

July 13, 1965

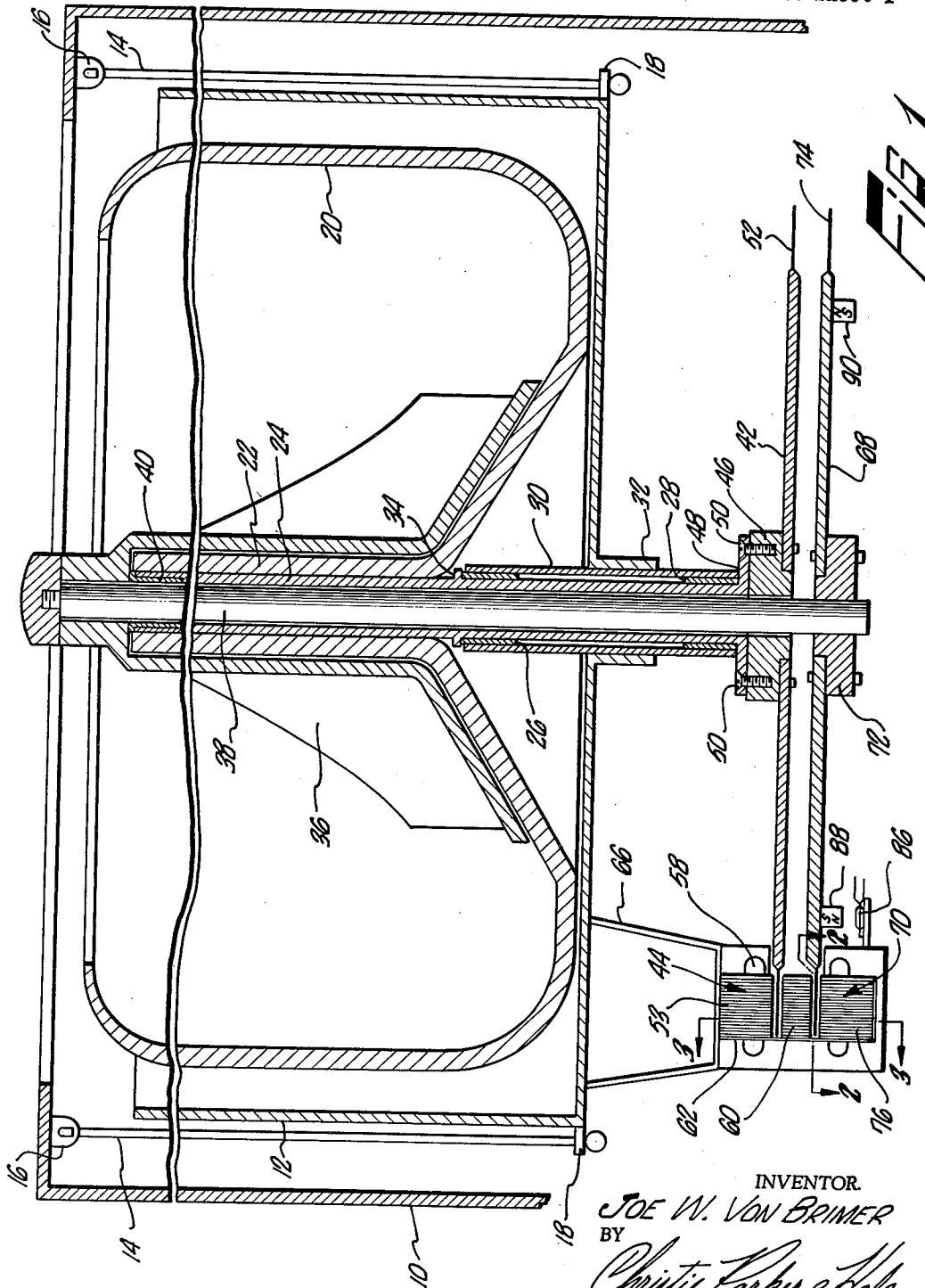
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3,194,032

WASHING MACHINE AND ELECTROMAGNETIC DRIVE SYSTEM THEREFOR

Filed Nov. 5, 1962

4 Sheets-Sheet 1



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4 Sheets-Sheet 2

FIG. 2.

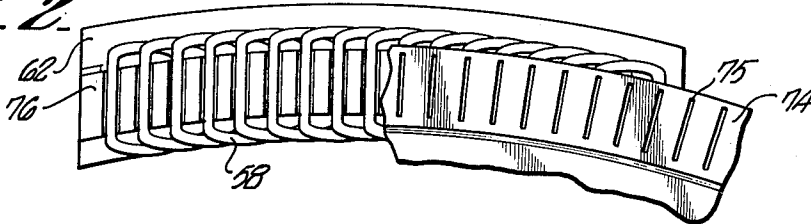


FIG. 3.

