Dec. 19, 1967 G. HESKESTAD 3,358,478

MULTI-JET AGITATION OF WASH SOLUTION
IN A WASHING MACHINE
Filed Feb. 25, 1966

FIG. 1

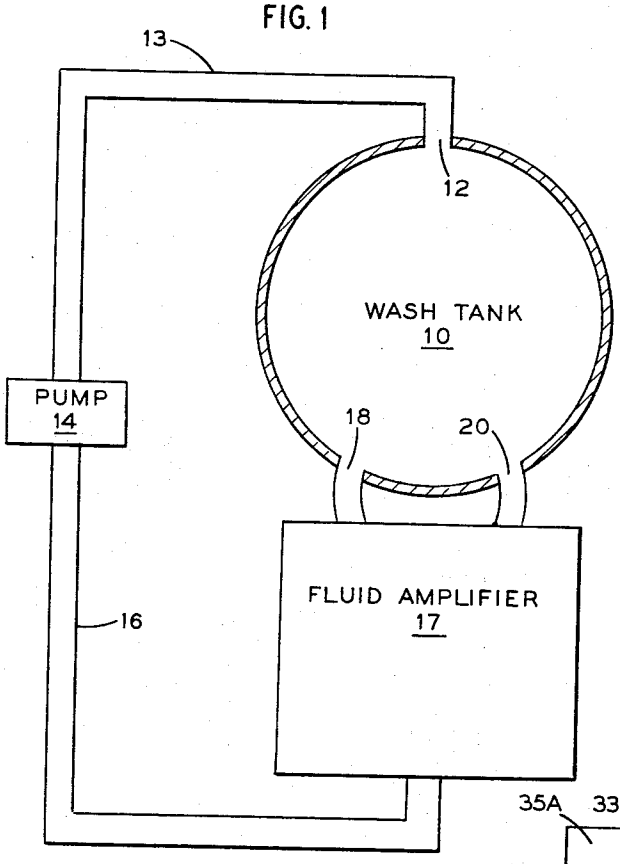


FIG. 4

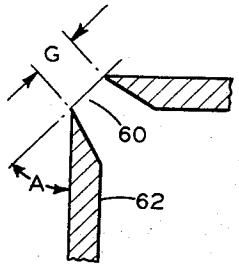


FIG. 5

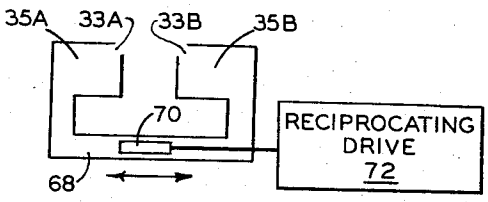


FIG. 2

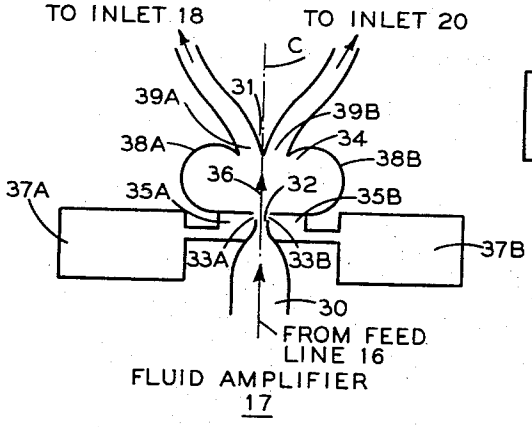
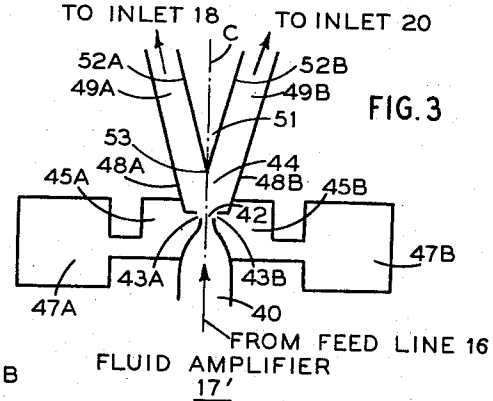


FIG. 3



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United States Patent Office 3,358,478 Patented Dec. 19, 1967

3,358,478

MULTI-JET AGITATION OF WASH SOLUTION IN A WASHING MACHINE

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Filed Feb. 25, 1966, Ser. No. 530,181
7 Claims. (Cl. 68—184)

ABSTRACT OF THE DISCLOSURE

This invention provides a washing machine that omits the conventional mechanically-driven, rotationally-oscillating vane configuration. Instead of the oscillating vane construction, the invention contemplates a wash solution mechanism which feeds two jets of the wash solution into the wash tank via two inlets circumferentially displaced in the wash tank. The two jets are fed by a fluid amplifier which controllably feeds the jots of the wash solution into the two inlets. The directions of the two jets are controllably varied by suction applied at the region of entry of the respective jets.

