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Sikamori et al.

[11] **3,872,694**

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[54] **WASHING MACHINE**

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[73] Assignee: **Hitachi, Ltd.,** Tokyo, Japan

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[30] **Foreign Application Priority Data**

May 12, 1972 Japan 47-46352

[52] **U.S. Cl.** ..... **68/12 R,** 68/23.6

[51] **Int. Cl.** **D06f 23/04,** D06f 33/02

[58] **Field of Search** ..... 68/12 R, 23, 23.6, 23.7, 68/24, 133; 318/207 R

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Assistant Examiner—Philip R. Coe
Attorney, Agent, or Firm—Craig & Antonelli

[57] **ABSTRACT**

A washing machine with a drying basket rotatably provided in a water tank and with a pulsator provided at the bottom portion of the drying basket has a difference between the optimum number of revolutions of the drying basket and that of the pulsator. The washing machine is provided with a pole change motor for driving the drying basket and the pulsator wherein the motor is driven with a large number of poles in washing and rinsing operations and with a small number of poles in a drying operation to drive the dehydrating basket and the pulsator at an optimum speed of rotation.

7 Claims, 8 Drawing Figures

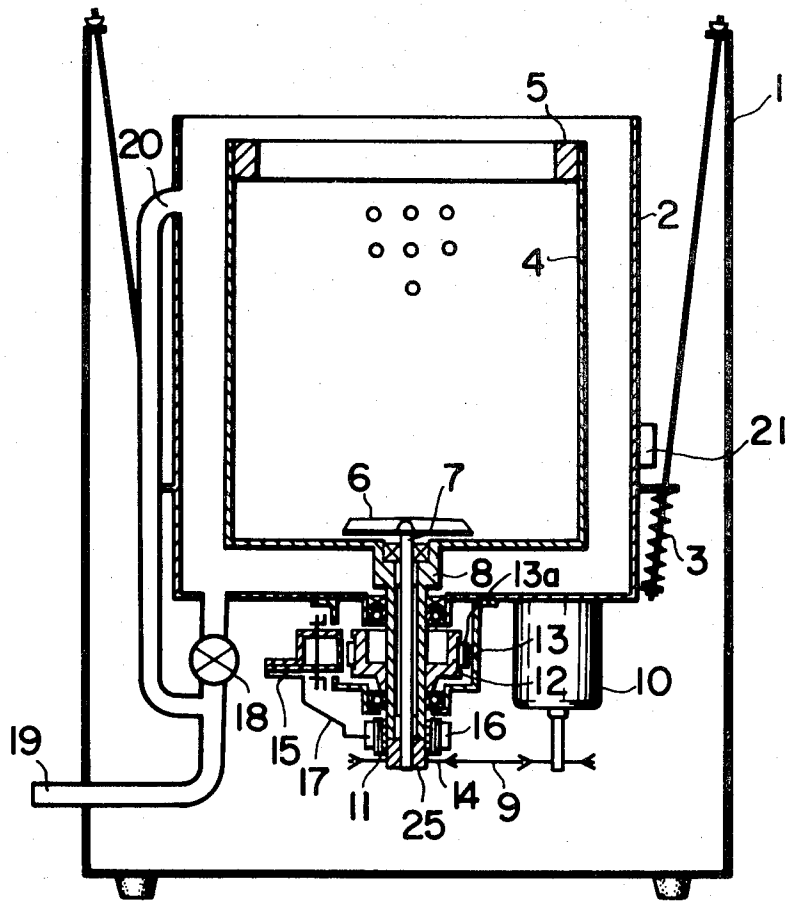

FIG. 1

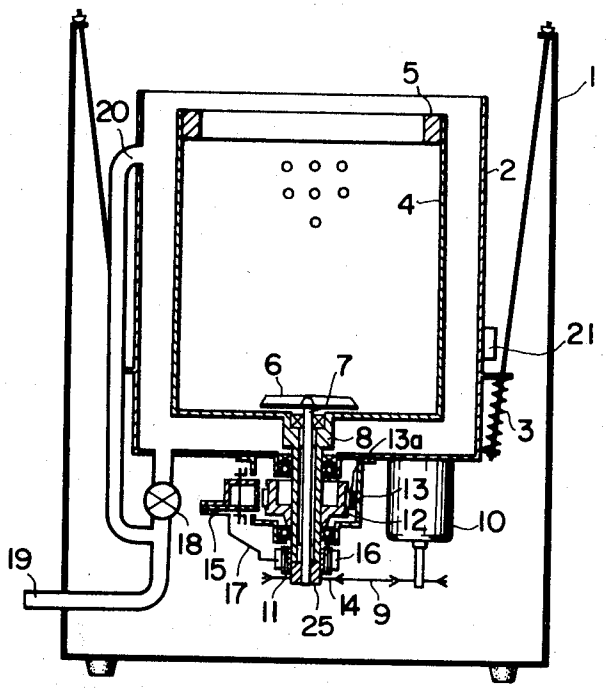
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FIG. 3

