This invention relates to automatic clothes washing machines, and more particularly to a clothes washing machine having an improved agitator mechanism.

In many prior art clothes washing machines, particularly those of the automatic vertical axis type, there is provided a vertically extending agitator which oscillates back and forth in order to effect the desired washing action. Inasmuch as the source of power for the agitator is almost invariably the rotating shaft of an electric motor, a relatively complex gear train is required to transform the rotary motion provided by the motor into the oscillating motion required of the agitator.

It is, therefore, an object of my invention to provide in a washing machine an agitator of the type which operates suitably upon reception of a rotary motion, thereby eliminating the necessity for a complex transmission to convert rotary motion into oscillating motion.

A further object of my invention is to effect a structure which, by virtue of rotary motion transmitted to the agitator, will cause the wash water to circulate in a generally toroidal path.

It is yet another object of my invention to achieve the foregoing desired object by a structure which, while it receives rotary motion, does not itself rotate and thereby cannot cause the damage to the clothes which could be provided should a high speed rotating shaft be located in the clothes washing mechanism.

In one aspect of my invention, I provide a clothes washing machine which has the conventional tub for receiving washing liquid and articles to be washed and, extending upwardly into the tub substantially at the center thereof, a rotatable drive shaft. Suitable means for rotating the shaft is provided, generally in the form of an induction-type motor. On the shaft within the tub, I provide at least one pair of substantially circular washing elements which are axially spaced along the shaft and are positioned to be submerged in washing liquid during a washing operation. Each of the elements encircles the shaft in a rotatable relation thereto and as an important feature of my invention, each of the elements further is required to have its radially outer portion formed as a flexible circular fin extending downwardly and outwardly. The fin is formed of a flexible resilient material. My circular elements are secured against rotation relative to the tub, and I provide means connected to the shaft and engaging the elements so as to provide a vertical oscillatory motion to each point on the element, in which movement vertically aligned portions of the elements respectively move in opposite directions at any given instant of operation.

The flexible nature of the outer part of the fins, and the fact that the outer part of each fin extends downwardly and outwardly means that a downward movement of the fin has a greater effect on the water than an upward movement of the fin. This causes the net movement of water and hub 7 during spin being directed by adjacent the fins and, of necessity, in an upward direction at the outer part of the tub away from the fins. As a result, there is a continuous turning over of the clothes by virtue of the fact that the water moves in a substantially vertical closed path.

The features of my invention which are believed to be novel are set forth with particularity in the appended claims. The invention itself, however, both as to organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following detailed description taken in connection with the accompanying drawings.

In the drawings, FIGURE 1 is a side elevational view of a clothes washing machine including my improved agitator, the view being partially broken away and partially in section in order to show details; and

FIGURE 2 is an enlarged side elevational view of my improved agitator, the view being partially broken away and partially in section to show details.

Referring now to FIGURE 1 of the drawings, I have shown therein an agitator type washing machine 1 having an inner clothes containing tub 2 disposed within an outer perforate tub or casing 3. Tub 3 is mounted within an appearance cabinet 4 which includes an appropriate cover (not shown) for providing access to tub 2. At the center of tub 2 there is provided a vertically extending agitator, generally indicated by the numeral 5, which forms the focal point of my invention and is discussed in complete detail here below in connection with FIGURE 2. Tub 2 is mounted on a flange 6 of a rotatable hub, partly shown at 7, and agitator 5 has, as shown in FIGURE 2, a shaft 8 extending downwardly therein and mounted within hub 7 and, by means of bearing 9, is rotatable in relation thereto. During the cycle of operation of machine 1, the shaft 8 is first rotated, which, as explained below, effects a washing action of the clothes tub 2. Then, after a predetermined period of the washing action, the tub 2 is rotated at high speed to extract centrifugally the washing liquid and discharge it into the outer tub 3 through appropriate small openings in tub 2, as shown at 11, which in the construction shown extend in a horizontal line around and adjacent the top of the basket. Following this extraction operation, a supply of clean liquid is introduced into the wash basket for rinsing the clothes and the agitator shaft 8 is again rotated. Finally, the basket is once more rotated at high speed to extract the rinse water and discharge it into the outer tub.

