Nov. 29, 1966 D. S. CUSHING 3,288,372

NON-CLOGGING DISHWASHER ARM ORIFICES FORMING A FAN-LIKE VENA CONTRACTA SPRAY PATTERN

Filed Aug. 27, 1964 3 Sheets-Sheet 1

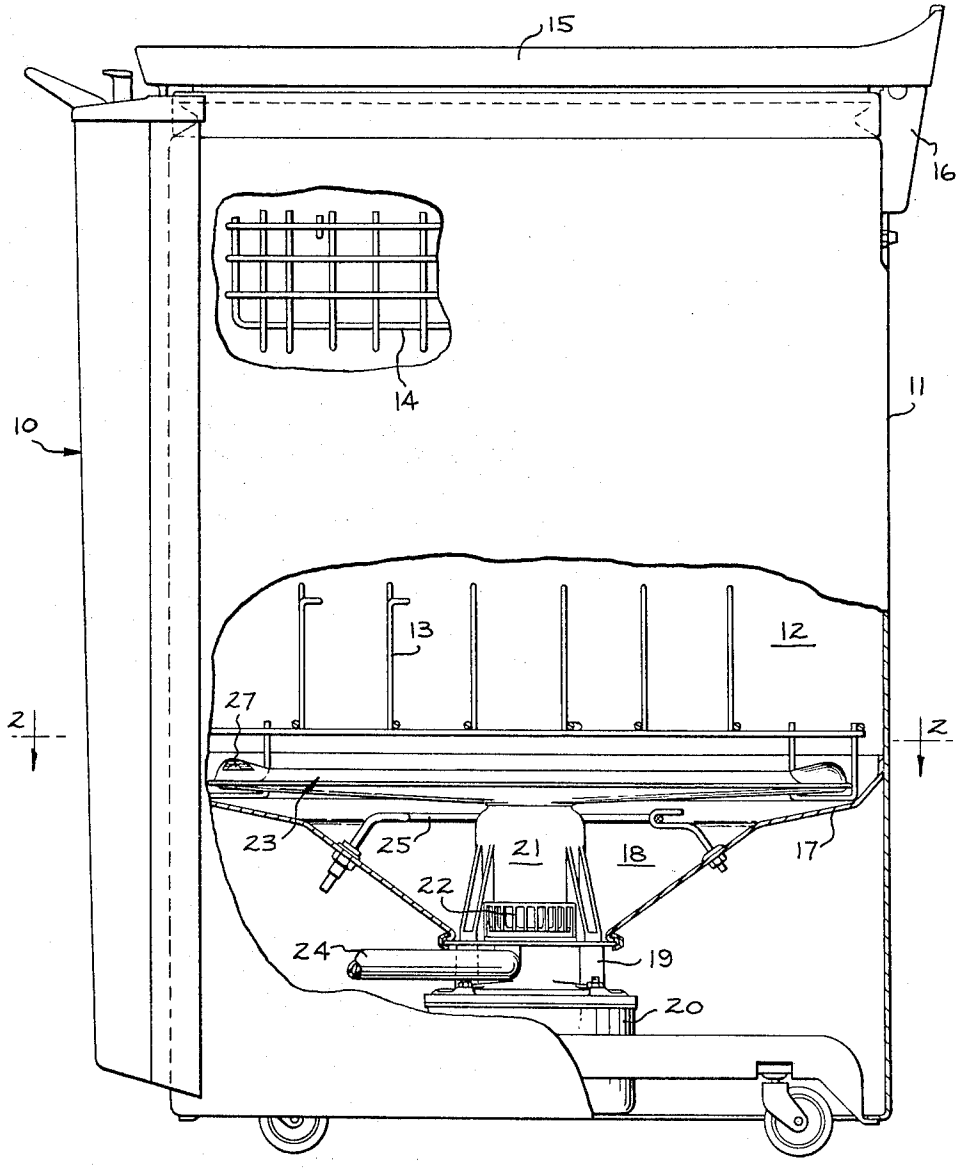

FIG. 1

INVENTOR.
DONALD S. CUSHING
BY James E Espe
HIS ATTORNEY

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Filed Aug. 27, 1964 3 Sheets-Sheet 2

