view with parts broken away of the upper portion of the dishwasher shown in FIGURE 1 showing the supporting means for the dish carrying baskets;

FIGURE 3 is a front view of a control panel used with the dishwasher of this invention;

FIGURE 4 is a side view of a timer used with the dishwasher of this invention;

FIGURE 5 is a side view of a modified tub arrangement made in accordance with this invention; and

FIGURE 6 is a circuit diagram of the control circuit for the dishwasher of this invention.

The dishwasher generally denoted by reference numeral **10** is shown somewhat diagrammatically in FIGURE 1 and includes a main upper housing **12**, a lower housing **14**, and a housing **16** that forms a machinery compartment for the dishwasher. The top wall **18** of the housing **16** also forms a loading support for the dishwasher **10**. The upper housing **12** is provided with an access opening **20** that is closable by a vertically slidable door **22**. The door in FIGURE 1 is shown in its closed position and is attached to a door slide **24** which is in turn attached to a belt or chain **26**. The belt or chain **26** is supported by a pair of pulleys **28** and is driven through a belt or chain **30** by a reversible electric motor **31**. When the motor **31** is actuated in a clockwise direction the door **22** is moved upwardly in order to open the access opening **20**. On the other hand counter clockwise rotation of motor **31** moves the door downwardly to its closed position. The motor **31** is always deenergized by limit switches **33** and **35** whenever the door reaches its fully open or closed position in accordance with conventional practice.

The upper housing **12** is provided with chain or belt supporting pulleys **32** that support belts **34**. In the drawings the members **34** have been shown as belts, although

it is apparent that they could be formed by chains. In the sectional view of FIGURE 1 only two pulleys **32** are shown but the dishwasher is provided with two other pulleys spaced laterally from the pulleys **32** and with a second chain or belt **34** spaced laterally from the belt **34** as shown in FIGURE 2. A plurality of dish carrying baskets **36** are supported by the belts **34** by means of cradles **38** that are interposed between the belts **34**. One of the lower pulleys **32** is connected with an electric drive motor **37** which operates to move the belt or chain **34** in either a clockwise or counter clockwise direction. A switch device **40** is disposed near the top of the upper housing **10** and is engaged by the cradles **38** when a basket reaches the uppermost position in upper housing **12**.

The upper housing **12** is provided with a partition **39** and the space on one side of this partition is divided into a rinsing section **42** and a drying section **44**. The rinsing section has a pipe **46** provided with a plurality of spray apertures, the pipe being connected to a suitable water supply through a solenoid operated valve **47**. When a basket **36** is located adjacent the pipe **46** the dishes therein will be rinsed when water is supplied to the pipe **46**, the rinse water flowing into the tub **58** from rinsing chamber **42**. The drying section **44** is provided with a plurality of heating devices **48** that preferably take the form of electrical lamps. The rinsing section **42** and drying section **44** are separated by rubber flaps **50**. An air inlet **52** connects the atmosphere with the drying section **44**, the air being drawn through the inlet by an electric motor driven blower **54** that exhausts through an opening **56** formed in upper housing **12**.

The lower housing **14** is provided with a liquid containing tub **58** that carries a plurality of transducers **60**. The transducers **60** transform high frequency electric energy into mechanical energy for agitating the washing solution located within tub **58**. These transducers may be of the magnetostrictive type or may be of the piezoelectric type. Both of these types are well known to those skilled in the art. The transducers **60** are connected with a source of high frequency energy **62** that preferably has an output in the neighborhood of 40 kilocycles. In FIGURE 1 the conducting faces of the transducers **60** face inwardly toward the center of the tub **58**. The tub **58** is provided with suitable water inlet means **64** that includes solenoid operated valve **66**. The tub is also provided with a drain pipe **68** connected with an electric motor driven outlet pump **70**. With this arrangement dishes located within a basket **36** are cleaned when the basket is located within the tub **58**.