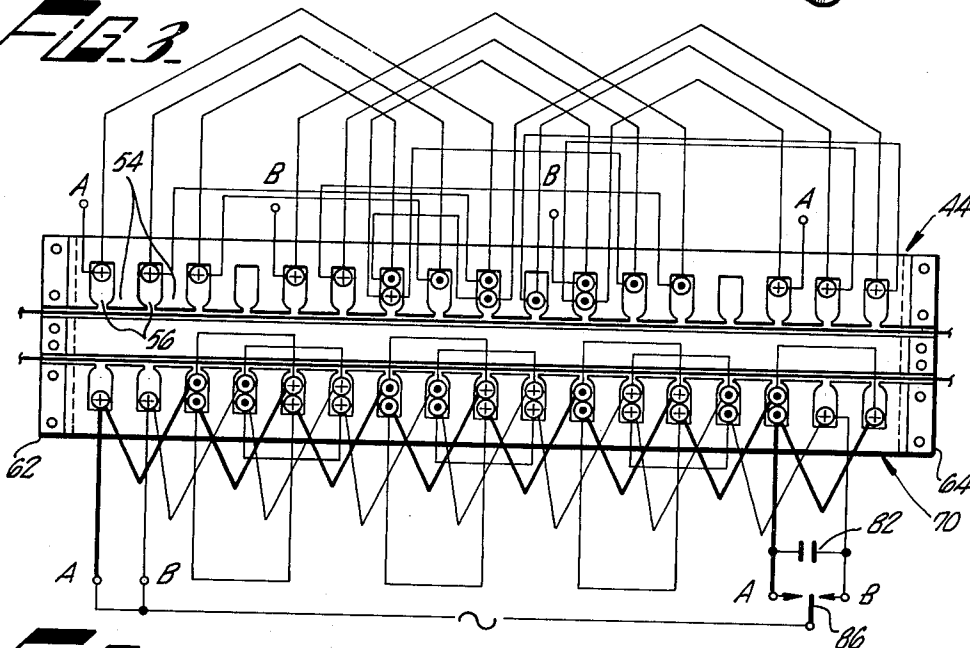


FIG. 4.

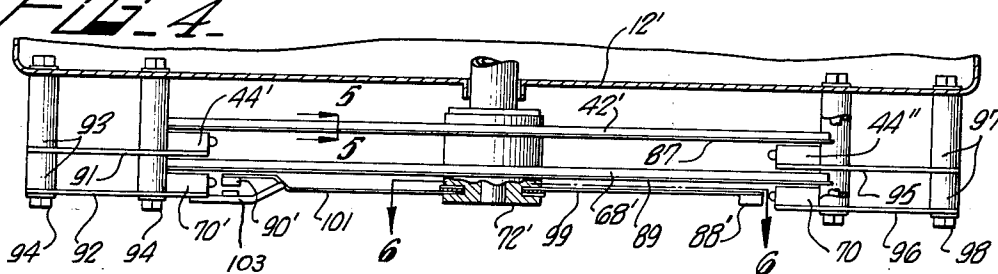
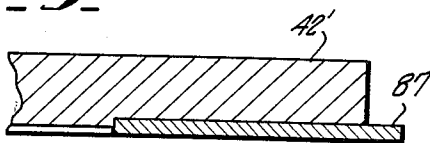


FIG. 5.



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4 Sheets-Sheet 3

FIG. 6.

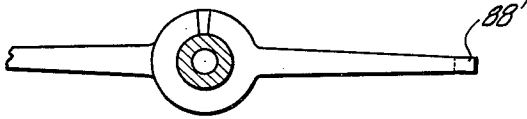


FIG. 7.

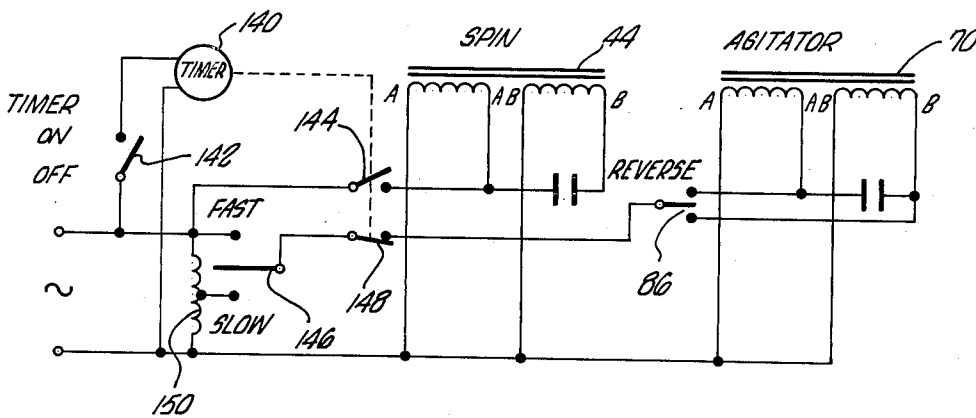
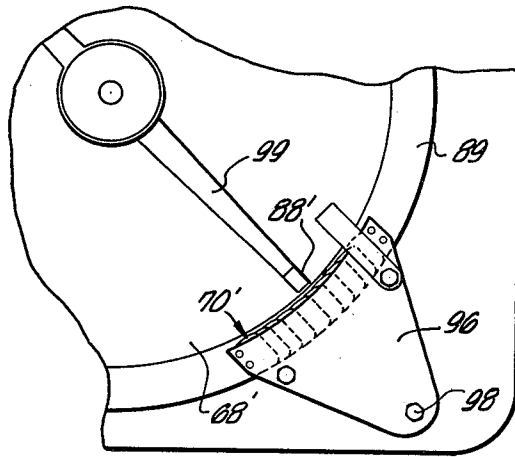


FIG. 10.

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3,194,032

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4 Sheets-Sheet 4

FIG. 8.