FIG. 2

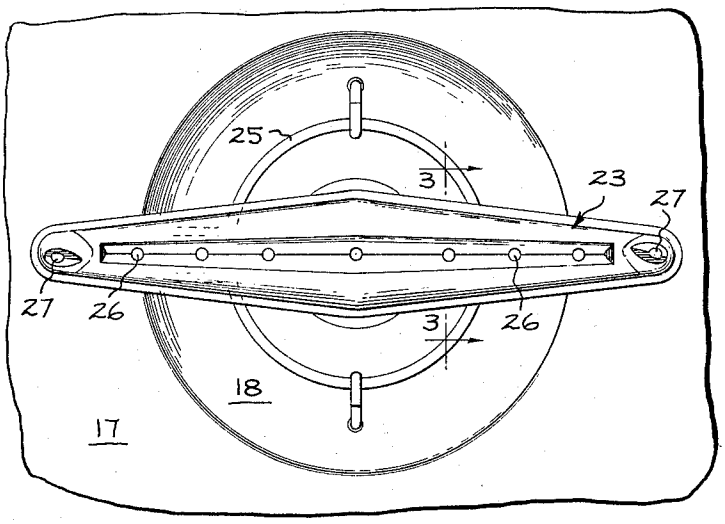


FIG. 3

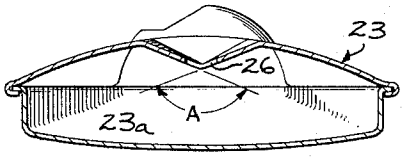


FIG. 8

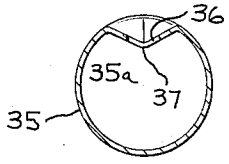


FIG. 7

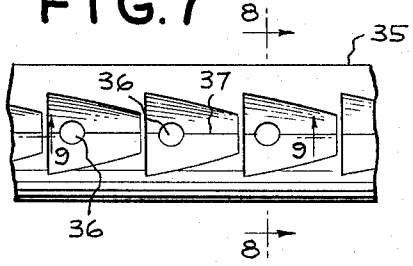
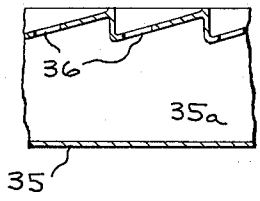


FIG. 9



INVENTOR.
DONALD S. CUSHING
BY James E Espe
HIS ATTORNEY

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Filed Aug. 27, 1964 3 Sheets-Sheet 3

FIG. 4

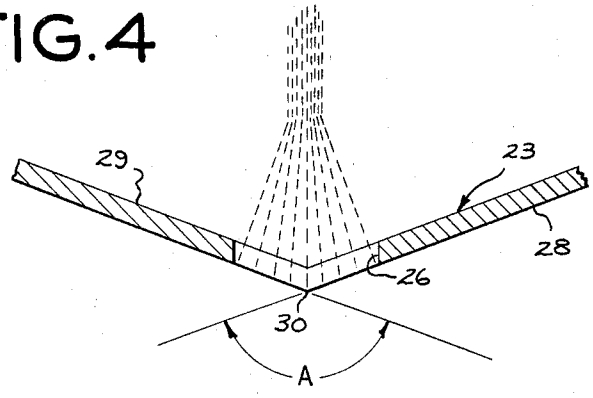


FIG. 5

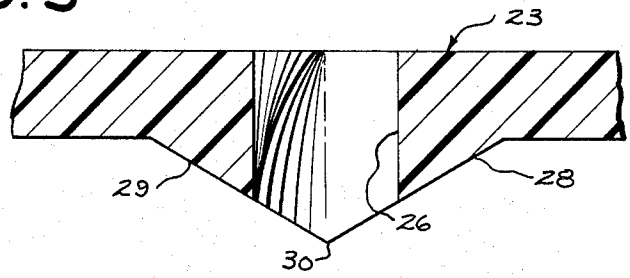
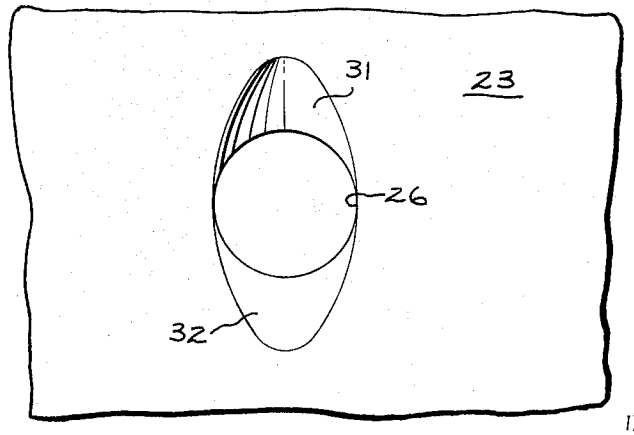