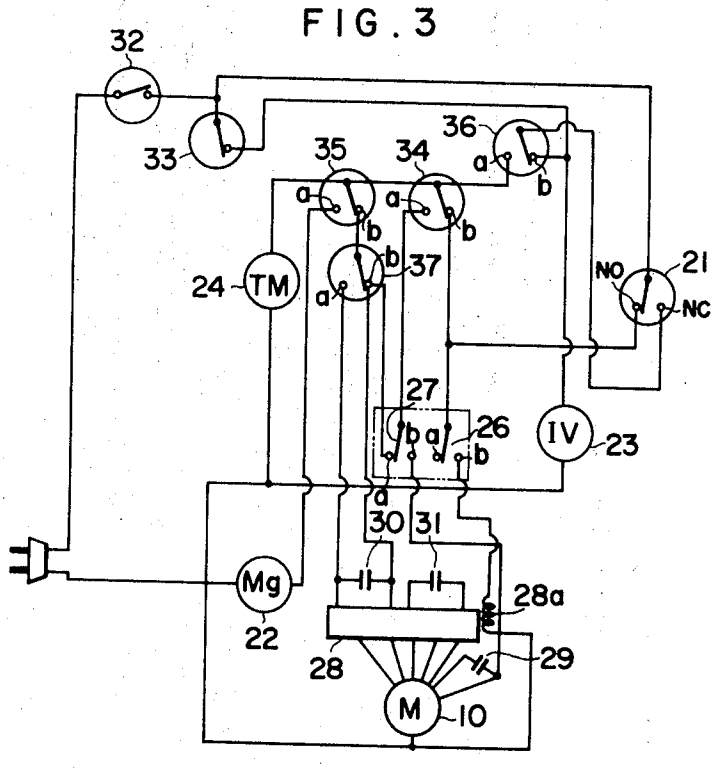
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FIG. 2

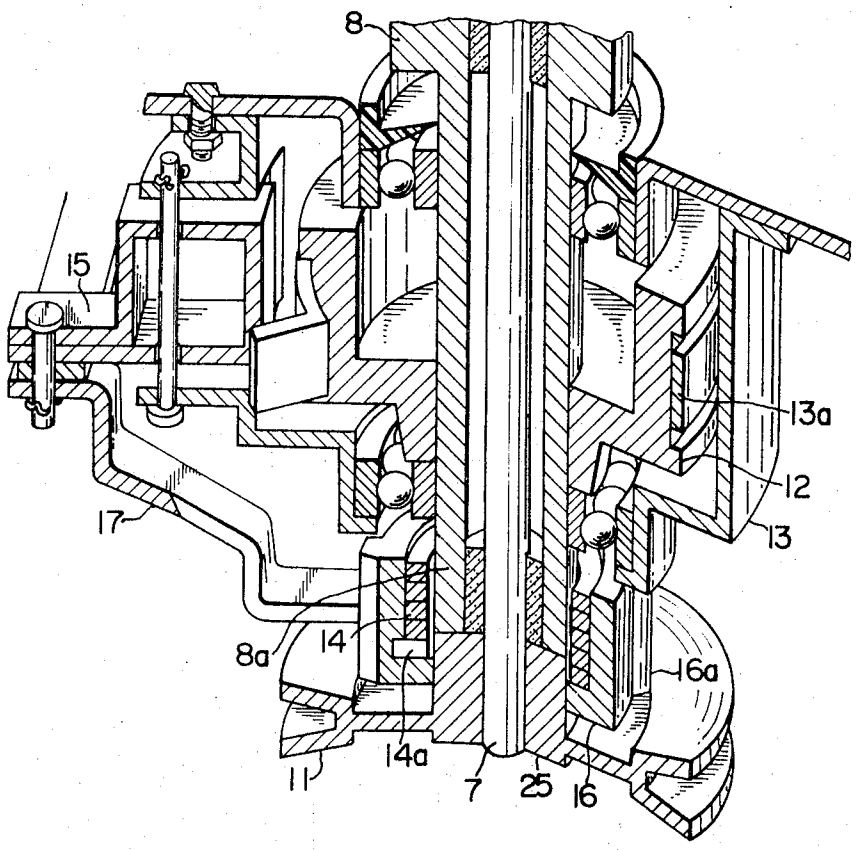


FIG. 4

PROGRAM NOS	WASHING WATER FLOW	DRYING REVOLUTION	SELECTION SWITCH 26	SELECTION SWITCH 27	POLE NUMBER OF MOTOR AT DRYING	POLE NUMBER OF MOTOR AT WASHING
1	STRONG	STRONG	a	b	4	2
2	STRONG	WEAK	a	a	4	4
3	WEAK	STRONG	b	b	6	2
4	WEAK	WEAK	b	a	6	4