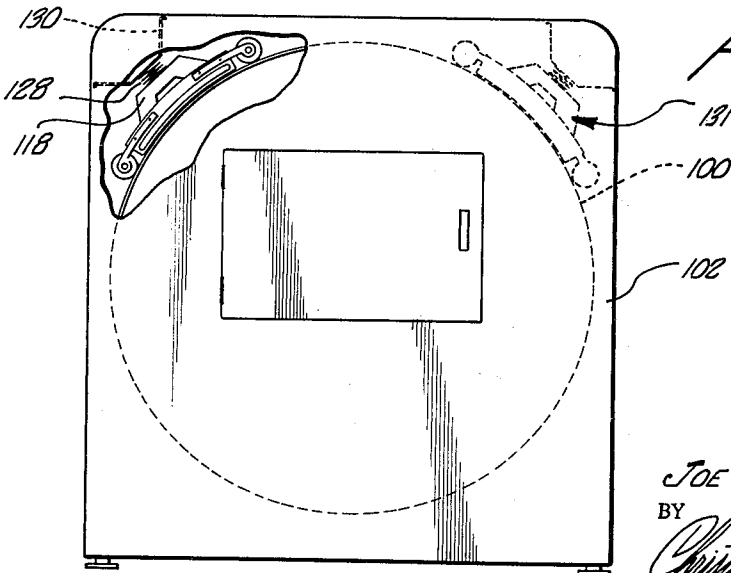
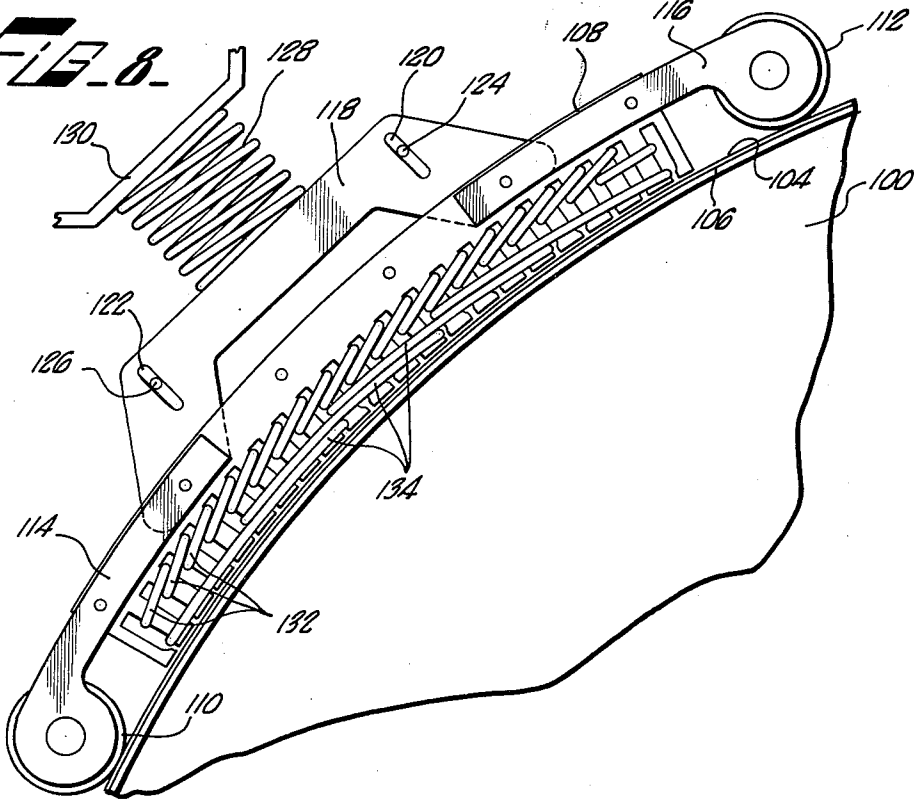


FIG. 9.

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1

3,194,032

WASHING MACHINE AND ELECTROMAGNETIC DRIVE SYSTEM THEREFOR

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17 Claims. (Cl. 68—23)

This invention relates to automatic washing machines and the like, and more particularly is concerned with an improved drive arrangement for spinner-type automatic home laundry equipment.

Substantially all home laundry washing machines on the market today utilize the spinner system for removing water from the clothes. Washing action may be either imparted by a reciprocating agitator or by revolving the spinner at low speed around a horizontal axis to impart a tumbling action to the clothes. Such machines require a drive mechanism which is capable of imparting high rotational speeds to the spinner basket during the drying cycle and imparting the required tumbling action or agitator action during the washing cycle. In addition, many machines are designed to provide different speeds of the agitator to provide a gentle or a vigorous washing action at the selection of the operator.

Intricate mechanical mechanisms have been developed utilizing gears and clutches by which the constant speed rotary motion of an electric motor may be translated into the various drive motions required by the washing machine, i.e., the high speed spin action for the spinner basket and the multi-speed reciprocating motion of the agitator or the slow tumbling speed action of the tumbling-type machine. Such drive mechanisms, because of their mechanical design and complexity, are costly in their manufacture, noisy in their operation, and subject to wear and mechanical failure resulting in substantial maintenance cost to the user.