FIG. 6



INVENTOR.
DONALD S. CUSHING

BY James E Espe
HIS ATTORNEY

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3,288,372

NON-CLOGGING DISHWASHER ARM ORIFICES FORMING A FAN-LIKE VENA CONTRACTA SPRAY PATTERN

Donald S. Cushing, Louisville, Ky., assignor to General Electric Company, a corporation of New York

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5 Claims. (Cl. 239—251)

The present invention relates generally to automatic dishwashers and, more particularly, to an improved spray device for an automatic dishwasher.

For many reasons it is desirable to provide a divergent or sheet-like spray to effectuate the wash action in the wash chamber of an automatic dishwasher. Among these reasons is that a more efficient use of the wash fluid is achieved by the use of a divergent spray requiring a smaller quantity of wash fluid and, additionally, requiring a less powerful motor-pump assembly. Each of these results in cost savings to either the consumer, due to decreased use of water and detergent, or to the manufacturer, due to a less expensive motor-pump assembly without sacrifice of washability. Attempts have been made heretofore to produce a divergent or sheet-like spray, in arts other than the dishwashing art, and many of them have been successful. However, in order for such a device to be successful in a dishwasher, the device must be capable of passing relatively large food particles. As opposed to a lawn sprinkler, for example, where the fluid being sprayed is relatively free of foreign objects, the spray device in a dishwasher must handle a fluid having food particles as large as a kernel of corn or a green pea entrained therein without clogging or seriously interrupting the spray configuration. Therefore, most of the devices for achieving a sheet-like spray proposed heretofore have been unsuitable for use in a dishwasher.

Accordingly, it is an object of this invention to provide an improved spray nozzle for use in an automatic dishwasher.

It is another object of this invention to provide an improved spray nozzle which creates a divergent or sheet-like spray.

It is also an object of this invention to provide a spray device which will create a divergent spray configuration and which will also adequately pass fluids containing food particles without clogging or interrupting the spray configuration.

Briefly stated, in accordance with one aspect of the present invention, there is provided a spray device for use in an automatic dishwasher including a wall defining a fluid passageway. The wall has an interior surface facing the passageway and a dihedral angle of less than 180° is formed in at least a portion of the interior surface of the wall. An opening is formed through the wall at the apex of the dihedral angle. With this structure, wash fluid is forced through the opening and, due to the dihedral angle, the issuing jet is in the form of a sheet of fluid. Moreover, the dihedral angle creates a vena contracta in the fluid jet of smaller cross sectional area than the opening. As a result, the effective cross sectional area of the jet or spray, and this is the dimension which governs the quantity of fluid issuing from the spray device, is that of the vena contracta; however, whenever a foreign object such as a food particle is attempting to pass through the spray device, the opening will pass any object up to the dimension of the opening. Therefore, a spray device constructed in accordance with the present invention achieves the aforementioned objects.

While the specification concludes with claims particularly pointing out and distinctly claiming the subject

matter which is regarded as the invention, it is believed the invention will be better understood from the following description taken in connection with the accompanying drawings, in which:

FIGURE 1 is an elevational view, partially cut away to show details, of a conventional dishwasher with which the present invention may be employed;

FIGURE 2 is a partial sectional view taken along line 2—2 of FIGURE 1;

FIGURE 3 is a sectional view taken along line 3—3 of FIGURE 2;

FIGURE 4 is an enlarged view showing details of the present invention;

FIGURE 5 is a view similar to FIGURE 4 showing the invention employing a relatively thick material;

FIGURE 6 is a view of the device of FIGURE 5 as seen from above in FIGURE 5;

FIGURE 7 is a partial plan view showing a spray device incorporating one modification of the present invention;

FIGURE 8 is a sectional view taken along line 8—8 of FIGURE 7; and

FIGURE 9 is a partial sectional view taken along line 9—9 of FIGURE 7.