The tub 2 and agitator 5 may be driven by any suitable means as the drive means forms no part of the present invention. However, by way of example, I have shown them as driven from a reversible motor 10 which drives the inner tub and agitator through a clutch 11 mounted on the motor shaft. Clutch 11 allows the motor to start without load and then picks up the load as the shaft 8 is rotated. A suitable belt 12 transmits power to transmission assembly 13 through pulley 14. Thus, depending upon the direction of motor rotation, pulley 14 of transmission 13 is driven in opposite directions.

The transmission 13 is so arranged that it supports and drives both the agitator drive shaft 8 and the basket mounting hub 7. When motor 10 is rotated in one direction the transmission causes rotation of shaft 8 without any corresponding rotation of hub 7. Conversely, when the motor 12 is driven in the opposite direction, the transmission drives both the shaft 8 and the hub 7 together at high speed for centrifugal extraction of liquid from the clothes contained within tub 2. It will readily be recognized that the transmission 13, while not shown in detail, may be of extremely simple design, the connection from pulley 14 to shaft 8 being direct, and connection between shaft 8 and hub 7 being carried out by any suitable simple means such as a conventional direction sensitive clutch (not shown) which couples shaft 8 and hub 7 for one direction of rotation and uncouples them for the other direction of rotation.

In order to introduce washing and rinsing liquid into tub 2, a suitable conduit 15 is provided having an outlet opening over tub 2 so that water introduced into conduit 15 flows into the tub. The water is supplied in the usual
In addition to operating transmission 13 as described, member 41 which forms part 15 through a flexible coupling 16 which connects the motor shaft and the pump shaft during washing and rinsing operations. Pump 15 discharges into a conduit 17 which leads to a nozzle 18 positioned above tub 2 so that liquid overflowed through openings 11 may be recirculated through a suitable filter 19 secured to the top of the agitator mechanism 5 in order to clean and filter the liquid during the operation. The system constantly circulates the washing machine liquid from outer tub 3 through conduit 17 and nozzle 18 into filter 19 and back into wash tub 2 where it overflows through openings 11 into tub 3 to repeat the cycle. This recirculation system forms no part of the present invention, but is briefly described in order to complete the description of the machine. At the end of the washing and rinsing portions of the cycle, and in response to a reverse direction of rotation of motor 10, pump 15 discharges into a conduit 20 which is adapted for discharge to a stationary tub or drain line so that the pump is effective to drain tub 3. While any suitable pump may be used for draining purposes, I prefer to use the one just now described; it is described in detail and claimed in Patent 2,883,843 issued to me on April 28, 1959, and owned by the General Electric Company, assignee of the present invention.

Completing the description of the elements shown in FIGURE 1, wash tub 2 may be provided with a conventional balance ring 21 secured near the top thereof in order to assist in balancing during spinning operations, and with a suitable clothes retaining structure 22 to preclude the rotation of clothes over the top of the tub 2 and into the outer tub 3.

Referring now to FIGURES 1 and 2 together with a description of the essence of my invention, it will be observed that shaft 8 extends up within the agitator 5 a substantial distance into the tub 2. Axially spaced along the shaft 8 are a pair of bearing receiving portions 23 and 24, which portions are formed on eccentric axes, that is, axes which intersect the axes of rotation of shaft 8 at an acute angle thereto. In addition, the axes of portions 23 and 24 intersect the axis of rotation 180° from each other, i.e., portions 23 and 24 are oppositely canted. Since portions 23 and 24 form part of shaft 8 it must, of necessity, rotate around the axis of shaft 8, it will be seen that during rotation they will, in effect, have an orbit about shaft 8.

Secured on the surface of portion 24 is a ball bearing member 26 which has its inner race 27 secured to surface 24 and its outer race 28 secured to an annular member 29 which forms part of a circular washing element generally indicated by the numeral 30. The inner and outer races of bearing 26 are, in the usual manner, positioned to be rotatable relative to each other but to be secured against any substantial axial or other movement in relation to each other.

The outer part 31 of member 29 is secured by any suitable means, such as the rivets 32, to a housing 33. Housing 33 has an annular opening 34 within which is clamped an annular fin member 35. Fin member 35 may be provided with an inwardly positioned enlarged or bead portion 36 in order to assist the clamping action. The fin forms of relatively thin material tapering to a lesser thickness as one moves in a radially outward direction along the outer portion 37 of the fin. It will be observed that outer portion 37 of fin 35 extends generally outwardly relative to the axis of rotation of shaft 8 and downwardly from the shaft. The fin member 35 forms part of a second circular washing element which is both flexible, so as to yield readily, and resilient so as to tend to return to its original position; for instance a suitable material to be used in this instance is rubber.