The present invention is directed to an improved drive arrangement which can be incorporated in either the agitator-type machine or the tumbler-type machine. The drive provides the high speed necessary for the spin drying action, and the low speed reciprocating motion for the washing action. The drive is entirely electrical, requiring no moving parts other than the rotary support for the spin basket and the agitator. In addition to being substantially free from mechanical wear, the drive arrangement of the present invention is extremely quiet in its operation. The speed and direction of the drive can be readily controlled electrically, eliminating the need for electromechanically operated clutch devices and the like found in conventional automatic washers.

These and other advantages of the present invention are accomplished by means of a unique motor drive arrangement incorporating the principles of the eddy-current type linear actuator. In brief, the washing machine of the present invention incorporates a rotatable spin basket to which is secured a large diameter continuous circular conductive strip which may be either in the form of a flat annular disk, or a cylindrical strip secured directly to the spin basket and concentric with the rotating axis thereof. A motor stator in the form of a multiple pole magnetic core with distributed polyphase windings thereon is disposed adjacent a small section of the strip and is mounted in fixed relation to the rotatable spin basket so as to maintain a small air gap between the annular conductive strip and the pole faces of the stator. The stator windings are excited by an alternating current in a manner that effectively generates a moving field which sweeps along the length of the stator. The moving field induces eddy-currents in the conductive strip, which in turn generate a counter field that interacts with the moving

2

field to produce a force on the conductive strip tending to move the strip and produce a torque on the spin basket. As in the conventional eddy-current type motor, the conductive strip, being endless, moves past the stator at a speed approaching the speed at which the moving field sweeps across the stator. The latter speed is determined by the spacing between the poles, and the frequency of the alternating current produced in the field. In the agitator-type washer, a similar conductive annular strip and associated stator are associated with the agitator, the direction of torque produced by the stator on the conductive strip being reversed electrically by suitable means to produce a reciprocating or reversible drive action for the agitator.

For a more complete understanding of the invention, reference should be made to the accompanying drawings, wherein:

FIGURE 1 is a sectional view partially cut away showing the invention as embodied in an agitator-type washing machine;

FIGURE 2 is a sectional view taken on the line 2—2 of FIGURE 1;

FIGURE 3 is a partially schematic view showing the stator windings;

FIGURE 4 is a partial sectional view showing a modification of the drive of FIGURE 1;

FIGURE 5 is a sectional view taken on line 5—5 of FIGURE 4;

FIGURE 6 is a partial sectional view taken on the line 6—6 of FIGURE 4;

FIGURE 7 is a cut away bottom view of the embodiment of FIGURE 4;

FIGURES 8 and 9 illustrate a further embodiment of the invention as applied to a tumbler-type machine; and

FIGURE 10 is a schematic wiring diagram of the machine control.

Referring to the embodiment of FIGURES 1—3 in detail, the numeral 10 indicates the outer frame and enclosure of a washing machine. As in the conventional agitator-type washing machine, the top of the encasing frame is open to receive the clothes. A suitable lid or cover (not shown) may be provided. The washing machine includes a water tight tub 12 positioned within the encasing frame 10. The tub is normally suspended from the frame 10 so that it can move laterally to adjust for any unbalanced loads. To this end, hanger members 14 are pivotally secured at their upper ends to brackets 16 associated with the frame 10 and pivotally secured at their lower ends to brackets 18 associated with the tub 12. The usual means (not shown) is provided for filling and emptying the tub during the washing cycle.

Rotatably supported within the tub 12 is a spinner basket indicated generally at 20. The spinner basket 20 is generally perforated to permit passage of water through the wall of the basket. The basket 20 is formed with a central hub 22 which is secured to a hollow drive shaft 24 that extends through the bottom of the tub 12. The shaft is journaled in a pair of sleeve bearings 26 and 28, the bearings being supported from the tub 12 by a sleeve 30 secured to an annular flange 32 formed in the bottom of the tub 12. A shoulder 34 on the shaft 24 rests against the upper edge of the sleeve 26 to provide thrust bearing support for the shaft 24 and associated spinner basket 20 in relation to the tub 12.

An agitator 36 of conventional design extends concentrically over the hub 22 of the spinner basket 20. The upper end of the agitator 36 is secured to a shaft 38 extending through the hollow shaft 24. A sleeve bearing 40 pressed in the upper end of the shaft 24 gives vertical thrust support and rotatably aligns the shaft 38 within the hollow shaft 24.

3

According to the present invention, high speed rotational motion is imparted to the basket 20 through a unique drive arrangement. The drive consists of what in principle of operation is an eddy-current type motor including a nonmagnetic rotor in the form of a disk 42 and a multiple-pole stator 44. The disk 42, which is preferably made of a light nonmagnetic conductive material such as aluminum, is provided with a hub 46 which is riveted or otherwise secured to the center of the disk. The hub 46 is journaled on the shaft 38 and is secured to the hollow shaft 24 by means of integral flange 48 formed on the lower end of the shaft 24. The hub is secured to the flange 48 by screws 50. The outer periphery of the disk 42 is reduced in thickness as indicated at 52. The outer radius of the disk is comparable to the radius of the spin basket to provide high torque.