This invention pertains to improvements in washing machines and more particularly to improvements in the jet agitation of the wash solution in the wash tank of a washing machine.

The wash solution agitators in common home washing machines usually comprise a rotationally oscillating vane configuration. The washing of clothes in the wash tank is caused by agitator produced turbulent convection of the water solution past and through the material being washed.

Although this type of wash solution motion adequately cleans the material in the wash tank, the rotationally oscillating vane configuration is a combination of movable parts which are mechanically driven. Accordingly, because of the constant movement of these parts during the wash cycle, the parts are subject to wear.

It is, accordingly, a general object of the invention to provide improvements for creating the agitator action in washing machines.

It is another object of the invention to provide for the agitation of the wash solution in a washing machine by utilizing apparatus which is more simple and more immune to wear than presently available rotational type agitators.

It is a further object of the invention to provide an improved apparatus for producing turbulent convection of the wash solution in the wash tank of a washing machine.

Briefly, the invention contemplates controllably feeding at least two jets of wash solution into the wash tank of a washing machine to produce a turbulent convection of the wash solution.

Other objects and the features and advantages of the invention will be apparent from the following detailed description when read together with the accompanying drawings which show, by way of example and not limitation, preferred apparatus for practicing the invention.

In the drawings:

FIG. 1 is a schematic diagram of the wash solution system of a washing machine which includes a fluid amplifier for controllably injecting two jets of wash solution into a wash tank;

FIG. 2 is a cross-sectional view of a proportional type fluid amplifier;

FIG. 3 is a cross-sectional view of a bistable type fluid amplifier;

FIG. 4 is an enlarged sectional view of the peripheral edge of the orifices of the fluid amplifiers of FIGS. 2 and 3; and

FIG. 5 is a schematic diagram of a suction system for use with the fluid amplifiers of FIGS. 2 and 3.

Referring now to FIG. 1, those parts of a washing machine concerned with the invention are shown. In particular there is a cylindrical wash tank **10** having a wash solution outlet **12** which is connected by a return line **13** to the input of a pump **14**. The output of pump **14** is connected via a feed line **16** to a fluid amplifier **17** which controllably feeds jets of wash solution to the inlets **18** and **20** of wash tank **10**. Amplifier **17** can alternately feed jets of wash solution to wash tank **10** or can control the delivery rate of wash solution. By controlling the alternation and/or rates of flow of the jets the desired turbulent convection of the wash solution is obtained. The solution is, of course, recirculated via a path which includes outlet **12** and return line **13** to the input of pump **14**.

Of course, a complete washing machine solution circulation system would include valving means to control the initial introduction of water into the system and the final removal of wash solution from the system. Since the invention is not concerned with these aspects of the washing machine, they are not shown.

The fluid amplifier **17** utilizes the phenomenon of applying suction to the peripheral edge of an orifice to laterally divert a stream of fluid entering the amplifier to mutually displaced outputs of the amplifier.

Accordingly, FIG. 2 shows a proportional type amplifier. The amplifier **17** includes an inlet power conduit **30** having an inlet adapted to receive fluid under pressure from feed line **16** and an outlet orifice **32**. The center of the outlet orifice **32** is on the central axis C and the plane of the outlet orifice **32** is perpendicular to the central axis C. Power conduit **30** is a nozzle which provides a free stream of fluid for expulsion from the outlet orifice **32**. The inlet of a chamber **34** is connected to the outlet orifice **32**. Chamber **34** is provided with side walls **38** that are radially displaced from the axis C so that the turbulent mixing layers of fluid do not contact the side walls. A suitable shape for the chamber is generally cardiodal. The end of chamber **34** downstream from the output orifice **32** has two outlet regions **39A** and **39B**. Outlet regions **39A** and **39B** are laterally displaced from the central axis C and are positioned diametrically opposite each other with respect to traverse directions from the central axis C. A fluid divider **31** separates the outlet region **39A** from the outlet region **39B**. In such a case, the stream of pressurized fluid expelled from outlet orifice **32** divides, substantially equally, to exit via the outlet regions **39A** and **39B**. Proportional control and amplification is indicated by the difference in the fluid flow exiting from the outlet regions **39A** and **39B**. In order to obtain this proportional control, it is necessary to preferentially divert the fluid to one of the outlet regions. Diversion or deflection of the fluid flow is obtained, in accordance with the invention, by providing the outlet orifice **32** with slits in its peripheral edge and by the differential application of pressure to these slits. Therefore, slits **33A** and **33B** are disposed in the peripheral edge of outlet orifice **32**. The slits are diametrically opposite each other and traversely aligned with the outlet regions **39**. In particular, the slit **33A** has the same traverse angle with respect to the central axis C as the outlet region **39A**, and the slit **33B** has the same traverse angle with respect to the central axis C as the outlet region **39B**. The suction chambers **35** are respectively connected to sources of suction **37**.