Referring now to the drawings, and particularly to FIGURE 1, there is illustrated an automatic dishwasher 10 with which the present invention may be utilized. Dishwasher 10 includes an outer cabinet 11 defining therein a wash chamber 12. Disposed within wash chamber 12 are dish supporting racks 13 and 14 each of which supports plates, glasses, cups and the like during operation of dishwasher 10. An access opening is provided in the top of cabinet 11 to provide access to wash chamber 12. A closure member or door 15 is pivotally attached to cabinet 11 by means of hinge member 16 to provide access to wash chamber 12 so that dish supporting racks 13 and 14 may be loaded and unloaded.

The lower extremity of wash chamber 12 is defined by a bottom wall 17 which has a depressed central portion forming a sump 18. Positioned within sump 18 and supported by bottom wall 17 is a motor-pump assembly 19. Motor-pump assembly 19 includes an electric motor 20 and a pump 21. Motor 20 is preferably of the electrically-reversible type well known in the electric motor art. Pump 21 may be mechanically directly linked to motor 20 so that as the direction of rotation of motor 20 is reversed, the direction of rotation of pump 21 is also reversed. In one direction of rotation of motor 20, pump 21 withdraws wash fluids from sump 18 through an inlet 22 and propels the fluids upwardly through a rotatable reaction-type spray arm 23. The wash fluids issuing from spray arm 23 effectuate a wash action upon the dishes supported by racks 13 and 14 in wash chamber 12.

In the opposite direction of rotation of motor 20, pump 21 withdraws wash fluids from sump 18 through inlet 22 and propels these fluids out through an effluent discharge conduit 24 which communicates with the normal household sewer system (not shown). An electrical resistance heating element 25 may be provided to facilitate drying of the dishes supported by racks 13 and 14 upon completion of the wash operation or, additionally, to heat the wash fluids during the wash operation.

It should, of course, be understood that all of the structure thus far described may be modified a great deal without seriously affecting the present invention since this structure is substantially conventional and comprises only one illustrative structure with which the present invention is compatible.

As discussed above, it is an object of this invention to provide a spray device which will produce a divergent or sheet-like spray configuration of the wash fluids issuing

from spray arm **23**. Referring now to FIGURES 2 and 3, spray arm **23** is illustrated as including a plurality of openings **26** longitudinally spaced along the spray arm **23** and communicating with a fluid passageway **23***a* (FIGURE 3) within the spray arm. Openings **26** are substantially circular in configuration when viewed from the top, as in FIGURE 2, and are of sufficient diameter to allow food particles of the size of a kernel of corn or a green pea to pass therethrough. Near each end of spray arm **23** is an additional opening **27**. Each of the openings **27** is directed laterally of spray arm **23** and, because of this, when wash fluids are introduced into spray arm **23** under pressure, the jets issuing from openings **27** cause a reaction force which rotates spray arm **23**. With the openings oriented as shown in FIGURE 2, spray arm **23** will rotate clockwise, as viewed from the top, as the wash fluid issues from openings **27**.

FIGURE 3, which shows a sectional view of spray arm **23** as taken along line 3—3 of FIGURE 2, illustrates that openings **26** are positioned in the apex of a dihedral angle formed on the inner surface of upper wall of spray arm **23**. The size of the dihedral angle is represented in FIGURE 3 as A. The relationship between opening **26** and the dihedral angle creates the sheet-like spray which issues from opening **26** when wash fluid is introduced into spray arm **23** under pressure.