A modified ultrasonic transducer arrangement for a tub is shown in FIGURE 5. In this case the tub **72** is provided with a top opening and side and bottom walls or wall portions, each of said walls or wall portions having equal linear dimensions and supporting in parallel relationship thereto a transducer **74** of the type wherein the high frequency energy radiates from the opposite ends of the transducers. The side and bottom walls of the tub **72** each have a pair of equally sized wall portions **76** that face the opposite ends respectively of each transducer **74** and are preferably located at an angle of 30° to the end faces of the transducers. And note in FIGURE 5 that each side wall forms with its particular pair of extended wall portions **76** a recess which opens towards the center of the tub **72** and retains the transducer in an out-of-the-way location. The same may be said for the bottom wall which forms a bottom recess with its terminal wall portions **76** to receive the bottom transducer. With this arrangement energy radiating from the ends of transducers **74** is reflected by the obtuse wall portions **76** facing the respective ends of each transducer back toward the center of tub **72** as clearly shown

in FIGURE 5. Thus the generated wave energy is concentrated generally throughout the center of said tub. The tub structure of FIGURE 5 may be substituted for the tub structure 58 shown in FIGURE 1.

The control mechanism for the ultrasonic transducer shown in FIGURE 3 includes a control panel 78 having a manually actuable knob 80 and pushbuttons 81, 82 and 83 marked respectively, "door," "index," and "reverse." The control knob 80 as shown in FIGURE 4 is connected with a timer motor 85 and is driven by the timer motor by a shaft 84 that carries a plurality of switch actuating cams 79. The control panel 78 may be disposed at any convenient part of the dishwasher and its function will be more fully described hereinafter.

As noted hereinbefore, the motor 37 drives the pulley 32 to move the dish carrying baskets 36 progressively through the tub 58, through the rinse section 42, and through the drying section 44. The motor 37 is controlled by an indexing circuit shown in FIGURE 6. This circuit includes the switch device generally denoted by the reference numeral 40 that is located near the top of upper housing 12, and which is actuated by either clockwise or counterclockwise movement of cradles 38 carried by chain or belt 34. The switch device 40 includes normally closed switches 40*a* and 40*b*, the switch 40*a* being actuated by forward or counterclockwise rotation of chain 34, and the switch 40*b* being actuated by reverse or clockwise rotation of chain 34. Both switches 40*a* and 40*b* are normally closed except when they are engaged by a cradle 38 of a dish carrying basket. When the switch device 40 is engaged by the cradle of a dish carrying basket both switches 40*a* and 40*b* are held in an open position.

In operation, temporary closure of switch 82*a* by manual movement of the button 82 marked "index" in FIGURE 3 completes a circuit for a relay solenoid 86 across main power lines L1 and L2. The circuit may be traced from line L1, through switch 82*a*, through normally closed contact 87 under the control of solenoid coil 88, and through relay solenoid 89. Energization of relay 89 closes contacts 90 to complete a circuit for relay 86. The energization of relay 86 closes normally open contacts 86*a*, 86*b*, 86*c* and 86*d* and opens normally closed contact 86*e*. This switching operation energizes the main winding 37*a* and the phase winding 37*b* of motor 37, which in turn moves the belts 34 in a forward direction. The motor 37 remains energized until the belts move a distance between two dish carrying baskets, whereupon switch 40*a* is actuated by a cradle 38 to open the circuit to relay 86 and thereby move switches 86*a*, 86*b*, 86*c* and 86*d* to an open position to deenergize motor 37. The deenergization of relay 86 permits the contacts 86*e* to once more be closed.

It should be noted that only a momentary closure of switch 82*a* is required in order to set the motor 37 into operation. When the switch 82*a* is released, a circuit is completed therearound by closure of normally closed switch 40*a* which closes when the dish carrying basket moves away from the switch 40*a*. The concurrent closure of switches 40*b* and 40*a* a when a basket moves away therefrom will not energize relay 88, as normally closed contact 86*e* in series with switch 40*b* is held in an open position by solenoid 86 when the solenoid is energized. When the baskets have moved the distance between two baskets, the switches 40*a* and 40*b* are held open and the belts 34 are now at rest.

The movement of the belts may be reversed by pressing button 83 marked "reverse" in FIGURE 3, thereby closing switch 83*a*. The closure of switch 83*a* completes a circuit for a relay 88. This circuit is traced from line L1 through normally closed contact 86*e*, and through relay 91. Energization of relay 91 closes contacts 92 to complete a circuit for relay 88. The energization of relay 88 closes normally open contacts 88*a*, 88*b*, 88*c* and 88*d*, and opens a normally closed contact 87. Closure of contacts 88*a*, 88*b*, 88*c* and 88*d*, reverses the connection of the phase winding 37*b* of the motor 37 with lines L1 and L2 from the connection brought about by the energization of solenoid relay 86. The motor 37 is thus energized to reverse rotation of belts 34 and the motor 37 is cut off when a basket moves the distance between two baskets to open switch 40*b*. It will thus be apparent that the belts 34 may be indexed the distance between two baskets in either a forward or reverse direction by a manual closure of either the "index" or "reverse" buttons shown in FIGURE 3.