When no suction is applied to either of the slits **33** or when equal suction is applied thereto the stream of fluid expelled from outlet orifice **32** divides equally to

exit via the outlet regions 39. However, when there exists a differential suction between the suction chamber 35, fluid is preferentially diverted to one of the outlet regions 39. For example, if the suction chamber 35A has applied thereto a greater rate of suction than the suction chamber 35B, more of the fluid will exit via the outlet region 39A. As the suction differential increases, more and more fluid exits via the outlet region 39A until all of the fluid exits from the region 39A. In other words, the amount of the fluid exiting from region 39A is proportional to the differential in suction applied to the slits 33.

While the proportional amplifier described with respect to FIG. 2 performs amplifications in the usual sense, it is possible to modify the amplifier to provide a bistable amplifier, that is, an amplifier in which once the output stream is diverted to a particular channel the stream remains flowing in that channel until deflected to another channel. Such an amplifier is similar to flip-flops and trigger circuits in the electronic art. Such an amplifier utilizes the Coanda effect wherein fluid expelled under pressure into the chamber will adhere to one of the walls of the chamber downstream from the orifice until a sufficient disturbance deflects it to the other wall.

With this in mind, a bistable amplifier 17' will be described with respect to FIG. 3. The amplifier comprises an input power conduit 40 having an inlet adapted to receive fluid under pressure and an outlet orifice 42. The input power conduit 40 is a nozzle which supresses turbulence in the fluid as it reaches the outlet orifice 42. The plane of the outlet orifice 42 is perpendicular to the central axis C and the center of the outlet orifice 42 is preferably disposed on central axis C. Connected to the inlet power conduit 40 is a chamber 44 including an inlet connected to the outlet orifice 42. Chamber 44 has side wall portions 48 that flare outwardly from the inlet. The portion of chamber 44 downstream from outlet orifice 42 is provided with two outlets 49 which are disposed at diametrically opposite regions radially displaced from the central axis C. Extending into chamber 44 is a fluid divider 51. Fluid divider 51 has side wall portions 52 that are opposite the side wall portions 48 of chamber 44. The side wall portions 52 converge to a point 53 on the central axis C and face the outlet orifice 42. Therefore, the side wall portions 52 of divider 51 cooperating with the side wall portions 48 of chamber 44 provide two channels which exit at the outlets 49. Fluid expelled from outlet orifice 42 will travel in either one of the channels. However, because of the Coanda effect, the expelled fluid will only travel in either one of the channels. In order to divert the expelled fluid controllably to a selected channel the peripheral edge of outlet orifice 42 is provided with a pair of slits 43. Slits 43 are diametrically disposed about the periphery of outlet orifice 42. Slit 43A is traversely aligned with the channel defined by wall portion 48A and wall portion 52A; and slit 43B is traversely aligned with the channel defined by wall portion 48B and wall portion 52B. Each of the slits 43 is respectively connected to suction sources 47. For example, suction source 47A applies suction to suction chamber 45A which is connected to slit 43A.

In operation, the output stream will exit from one of the outlets 49 depending on some previous transient condition. Assume that the fluid is exiting via outlet 49A. The fluid will continue to exit from that outlet until a suction pulse from source 47B is applied to suction chamber 45B. The suction created in chamber 45B introduces edge suction at the slit 43B and the stream will be diverted from the outlet 49A to the outlet 49B. The state of the device will remain so until a suction pulse is applied to the suction chamber 45A by the suction source 47A. At that time, the outlet stream will swing over to the outlet 49A.

In other words, the stream locks into one of two stable states and remains in that state until forcibly diverted to the other state.

In order to obtain maximum control of the jet expelled from the orifice certain slit geometry is required. In particular, FIG. 4 shows the desired geometry. The slit width G of slit 60 should be between one-half and ten percent of the diameter or width of the outlet orifice. In addition, the angle of inclination A of the slit 60 with respect to the inner wall 62 of the outlet orifice should be in the range of thirty to ninety degrees. Generally, the larger the inclination angle of the slit and the greater the width of the slit, the greater the deflection of the jet. However, with larger inclination angles and slit widths, greater suction rates are required. The slit geometry applies to both the fluid amplifiers 17 and 17'.

In FIG. 5, there is shown schematically means for alternately applying suction to the slits 33A and 33B of the amplifier 17 (FIG. 2). A conduit 68 connects the chambers 35A and 35B. Within the conduit 68 is a piston 70 which is reciprocatingly driven by drive 72. When the piston 70 moves to the right (as shown in FIG. 5) suction occurs in chamber 35A and pressure occurs in chamber 35B. The suction at the left slit 33A will deflect the jet of solution to the left. This deflection is slightly reinforced by the pressure at the right slit 35B. A complementary effect occurs when the piston 70 moves to the left. A similar device can be used for applying suction to slits 43 of fluid amplifier 17'.