Referring now to FIGURE 4, which provides an enlarged view of opening **26** and the associated dihedral angle, it can be seen that the dihedral angle includes members **28** and **29** which come together at an apex **30**. The opening **26**, which is preferably circular in cross section, since this increases its ability to pass relatively large food particles, is formed through wall **23** and has its center concurrent with apex **30**. Still referring to FIGURE 4, an approximation of the configuration of the wash fluids issuing from opening **26** is also given. It can be seen from FIGURE 4 that the stream of fluid is considerably smaller, in the plane of FIGURE 4, than the opening **26**. This accentuated vena contracta is a result of the dihedral angle formed by members **28** and **29**. Since a fluid issuing from an orifice tends to travel in a path normal to the surface adjacent the orifice, the fluid issuing from opening **26** attempts to follow a path normal to each plane of the dihedral angle. This causes an interference between fluid issuing from opposite sides of the orifice and the interference results in a fanning out or diverging of the fluid in a plane parallel to the apex of the dihedral angle. Therefore, the dihedral angle, with the opening formed at its apex, creates a sheet-like jet of water generally aligned with the apex of the dihedral angle.

The size A of the dihedral angle may vary from just less than 180° down to about 45°. With a circular opening, the configuration of the spray will vary from almost circular at or near 180° angle to an increasingly accentuated sheet-like spray as the angle size decreases.

FIGURES 5 and 6 illustrate a modification particularly suitable for use with a spray arm having a wall of substantial thickness. If the spray arm wall is of substantial thickness, there is a possibility that the diverging edges of the fluid stream may meet interference from the outer edges of the opening. Accordingly, it may be desirable to chamfer the edges of opening **26** in the areas where the spray diverges. In FIGURE 6, chamfered areas **31** and **32** are provided to avoid interference between the outer surface of the wall of spray arm **23** with the diverging fluid. If desired, opening **26** may be formed as a truncated cone.

Referring again briefly to FIGURES 2 and 3, it can be seen that the cross sectional area of spray arm **23** is very large in relation to the cross sectional area of the individual openings **26**. Because of this substantial difference in cross sectional areas, there is a very low velocity of the fluid passing through spray arm **23**.

Referring now to FIGURES 7, 8 and 9, there is illustrated a spray arm **35** having therein a plurality of openings **36** communicating with a fluid passageway **35***a* within the spray arm. Openings **36** are similar in size and function to openings **26** as discussed above with regard to spray arm **23**. However, spray arm **35** has a cross sectional area which is much smaller than the cross sectional area of spray arm **23**. Accordingly, a significant velocity will be established within spray arm **35** when sufficient wash fluid is propelled therethrough to feed all of the openings **36**. This velocity can affect the configuration of the spray issuing from each of the openings **36**. That is, as the wash fluid passes through an opening **36**, in addition to having velocity components normal to the opening, it will have a velocity component parallel to, and in the same direction as, the velocity of the fluid within the spray arm **35**.

To overcome, or to compensate for, this additional velocity component in the fluid issuing through opening **36**, the apex **37** of the dihedral angle is inclined with respect to the longitudinal axis of the spray arm **35**. Since the fluid passing through an orifice such as opening **36** has a tendency to issue therefrom in a path normal to the surface adjacent the orifice, the fluid thus passing through orifice **36** is inherently provided with a velocity component which overcomes the velocity component present within spray arm **35**.

Thus, it can be seen that the present invention provides a spray device for an automatic dishwasher which achieves a diverging or sheet-like spray to effectuate the wash action in the dishwasher wash chamber. Because the spray issuing from the individual orifices in the spray device is sheet-like, it is therefore possible to space the individual orifices farther part from each other while at the same time achieving substantially the same effective water distribution within the wash chamber. Since a smaller number of orifices is needed, less wash fluid is necessary and, additionally, a less powerful motor-pump assembly may be employed since less fluid needs to be recirculated.

Of particular significance is the use of a circular orifice in combination with a dihedral angle to achieve the sheet-like spray. The circular opening allows relatively large food particles, i.e., the size of a kernel of corn or a green pea, to pass through the orifice while the dihedral angle achieves a vena contracta which effectively reduces the orifice size with respect to the amount of fluid which passes therethrough. In other words, it would be possible to achieve a sheet-like spray by using an accentuated elliptical opening; however, such an elliptical opening would not allow the passage of food particles that a circular opening, of the same area, would allow.