A similar drive arrangement is provided for the agitator 36. The drive motor for the agitator includes a disk 68 and a stator 70. The disk 68, which is substantially identical to the disk 42 and is made of aluminum or other nonmagnetic conductive material, is provided with a hub 72 that is secured to the shaft 38 so that rotation of the disk 68 imparts rotation to the agitator 36. The disk 68 is reduced in thickness at the outer perimeter as indicated at 74. Both the disks 42 and 68 may be provided with radial slits, such as indicated at 75 in FIGURE 2, to form clearly defined current paths in the rotors. A stator core 76 of similar construction to the stator core 53 is positioned below the disk 68. A block 60 is positioned between the disks and the core is thus common to the magnetic circuit of both stators. The entire stator assembly is preferably potted in an epoxy resin to protect the windings and to give added strength to the assembly.

The construction of the stators 44 and 70 is shown by FIGURES 1, 2 and 3. Each stator includes a laminated core structure 53 which, as shown in FIGURE 2, is arcuate in shape in the longitudinal direction to conform with the radius of the outer edge of the associated disk. As shown in FIGURE 3, the laminations of the core structure 53 are notched to form poles 54 with intermediate slots 56.

Each stator shares the common laminated core 60 of magnetic material positioned between the disk 42 and the disk 68. The stator cores 53, 60 and 70 may be held in spaced relationship by end brackets 62 and 64 to form a pair of air gaps through which the reduced thickness portions of the disks 42 and 68 pass. The stator 44 is mounted in fixed relation to the tub 12 by a suitable support bracket 66 to which the core 53 of the stator is secured.

The two stators 44 and 70 are shown as having identical core structures but they are wound differently to provide a difference in drive speed. The spin basket preferably spins at about 480 r.p.m. while the agitator preferably should make about 60 cycles per minute. This difference in speed is provided by the difference in the pitch of the windings. Thus the stator 70 is provided with a plurality of coils series connected in two groups, series windings A and B. As shown in FIGURE 3, each coil of winding A lies in a pair of slots separated by one slot, the coils occupying all the odd numbered slots. The coils of the winding B occupy the even numbered slots. The coils forming each group of windings are connected such that poles of opposite magnetic polarity are produced in response to current flow in one direction through the winding. The poles produced by the two groups of windings are arranged in interdigital fashion. For operation from a single phase A.C. source, one group of windings is connected through a phase splitting capacitor 82. The stator thus generates a moving magnetic field in the manner of a conventional split phase induction motor. The direction of the moving field can be reversed by means of a switch 86 which is arranged to connect the phase splitting capacitor 82 in series with one or the other of the two windings. The reversing feature is im-

4

portant in providing a reciprocating motion to the agitator 36, as hereinafter described. In stator 44 the coils are wound differently. Three concentrically wound coils are provided for each magnetic pole and the coils are distributed as shown in FIGURE 3. With the winding arrangement of the stator 44, there is a spacing equivalent to eight slots between adjacent magnetic poles whereas in the stator 70 described above there is a spacing of two slots between poles.

In operation, the moving magnetic field produced in the gap of the stator induces eddy-currents in the associated conductive disk if the disk is moving at a speed such that the disk is cutting flux in the gap. The eddy-currents in turn generate a magnetic field. The interaction between the two fields produces a torque on the rotating disk causing it to rotate. The disk tries to rotate at a speed at which the outer periphery moves in synchronism with the moving field. Any slippage between the disk and the moving field results in a reaction torque on the disk, the greater the slippage, the greater the torque. Because of the large diameter of the disk, which may be several feet, substantial torques can be developed even though the stator structure is relatively small in terms of the amount of copper and iron required as compared to the stator of a conventional washing machine induction motor. Because of the difference in the spacing of the magnetic poles in the two stators 44 and 70, there is a four to one ratio in the synchronous speed of the two drives. However, the agitator unit, because it is continually being reversed, operates at substantially twice the slip, so that the difference in speed is more nearly eight to one, corresponding to the desired ratio of 480 r.p.m. to 60 cycles per minute between the spin speed and agitator speed.

As mentioned above, the direction in which the field moves across the face of the stator core is determined by the relative phase of the two groups of windings, which may be referred to as the primary winding and the quadrature winding. This is controllable by the reversing switch 86 in the case of the agitator drive. One group of windings can be caused to lead or lag by 90° the phase of the excitation current in the other group of windings so that the windings are excited in phase quadrature. The switch 86 may be arranged to be operated by the movement of the agitator and associated disk 68. The switch 86 may be a mechanical limit switch which is tripped by stops on the disk 68. Preferably, however, the switch 86 is a common type of polarized magnetic reed switch which is operated magnetically by permanent magnets carried on the disk 68. As shown in FIGURE 1, the switch 86 is mounted below the disk 68 on a support extending out from the stator assembly 70. Permanent magnets 88 and 90 are secured to the bottom side of the disk 68 in position to pass over the switch 86 as the disk rotates, preferably at diametrically opposite positions. The magnets 88 and 90 are oppositely polarized so that one magnet actuates the switch 86 in one direction and the other magnet actuates the switch in the opposite direction. Thus the direction of rotation of the agitator is reversed as the respective magnets 88 and 90 move into position adjacent the switch 86.

An alternative embodiment is shown in FIGURES 4-7 in which similar elements are given the same numbers as in FIGURES 1-3 but primed. Here the disks 42' and 68' are made of magnetic material, such as steel. A thin flat annular strip of aluminum, as indicated at 87 and 89, is secured to and extends around the outer periphery of each of the disks. Stators 44' and 70' are mounted respectively below the disk 42' and the disk 68'. The stators are supported by plates 91 and 92 secured to the bottom of the tub 12' by spacers 93 and associated bolts 94. The disks 42' and 68' being of magnetic material provide the magnetic circuit path for the flux produced by the respective stators. Operation is substantially the same as described above. However, since the disks ro-

5

tate past the stators, heating of the disks due to eddy-currents and hysteresis losses is more easily controlled than in the case of the single common core block 60 of the arrangement of FIGURE 1.