There has thus been shown improvements in generating jet agitated turbulent convection in the wash solution in the wash tank of a washing machine. In particular, by controllably introducing two jets of wash solution into the wash tank of a washing machine the desired agitation is obtained with a minimum of apparatus.

While only several embodiments of the invention have been shown and described in detail, there will now be obvious to those skilled in the art many modifications and variations satisfying any, or all, of the objects of the invention but which do not depart from the spirit thereof, as defined in the appended claims.

What is claimed is:

1. In a washing machine which includes a cylindrical wash tank having a wash solution outlet, a return line connected to said wash solution outlet, a feed line and a pump connecting said return line to said feed line, the improvement comprising apparatus for controllably delivering two jets of wash solution to said wash tank comprising first and second wash solution inlets circumferentially displaced in said wash tank and a fluid amplifier comprising input conduit means connected to said feed line, first and second outlet conduits connected respectively to said first and second wash solution inlets and control means for controlling the flow of wash solution from said input conduit means to said first and second outlet conduits.

2. The washing machine of claim 1 wherein said fluid amplifier comprises an input conduit means including an inlet means connected to said feed line and a outlet orifice, said outlet orifice having an output axis, an outlet conduit means including an inlet region conduitly connected to said outlet orifice, a central region coaxial with said output axis, and first and second bifurcated outlet conduits, each of said outlet conduits obliquely extending from a point on said output axis downstream from said outlet orifice in diametrically opposite radial directions from said output axis so that fluid expelled from said outlet orifice can flow in either of said outlet conduits, and said outlet orifice being provided with at least one slit in a region having the same radial direction from said output axis as said first outlet conduit, said slit being adapted to have suction applied thereto so that fluid is diverted to said first outlet conduit from said second outlet conduit.

3. The washing machine of claim 2 wherein said slit has a slit width which is from one-half to ten percent of the diameter or width of said outlet orifice.

4. The washing machine of claim 3 wherein said slit has a slit inclination angle of between thirty and ninety degrees.

5. The washing machine of claim 1 wherein said fluid amplifier is a proportional fluid amplifier comprising an input conduit means including an inlet connected to said feed line and an outlet orifice, the center of said outlet orifice being on a central axis perpendicular to the plane of said outlet orifice, a chamber including an inlet connected to said outlet orifice and first and second outlet regions downstream from said outlet orifice, said chamber including sidewall portions radially displaced from said central axis so that fluid under pressure can flow from said inlet to either of said outlet regions without contacting said sidewall portions, said outlet regions being disposed at diametrically opposite positions radially extending from said central axis, said outlet orifice being provided with first and second slits, said first slit beng traversely aligned about said central axis with said first outlet region and said second slit being traversely aligned about said central axis with said second outlet region, means for applying suction differentially to said slits so that the fluid flowing from said outlet orifice is diverted toward the outlet region of said chamber traversely aligned with the slit subjected to the greater suction, and first and second outlet conduits connected to said first and second outlet regions, respectively.

6. The washing machine of claim 5 wherein each of said slits has a slit width which is from one-half to ten percent of the diameter of said outlet orifice and the slit inclination angle is between thirty and ninety degrees.

7. The washing machine of claim 1 wherein said fluid amplifier is a bistable fluid amplifier comprising an input conduit means including an inlet connected to said feed line and an outlet orifice, the center of said outlet orifice being on a central axis perpendicular to the plane of said outlet orifice, a chamber including an inlet connected

to said outlet orifice, side wall portions flaring outwardly from said inlet, and first and second outlet conduits downstream from said inlet at diametrically opposite regions radially displaced from said central axis, said first and second outlet conduits being the outlet conduits of said fluid amplifier, a fluid divider extending into said chamber, said fluid divider including side wall portions opposite the side wall portions of said chamber and converging to a point on said central axis facing said outlet orifice and downstream therefrom, the oppositely disposed side wall portions of said chamber and said fluid divider cooperating to provide first and second fluid outlet channels exiting at said first and second outlet conduits of said chamber, said side wall portions of said chamber and said fluid divider being disposed with respect to said outlet orifice so that when fluid from said outlet orifice flows in one of said outlet channels said flow continues until diverted to the other of said outlet channels, said outlet orifice being provided with first and second slits, said first slit being traversely aligned with said first outlet channel and said second slit being traversely aligned with said second channel, and means for selectively applying suction to said slits so that when suction is applied to one of said slits, fluid flowing from said outlet orifice is diverted to the outlet channel traversely aligned therewith.

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