In similar fashion, a bearing 38 having inner and outer races 39 and 40 is positioned on eccentric portion 23 of shaft 8, the bearing having its outer race secured to a member 41 which forms part of the agitator mechanism generally indicated at 41a. Member 41 has an outer portion 42 secured by rivets 43 to a housing member 44. A fin 45 is secured within opening 46 of the housing member, and the fin, as before, is provided with an inner bead 47 and an outer portion 48. It will be observed that the elements positioned on portions 23 and 24 of the agitator 5 are identical and that the relationship of the elements of portion 23 to each other is identical to that described for those positioned on portion 24.

Wash tube 2 is gently curved upwardly at its bottom, as shown by the numeral 49 in both figures, so as to join portion 50 of agitator 5 substantially tangentially thereto. Portion 50 of agitator 5 is immovably secured to the tub 2 as shown at 50a.

A flexible rubber boot member 51 is positioned around shaft 8 and is secured to the top of member 50 and the bottom of housing 44 so as to join the two. In similar fashion, a second flexible rubber boot member 52 is secured to the top of housing 44 and the bottom of housing 33 so as to join these two members. It will thus be seen that the housing members 33 and 44 together with the boots 51 and 52 and member 50 cooperates to prevent the liquid within tub 2 from coming in contact with the shaft 8, the only liquid contact being with the portion of the agitator 5 which are held against rotation by securment to the tub 2. It will further be seen that since members 29 and 41 are secured to the non-rotating housings 33 and 44 respectively, and are also secured to the outer races 28 and 40 of bearings 26 and 38 respectively, the outer races of the bearings do not rotate. With this arrangement, relative rotation between the shaft 8 and the elements 30 and 41a is achieved, and there is no relative rotation between the elements and the tub 2.

While the elements 30 and 41a do not rotate with shaft 8, the fact that they are positioned on bearings 26 and 38, which in turn are arranged on eccentric portions 23 and 24, causes the elements to wobble up and down in an oscillatory motion as a result of rotation of the shaft. In other words, looking, for instance, at element 30 it can be seen, in FIGURE 2, that the left hand portion of the element is raised and the right hand portion of the element is lowered. It will, however, be seen that after shaft 8 rotates 180°, that part of portion 24 which is at the right of the shaft in FIGURE 2 will then have moved around to a position at the left of the shaft. Since the part which is at the right in FIGURE 2 is at a lower level than the part which is at the left, its 180° rotation will cause the left hand part of element 30 to move down in accordance with the position dictated by the bearing 26 and the portion 23. After a full 360° revolution of shaft 8 the parts will again be in the position shown.

Thus, each of the two elements 30 and 41a is, in effect, tilted, and during rotation of shaft 8 the plate of tilt is caused to move angularly at the same speed as the shaft rotation. The result of this is that each point on each element has one complete oscillatory movement in the vertical direction once for each revolution of the shaft, with the oscillation effectively travelling in an orbit around the shaft in response to shaft rotation. The fact that portions 24 and 23 are oppositely canted, as mentioned above, causes the elements 30 and 41a to be so positioned relative to each other that parts of the two elements which are vertically aligned with each other move in opposite directions at any given instant of operation. This is effected, as mentioned, by having the two upper parts 24 and 23 positioned so the eccentricity of one is substantially 180° removed from the eccentricity of the other.

Thus, when, as shown, the right hand portion of element 30 is at its lowest point, the right hand portion of...
element 41a is at its highest point; at the same time, since the left hand portion of element 30 is at its highest point the left hand portion of element 41a is at its lowest point.