As will be evident from the foregoing description, certain aspects of the invention are not limited to the particular details of construction of the examples illustrated, and it is contemplated that various other modifications or applications will occur to those skilled in the art. It is therefore intended that the appended claims shall cover modifications and applications as do not depart from the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In an automatic dishwasher having a wash chamber adapted to receive and contain articles to be washed therein, a spray arm to effectuate a fan-like spray directed toward said articles comprising:

(a) a wall at least partially defining a fluid passageway,

(b) said wall having an interior surface facing said passageway,

(c) a dihedral angle of less than 180° formed in at least a portion of said interior surface, and

(d) a substantially circular opening formed through said wall at the apex of said angle,

(e) the angular relationship between said opening and said interior surface adjacent said opening creating a vena contracta in the fluid spray issuing from said opening,

(f) said vena contracta having a cross-sectional area smaller than the cross-sectional area of said opening whereby said opening is free to pass a solid particle of larger size than the cross-sectional area of said vena contracta.

2. In an automatic dishwasher having a wash chamber adapted to receive and contain articles to be washed therein, a spray device to effectuate a fan-like spray directed toward said articles comprising:

(a) a conduit-like spray arm having a wall with an interior surface,

(b) at least a portion of said interior surface being formed in a dihedral angle of less than 180°, and

(c) a substantialty circular opening formed through said wall,

(d) the center of said opening being concurrent with the apex of said dihedral angle,

(e) the angular relationship between said opening and said interior surface adjacent said opening creating a vena contracta in the fluid spray issuing from said opening,

(f) said vena contracta having a cross-sectional area smaller than the cross-sectional area of said opening whereby said opening is free to pass a solid particle of larger size than the cross-sectional area of said vena contracta.

3. In an automatic dishwasher having a wash chamber adapted to receive and contain articles to be washed therein, a spray arm to effectuate a fan-like spray directed toward said articles comprising:

(a) a wall at least partially defining a fluid passageway,

(b) said wall having an interior surface facing said passageway and an exterior surface opposite said interior surface,

(c) a dihedral angle of less than 180° formed in at least a portion of said interior surface, and

(d) a substantially circular opening formed through said wall at the apex of said angle,

(e) the angular relationship between said opening and said interior surface adjacent said opening creating a vena contracta in the fluid spray issuing from said opening,

(f) said vena contracta having a cross-sectional area smaller than the smallest cross-sectional area of said opening whereby said opening is free to pass a solid particle of larger size than the cross-sectional area of said vena contracta,

(g) said exterior surface being chamfered about said opening so that the cross-sectional area of said opening is smallest where it intersects said interior surface and largest where it intersects said exterior surface.

4. In an automatic dishwasher having a wash chamber adapted to receive and contain articles to be washed therein, a spray device to effectuate a fan-like spray directed toward said articles comprising:

(a) a conduit-like spray arm having a wall with an interior surface,

(b) at least a portion of said interior surface being formed in a dihedral angle of less than 180°, and

(c) a substantially circular opening formed through said wall,

(d) the center of said opening being concurrent with the apex of said dihedral angle,

(e) The angular relationship between said opening and said interior surface adjacent said opening creating a vena contracta in the fluid spray issuing from said opening,

(f) said vena contracta having a cross-sectional area smaller than the cross-sectional area of said opening whereby said opening is free to pass a solid particle of larger size than the cross-sectional area of said vena contracta,

(g) the apex of said dihedral angle being inclined with respect to the axis of said spray arm.

5. In an automatic dishwasher having a wash chamber adapted to receive and contain articles to be washed therein, a spray arm to effectuate a fan-like spray directed toward said articles comprising:

(a) a hollow conduit-like member in communication with a source of wash fluid under pressure,

(b) the inner surface of said hollow member having formed therein a dihedral angle of less than 180°, and

(c) a plurality of subtantially circular openings in said conduit spaced along the apex of said dihedral angle,

(d) the angular relationship between each of said openings and said inner surface adjacent each of said openings creating a vena contracta in the fluid spray issuing from each of said openings,

(e) said vena contracta having a cross-sectional area smaller than the cross-sectional area of said opening whereby said opening is free to pass a solid particle of larger size than the cross-sectional area of said vena contracta.

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M. HENSON WOOD, JR., *Primary Examiner.*

V. C. WILKS, *Assistant Examiner.*