The over all operation of the dishwasher will now be described. The operator desiring to use the dishwasher may actuate the door pushbutton 81 shown in FIGURE 2 to move the door 22 into an open position. The dishes to be washed are then loaded into the basket that is at that time located adjacent the door access opening 20 and the door may be closed by actuation of pushbutton 81. When a basket has been loaded the operator moves the control knob 80 to the "fill" position shown in FIGURE 3. Movement of the control knob 80 to the "fill" position operates a cam operated switch 92 shown in FIGURE 6 to complete a circuit to solenoid operated valve 66. The switch 92 is closed for a predetermined amount of time and is opened at this point of time by rotation of timer motor 85. The period of time is so calculated that the valve 66 is open for a period of time sufficient to fill the tub 58. The tub also may be provided with a washing detergent in order to enhance the washing action.

When the fill cycle of the dishwasher is completed, the index button 82 is manually actuated to shift a loaded basket down into the tub 58. The control knob 80 is then shifted to the "Wash No. 1" position. Shifting of the control knob to the "Wash No. 1" position closes a cam actuated timer controlled switch 93. The closure of switch 93 completes a circuit to a relay solenoid 94. Energization of relay solenoid 94 closes contacts 94*a*, 94*b*, and 94*c*. The contacts 94*a* are connected in series with the electric motor driven blower 54 and with the electric lamps 48. The contacts 94*b* are connected in series with solenoid operated valve 47 that controls flow of rinsing fluid to the rinsing pipe 46, while the contacts 94*c* are connected in series with the high frequency oscillator 62 and the transducers 60. It will thus be apparent that the energization of relay 94 sets the blower 54 into motion and also energizes the electric heating lamps 48. The energization of relay 94 also completes a fluid circuit to the supply pipe 46 and completes a circuit between the high frequency oscillator and the transducers in order that the transducers will be energized. At this point the heating chamber 44 is being supplied with heat from lamps 48, the rinsing chamber is being supplied with rinsing fluid from pipe 46 and the water in tub 58 is being agitated by transducers 60. Thus the dishes in the basket that previously was lowered in the tub 58 are being cleaned. Moreover, if dishes were in the baskets adjacent the rinsing and drying sections they would be rinsed and dried at this time. The simultaneous cleaning, rinsing, and drying action continues as long as switch 93 is closed and will terminate after the timer motor has rotated a predetermined distance.

While the cleaning, rinsing, and drying action of the various baskets has been taking place the basket now adjacent the loading opening 20 may be loaded with dishes. The index button 82 is then actuated to shift the basket the distance between two baskets. The basket just loaded then moves down into the tub 58 and the basket previously in tub 58 moves into the rinsing section 42. The control knob 80 is then shifted to the "Wash No. 2" position which again closes switch 93 to again initiate washing, rinsing and drying of the baskets as described in conjunction with the "Wash No. 1" cycle.

The sequence just described above is repeated for the wash No. 3, wash No. 4, wash No. 5, and wash No. 6

cycles. The cams 79 on shaft 84 are so arranged that after the completion of the wash No. 6 cycle a cam operated switch 95 is closed. The closure of switch 95 energizes relays 96 and 97 and also energizes electric motor driven pump 70. The motor driven pump 70 will then operate to empty the tub 58. Energization of relay 96 closes a switch 100 to set the motor 37 into operation in order to shift the baskets the distance between two baskets. The energization of relay 97 closed contacts 98 and 99 to set the blower 54 and heating elements 48 into operation and also to open solenoid valve 47. With this arrangement the last basket is thus automatically shifted into the rinsing section where the basket is rinsed. The timer actuated switch 95 is so arranged that it opens after a predetermined time after the basket within the rinsing section has been rinsed. The switch 95 is then closed once more to again shift the last basket into the drying section and to set the blower 54 and heating lamps 48 into operation and to actuate the solenoid valve 47. The last basket is now in the drying section and the switch 95 is held closed until the drying action is completed. After the last basket has been dried the timer motor is shut off and the dishwasher is at a standstill. The last basket may then be moved to the position adjacent the loading door by actuation of the index pushbutton 82.