Since the magnetic material of the disks is attracted to the stators, the disks are unevenly loaded producing an undesirable deflection of the disks and torque on the drive shafts and bearings. This load can be balanced and additional drive torque produced by providing a second pair of stators 44" and 70" on the diametrically opposite side of the disks. The stators are similarly supported by plates 95 and 96 secured to the bottom of the tube 12' by spacers 97 and associated bolts 98.

In order to achieve a more gentle washing action, it may be desirable to change the angle through which the agitator reciprocates. At the same time, it may also be desirable to have the agitator advance slightly in one direction with each cycle of operation to provide better distribution of the heat generated in the disk by the eddy-currents. One example of an arrangement by which this may be accomplished is shown in FIGURES 4 and 6. In this modified arrangement, the magnets 88' and 90' are mounted on the end of a pair of arms 99 and 101 respectively. As seen in FIGURE 6, the arms are formed with collars which frictionally engage annular grooves in the hub 72'. The angle between the arms 99 and 101 may be adjusted to provide a means for varying the angle through which the agitator is rotated. By letting the arm 101 engage a stop 103 just as the agitator is reversing, the position of the arms 99 and 101 relative to the disk 68' can be changed slightly with each cycle of operation. Thus the disk 68' advances in one direction by a small amount on successive reversing cycles.

As an alternative, the switch 86 can be operated from a timer control so that the operation of the agitator will be on a time cycle rather than on a position controlled cycle. Changing the time cycle will alter the angle of drive during the reversing cycle.

Referring to FIGURES 8 and 9, a modified drive arrangement according to the present invention is shown as applied to a tumbler-type machine, such as a drier or a washer-drier combination. While the disk arrangement described above may be applied to the tumbler-type machine, the arrangement shown in FIGURES 8 and 9 provides a saving of space as to the overall depth of the machine. A tumbler drum 100 is journaled for rotation about a horizontal axis within the frame enclosure 102 of the washer-drier machine in conventional fashion. The drive element for the tumbler drum 100 includes a continuous band 104 of conductive nonmagnetic material, such as copper. The band 104 extends around the outer periphery of the drum 100. Between the band 104 and the drum 100 is an intermediate band 106 made of magnetic material. If the drum 100 is made of magnetic material, the band 106 may be eliminated. A stator core 108 is made up of a stack of slotted laminations which are arcuate in shape to conform to the outer radius of the conductive band 104. Nylon wheels 110 and 112 are rotatably supported from the core 108 by suitable support brackets 114 and 116. The wheels 110 and 112 are in rolling contact with the outer periphery of the band 104 and are arranged to maintain the required air gap between the face of the core 108 and the outer surface of the conductive band 104. The core 108 is anchored to the frame of the machine by a guide member 118 which has a pair of elongated slots 120 and 122. The slots receive guide pins 124 and 126 respectively, the guide pins being rigidly supported from the frame of the machine. A spring 128 extends between a portion 130 of the frame of the machine and the guide member 118 so as to urge the wheels 110 and 112 into engagement with the surface of the strip 104. In this manner, the stator assembly can be held in fixed relation to the outer periphery of the drum regardless of slight eccentricities or out of roundness of the drum. The slotted

6

stator is wound with a polyphase winding to provide a moving magnetic field which sweeps along the length of the air gap in the same manner as described in connection with the stator of the drive arrangement of FIGURE 1.

Multispeed operation to provide a slow tumbling action or a high speed spinning action may be achieved in several ways. The apparent speed at which the field sweeps across the face of the stator depends on the frequency of the exciting current and the physical spacing between the poles. The latter can be controlled by the arrangement of the windings in the slots so that there can be one pole for every pair of slots or one pole for every two or more pairs of slots. The more slots per pole, the further the moving field travels per cycle of exciting current. A second stator assembly may be provided, as indicated at 131, FIGURE 9, with a different winding pitch to provide a second drive of different speed using a common rotor element. Alternatively, two groups of windings may be provided on one stator, the coils of one winding linking adjacent slots and the coils of the other set of windings linking a larger group of slots. For example, the two different winding arrangements of FIGURE 3 could be used on the stator 108 and the stator drive 131. However, the two groups of polyphase windings may be wound on the same core by providing slightly deeper slots. In FIGURE 8, the stator core 108 is shown as having two groups of windings. One group includes coils 132 which link alternate slots, in the manner of the stator 70 described above. The other group includes coils 134 which link every eighth slot, in the manner of the stator 44 described above, giving a 4 to 1 ratio in the two synchronous speeds. If a greater ratio of speed is desired, the number of slots spanned by the spin drive coils may be increased.

While different drive speeds can be achieved by modifying the distance between poles, speed can be controlled to some extent by voltage and also by controlling the frequency of the power source. The speed as a function of load is different with different voltages, the lower the voltage the greater the slip between the rotor and the moving field. Frequency changers using solid state devices make speed control by changing the frequency practical for commercial washing machines.