FIG. 5

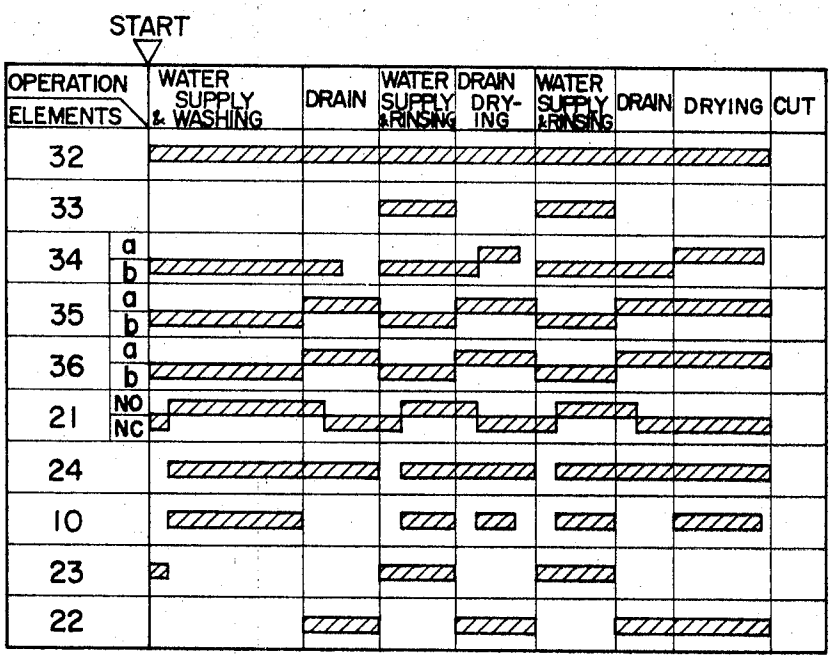


FIG. 6

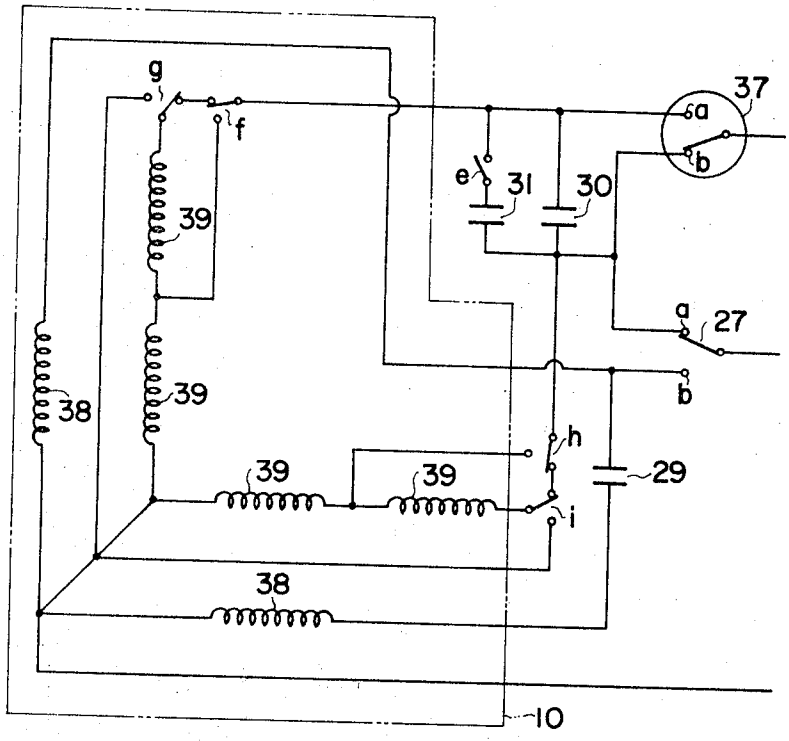


FIG. 7

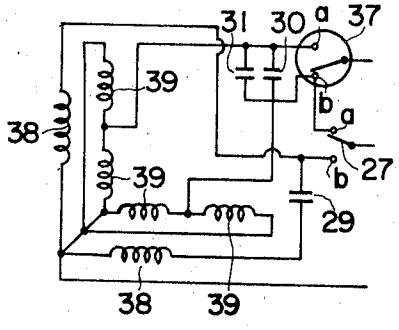
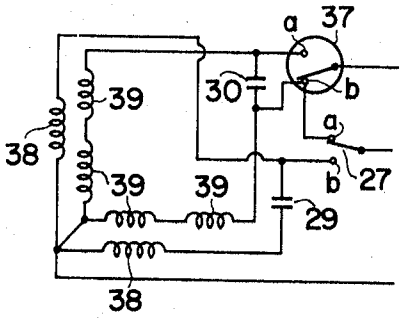


FIG. 8



WASHING MACHINE

The present invention relates to a washing machine, and more particularly to a washing machine provided with a pulsator at the central bottom portion of a basket disposed within a water tank in coaxial relation thereto with water reserved therein in which the pulsator is driven for washing and rinsing operations and the basket is rotated at a high speed to effect drying after the water in the water tank is drained.

A washing machine provided with a water tank, basket and pulsator is well known in U.S. Pat. No. 3,306,082. The disclosed well known washing machine includes a pulsator and a basket driven at the same rotational speed, and thus had the drawbacks of too much increased rotational speed of the pulsator with resultant great damages to cloths and articles to be washed and of too much reduced rotational speed of the basket, resulting in insufficient drying.

It has been known that the washing machine of the kind with rotational speed of 400 to 500 revolutions per minute is most suitable for general domestic use from points of view of damages to the cloths and articles to be washed and of a washing rate. It is, on the other hand, known that the greater the rotational speed of the basket, the more the drying rate is improved. Therefore, the speed of 800 to 1,000 revolutions per minute is practically preferable in view of the fact that the drying rate is maximized at the higher speed.

Thus, the conventional washing machine was provided with two motors for separately driving the pulsator and the basket because of the difference of the optimum rotational speed therebetween; alternatively, a system has been proposed in the case of use of one motor wherein a power transmission line from the motor to the pulsator is made different from that from the motor to the basket in reduction ratio by the use of a reduction gear device or belts wound around between motor and basket shafts and between motor and pulsator shafts in two-stepped manner, respectively.