It will be recalled that it has been stated that the portions 37 and 46 of fins 35 and 45 extend downwardly and outwardly and are both flexible and resilient. It is further to be understood that during a washing operation the level of the water is such that it rises approximately to the top of shaft 8. That is, it is below the filter 19, but it is also above both of the elements 30 and 41a. During the downward movement of element 30, the portion 37 of fin 35, because of the downwardly and outwardly extending shape thereof, exerts a substantially greater force on the liquid beneath it than it does on the liquid above it during the upward portion of an oscillation. As a result the net force on the liquid from either element is a downward one, and the net force resulting from the downward movement of one of the elements at the same time as the upward movement of a vertically aligned portion of the other element is also a downward one. This net downward force creates a gentle toroidal circulatory movement of the water in the direction shown by the arrow in FIGURE 1. The shape of the tub at the bottom thereof, as shown by the numeral 49, assists in this motion, tending to guide the clothes and water in the toroidal path. It is to be noted that the flexibility and resilience of parts 37 and 48 of the fins are of the utmost importance since, if there is any substantial rigidity to the fins, there will be much more of a tendency for the upward and downward force exerted respectively during the upward and downward movement of the fins to be equal. However, since the fins deform in response to the water pressure (as shown in dotted lines in FIGURE 2), the fact that they extend downwardly and outwardly is of great assistance in creating the net downward force. This results from the fact that the deformation provides a greater effective surface area for moving the water as each fin moves down, and a smaller effective area as each fin moves up.

In summary, it will thus be seen that as the shaft 8 rotates the elements 30 and 41a are held against rotation, and because of their tilted relationship to the shaft 8 are wobbled up and down so that each part of each element has a vertical oscillatory motion. In addition, the fact that the outer part of each element is resilient and flexible, and extends downwardly and outwardly, causes a net downward force in response to the opposed relationship of the two elements so that a gentle circulating action on the clothes is provided to cause them to move in a toroidal path. This has been found to be of a highly beneficial nature in effecting the desired washing action. In addition, the opposed nature of the pair of elements has been found to prevent any substantial tendency for a rotary circulation of the water, which in general has been found to impair the washing action. Thus, my invention provides a highly effective washing action while at the same time permitting the use of an exceedingly simple transmission since the only requirement of the transmission is that it transmit the rotary motion of the motor to the shaft 8 alone in one direction of rotation and to the shaft 8 together with the tub 2 for the other direction of rotation. Of course, my invention includes the concept of any number of pairs of elements rather than the single pair illustrated.

While in accordance with the patent statutes I have described what at present is considered to be the preferred embodiment of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and I therefore aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of this invention.

What I claim as new and desire to secure by Letters Patent of the United States is:
1. A clothes washing machine comprising: a tub for receiving washing liquid and articles to be washed; a rotatable drive shaft extending upwardly into said tub substantially at the center thereof; means for rotating said shaft; a pair of substantially identical circular washing elements axially spaced along said shaft and positioned to be submerged in the washing liquid during a washing operation, each of said elements encircling said shaft in rotatable relation thereto, each of said elements having at its radially outer portion a flexible circular fin extending downwardly and outwardly and formed of a flexible resilient material; means securing said elements against rotation; and means connected to said shaft and engaging said elements to provide a vertical oscillatory motion to each point on said elements in which movement vertically aligned portions of said elements respectively move in opposite directions at any given instant of operation.
2. The apparatus defined in claim 1 wherein said fin tapers down in thickness from its radially inner part to its radially outermost part.
3. A clothes washing machine comprising: a tub for receiving washing liquid and articles to be washed; a rotatable drive shaft extending upwardly into said tub substantially at the center thereof; means for rotating said shaft; a pair of substantially identical circular washing elements axially spaced along said shaft and positioned to be submerged in the washing liquid during a washing operation, each of said elements encircling said shaft in rotatable relation thereto and being tilted relative to said shaft, said elements being tilted in opposite directions to each other at any given instant, each of said elements having at its radially outer portion a flexible circular fin extending downwardly and outwardly and formed of a flexible resilient material; means securing said elements against rotation; and means connected to said shaft and engaging said elements to cause the location of the angle of tilt of each of said elements to move angularly around said shaft as it rotates thereby to provide a vertical oscillatory movement to each point on said elements in which movement vertically aligned portions of said elements respectively move in opposite directions at any given instant of operation.
4. The apparatus defined in claim 3 wherein said means securing said elements against rotation includes a first flexible tubular boot member extending around said shaft, said first boot member being joined at its base to said tub and at its top to the lower of said elements, and a second flexible tubular boot member extending around said shaft between said elements, said second boot member being secured to said elements at its bottom and top respectively.
5. The apparatus defined in claim 3 wherein the radially inner part of each of said elements is substantially rigid.

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