While the form of embodiment of the invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, as may come within the scope of the claims which follow.

What is claimed is as follows:

1. In an ultrasonic cleaning machine including a tub having integral first, second, third, fourth, fifth, sixth, seventh, eighth and ninth wall portions and a top opening, said second and third wall portions extending from said first wall portion at predetermined obtuse angles thereto and forming therewith a first recess, said fifth and sixth wall portions connected to said third and eighth wall portions, respectively, and extending from said fourth wall portion at predetermined obtuse angles thereto to form with said fourth wall portion a second recess, said eighth and ninth wall portions extending from said seventh wall portion at predetermined obtuse angles thereto and forming therewith a third recess, all of said recesses opening into said tub, a first ultrasonic transducer located within said first recess parallel to said first wall portion, said first transducer having a pair of wave generating faces located normal to said first wall portion and facing respectively said second and third wall portions, a second ultrasonic transducer located within said second recess parallel to said fourth wall portion, said second transducer having a pair of wave generating faces located normal to said fourth wall portion and facing respectively said fifth and sixth wall portions, a third ultrasonic transducer located within said third recess parallel to said seventh wall portion, said third transducer having a pair of wave generating faces located normal to said seventh wall portion and facing respectively said eighth and ninth wall portions, said angles being of such a value that ultrasonic energy impinging on said second, third, fifth, sixth, eighth and ninth wall portions is reflected out of said first, second and third recesses toward the center of said tub, whereby the generated wave energy is concentrated generally throughout the center of said tub.

2. In an ultrasonic cleaning machine including a tub having integral first, second, third, fourth, fifth, sixth, seventh, eighth and ninth wall portions and a top opening, said first, fourth and seventh wall portions being substantially the same length and said first wall portion being parallel to said seventh wall portion, said second, third, fifth, sixth, eighth and ninth wall portions being substantially the same length, said second and third wall portions extending from said first wall portion at predetermined obtuse angles of 120° thereto and forming therewith a first recess, said fifth and sixth wall portions connected to said third and eighth wall portions, respectively, and extending from said fourth wall portion at predetermined obtuse angles of 120° thereto to form with said fourth wall portion a second recess, said eighth and ninth wall portions extending from said seventh wall portion at predetermined obtuse angles of 120° thereto and forming therewith a third recess, all of said recesses opening into said tub, a first ultrasonic transducer located within said first recess parallel to said first wall portion, said first transducer having a pair of wave generating faces located normal to said first wall portion and facing respectively said second and third wall portions, a second ultrasonic transducer located within said second recess parallel to said fourth wall portion, said second transducer having a pair of wave generating faces located normal to said fourth wall portion and facing respectively said fifth and sixth wall portions, a third ultrasonic transducer located within said third recess parallel to said seventh wall portion, said third transducer having a pair of wave generating faces located normal to said seventh wall portion and facing respectively said eighth and ninth wall portions, whereby ultrasonic energy impinging on said second, third, fifth, sixth, eighth and ninth wall portions is reflected out of said first, second and third recesses toward the center of said tub and concentrated generally throughout the center of said tub.

3. In an ultrasonic dishwasher including a tub having integral first, second, third, fourth, fifth and sixth wall portions and a top opening, said second and third wall portions extending from said first wall portion at predetermined obtuse angles thereto and forming therewith a first recess, said fifth and sixth wall portions, extending from said fourth wall portion at predetermined obtuse angles thereto and forming with said fourth wall portion a second recess, said recesses opening into said tub, a first ultrasonic transducer located within said first recess parallel to said first wall portion, said first transducer having a pair of wave generating faces located normal to said wall portion and facing respectively said second and third wall portions, a second ultrasonic transducer located within said second recess parallel to said fourth wall portion, said second transducer having a pair of wave generating faces located normal to said fourth wall portion and facing respectively said fifth and sixth wall portions, said angles being of such a value that ultrasonic energy impinging on said second, third, fifth and sixth wall portions is reflected out of said first and second recesses toward the center of said tub, whereby the generated wave energy is concentrated generally throughout the center of said tub.

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