In the case of the tumbler-type machine of FIGURES 8 and 9, an intermediate spin speed is desirable to prevent sticking of the clothes to the tumbler walls when they are wet. To this end, the first stator drive unit 108 would have two groups of windings and the second stator drive unit, indicated at 131, would also utilize the same annular rotor band 104. The stator unit 131 may be wound with a different spacing between poles to achieve a third drive speed.

FIGURE 10 shows a typical control circuit in which the machine is controlled by a timer device 140. The timer is initially set and then turned on by a switch 142, which may be controlled by the timer control knob in conventional fashion. An A.C. source is connected through a switch 144 operated by the timer to the spin stator 44. The source is connected through a Fast-Slow switch 146, a switch 148 also operated by the timer oppositely to switch 144 and the reversing switch 86 to the agitator stator 70. The Fast-Slow switch 146 connects the agitator stator 70 to a selected tap on an autotransformer 150. By setting the switch 146 to the Slow position, a lower voltage is applied to the agitator stator. The reversing switch 86 is operated, as described above in connection with FIGURE 1, to cause the agitator to reciprocate. The timer is arranged to operate the agitator for any controlled length of time and then to operate the spinner to remove the wash water.

From the above description, it will be recognized that the present invention provides an improved drive for a washing machine which eliminates the need for any mechanical transmission. By eliminating such transmission, the design of the washing machine is greatly sim-

plified, eliminating a source of expense, noise, and operating failure. The drive arrangement is flexible in that by simple electrical controls and design of the stator circuit, the drive can be modified to achieve high speed spinning action, lower speed tumbling action, or reciprocating agitating action.

What is claimed is:

1. In a washing machine, the combination of a rotatable spin basket disposed within the washing machine, an elongated linear motor stator, means attaching the stator to the washing machine, means providing an annular strip of nonmagnetic, electrically conductive material rotatable with the spin basket around a common axis, a portion of the strip passing adjacent the stator so that the strip forms a moving rotor element with the linear motor stator, and a magnetic path return element of magnetic material positioned on the opposite side of the strip from the stator so that the magnetic path return element is disposed adjacent the stator to form a magnetic gap, the strip moving through said gap.

2. The apparatus of claim 1 in which said means providing a strip includes a flat disk attached to the basket at its axis of rotation and having a thin outer edge, the strip being formed by the thin outer edge of the disk.

3. The apparatus of claim 1 in which the annular strip is substantially cylindrical in configuration and disposed about and secured to the spin basket.

4. The apparatus of claim 3 in which the annular strip and the magnetic path return element are connected together in concentric relationship.

5. Apparatus as defined in claim 4 further including spring means for urging the stator toward the annular strip, and roller means attached to the stator for holding the stator a preselected distance from the annular strip.

6. A clothes washing machine comprising a frame, a clothes receiving basket rotatably mounted on said frame, drive means for said basket including a stator fixed to said frame at a position radially spaced from the axis of rotation of said basket, said stator having a plurality of poles and slots arranged to form a generally arcuate magnetic drive zone having an angular extent which encompasses a minor segment of the circumference of said basket, a plurality of electric coils in said slots forming primary and quadrature windings for operation on standard single phase alternating current and capable of developing when energized a travelling electromagnetic field, a circumferential drive member mounted in driving relation to said basket having a peripheral nonmagnetic conductive portion adapted to move through said zone within said field to develop induced currents therein with resultant creating of a driving force thereon, the radius of said member at said portion and the spacing of said zone from said axis being comparable to the radius of said basket.

7. A clothes washing machine comprising a frame, a clothes receiving basket rotatably mounted on said frame, drive means for said basket including a stator fixed to said frame at a position radially spaced from the axis of rotation of said basket, said stator having a plurality of poles and slots arranged to form a generally arcuate magnetic drive zone having an angular extent which encompasses a minor segment of the circumference of said basket, a plurality of electric coils in said slots forming primary and quadrature windings for operation on standard single phase alternating current and capable of developing when energized a travelling electromagnetic field, a circumferential drive member mounted in driving relation to said basket having a peripheral nonmagnetic conductive portion adapted to move through said zone within said field to develop induced currents therein with resultant creating of a driving force thereon, the arcuate spacing of said poles being correlated with the diameter of said drive member to provide a rate of rotation of said basket sufficient to spin-dry clothes contained therein.

8. In a washing machine having a rotatable spin basket,

drive means comprising a large diameter rotor member connected to the spin basket and rotatable therewith, the rotor member having an outer annular portion of thin conductive nonmagnetic material, and magnetic means for generating a moving magnetic field across an elongated air gap when energized from an alternating current source, the thin outer annular portion of said rotor member passing through said air gap.

9. A washing machine comprising a spin basket, an axial shaft for rotating the spin basket, a large diameter disk mounted on the shaft and rotatable with the shaft and basket, the outer periphery of the disk being made of nonmagnetic electrically conductive material, a stator device including a pair of elongated magnetic core elements spaced apart by an air gap, the stator device being positioned so that a portion of the outer periphery of the disk passes through the air gap, at least one of the core elements being slotted in a direction substantially transverse to the direction of movement of the disk periphery, a plurality of conductive coils extending through said slots, the coils being connected to form two groups of windings, each group of windings when energized generating flux of alternate polarity in spaced positions along the gap in the direction of movement of the disk periphery, means for connecting the two groups of windings to an alternating current source in phase quadrature relationship, an agitator, a concentric shaft coaxial with said first-mentioned shaft for rotating the agitator about a common axis with the spin basket, a second large diameter disk mounted on the agitator shaft, the outer periphery of the second disk being made of nonmagnetic electrically conductive material, a stator device including a pair of elongated magnetic core elements spaced apart by an air gap, the stator device being positioned so that a portion of the outer periphery of the disk passes through the air gap, at least one of the core elements being slotted in a direction substantially transverse to the direction of movement of the disk periphery, a plurality of conductive coils extending through said slots, the coils being connected to form two groups of windings, each group of windings when energized generating flux of alternate polarity in spaced positions along the gap in the direction of movement of the disk periphery, means for connecting the two groups of windings to an alternating current source in phase quadrature relationship, and means for reversing the phase of the excitation current on one of said groups of windings of the second stator to reverse the direction of drive of the agitator.

10. In a washing machine having a spin basket and a coaxially rotatable agitator within the spin basket, a pair of stator units, each stator including a slotted elongated core and windings wound in the core, means including the windings for generating a moving magnetic field in response to an exciting current, first rotor means rotatable with the spin basket including a large diameter annular strip of nonmagnetic material, means for mounting one of the stator units with its slotted surface positioned adjacent the surface of the strip of the first rotor means, second rotor means rotatable with the agitator including a large diameter annular strip of nonmagnetic material, means for mounting the other of the stator units with its slotted surface positioned adjacent the strip of the second rotor means, and means for electrically reversing the direction of movement of the magnetic field produced by the stator associated with the second rotor means.

11. A washing machine comprising a spin basket, an axial shaft for rotating the spin basket, a large diameter disk mounted on the shaft and rotatable with the shaft and basket, the outer periphery of the disk being made of nonmagnetic electrically conductive material, a stator device including a pair of elongated magnetic core elements spaced apart by an air gap, the stator device being positioned so that a portion of the outer periphery of the disk passes through the air gap, at least one of the core elements being slotted in a direction substan-

tially transverse to the direction of movement of the disk periphery, a plurality of conductive coils extending through said slots, the coils being connected to form two groups of windings, each group of windings when energized generating flux of alternate polarity in spaced positions along the gap in the direction of movement of the disk periphery, and means for connecting the two groups of windings to an alternating current source in phase quadrature relationship.

12. In a washing machine having a rotatable spin basket, drive means comprising an endless circular conductive nonmagnetic rotor member, means for connecting the rotor member to the spin basket such that the rotor turns with the basket, the rotor having a large outer diameter, a stator including a slotted magnetic core and current conducting coils wound in the slots, means for mounting the stator adjacent the outer periphery of the rotor with the core extending along a small portion of the outer periphery of the rotor surface and the slots being substantially transverse to the direction of movement of the rotor past the stator, the coils being connected in polyphase fashion to generate a moving field when excited by an alternating current, the moving field producing a force on the rotor in a direction to provide a torque about the axis of rotation of the spin basket.

13. Apparatus as defined in claim 12 wherein the rotor member is in the form of a flat band extending around the periphery of the spin basket and the stator core is positioned radially therefrom.

14. Apparatus as defined in claim 13 wherein the rotor member is in the form of a thin flat disk and the stator core is positioned to one side of the disk.

15. In a washing machine having a rotatable spin basket and an agitator driven by concentric shafts, drive means comprising a pair of large diameter disks having outer annular portions of conductive nonmagnetic material, the disks being directly mounted on the respective shafts, first magnetic means for generating a moving magnetic field across an elongated air gap when energized from an alternating current source, the outer portion of one of said disks passing through said air gap, second magnetic means for generating a moving magnetic field across an elongated air gap when energized from an alternating current source, the outer portion of the other one of said disks passing through said air gap, means including a switch for reversing the direction of movement of the magnetic field generated by the first magnetic means, and means for actuating the switch periodically to reverse the movement of the magnetic field.

16. In a multiple speed motor drive, the combination

of a rotatable member, a plurality of elongated linear motor stator means each of limited arcuate extent and in spaced relation to each other, means for mounting said stator means in fixed relation, means providing an annular nonmagnetic electrical conductor secured to and rotatable with said member, said conductor passing through the magnetic fields of said plurality of stator means, and means for energizing said stator means selectively to produce thereby magnetic fields travelling at different speeds with resultant induction of eddy-currents in said conductor to cause the driving of said member at different selected speeds.

17. An electromagnetic drive system for a rotatable member comprising an annular magnetic element, an annular nonmagnetic conductor fixed in driving relation to said member and in superimposed relation to said magnetic element, first stator means including a plurality of poles and slots of limited arcuate extent defining an arcuate drive zone in closely spaced magnetic driving relation with said conductor, coil means in said slots and phase displacement means connected to effect a linearly travelling magnetic field along the length of said zone at a first rate in response to the application of alternating current thereto, and second stator means in spaced relation to said first stator means having a further set of poles and slots of limited arcuate extent defining a second arcuate drive zone in closely spaced magnetic driving relation to said conductor, and further coil means associated with said second stator means including phase displacement means connected to effect a second linearly travelling magnetic field along the length of said second zone at a rate different from said first rate, said annular magnetic element forming a magnetic return path common to each of said first and second stator means.

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