These conventional washing machines, however, have the drawbacks that: the washing machine provided with two driving motors has one of them stopped either during washing or during drying operations and hence the provision of the two motors which are not operated simultaneously results in expensive manufacturing cost; the reduction gear system with one motor gives rise to a fear of generating noises during driving if no critical tolerance of the dimension of the gear assembly (i.e., pinion and gear) as well as that between their axes has been considered and thus the enhanced precision of parts results in much work required for machining and eventually in high manufacturing cost; and the belts disposed around in two-stepped manner can not successfully hold their tension constant because on the same shaft of the motor there are provided two sets of pulleys different from each other in reduction ratio with the belts different in length disposed around their corresponding pulleys, respectively, and further the relative velocity developed between the pulsator and the basket during the drying operation, results in the break-down of the washed cloths and articles when they are disposed on both the bottom of the pulsator and the basket in bridged relationship.

On the other hand, there arises a request that the washing machine of the kind should be designed to be driven with a washing water flow selected in two strong and weak modes and with the rotational speed of the drying basket selected in two high and low modes in accordance to the kind of cloths and articles to be washed, respectively.

An object of the present invention is to provide a washing machine in which one motor is provided therein to obtain the optimum driving speeds for the pulsator and the basket without the need for making any use of expensive gear reduction devices.

Another object of the present invention is to provide a highly reliable washing machine free from large noises and failures by simplifying a power transmission line from a motor to the pulsator or to the basket.

A still further object of the present invention is to provide a washing machine programmable in four different modes by effecting selective drive of each of the pulsator and the basket in two modes with respect to its rotational speed.

The present invention is characterized in that a pole change motor is employed for its drive with a maximum pole number during a washing operation and with a minimum pole number during a drying operation.

The present invention will be described by way of embodiments in connection with the accompanying drawings, in which:

FIG. **1** is a longitudinal cross section of a washing machine according to the present invention;

FIG. **2** is a view showing in detail a clutch and break construction for selectively driving a drying basket and a pulsator of the washing machine shown in FIG. **1**;

FIG. **3** is a control circuit diagram of the washing machine;

FIG. **4** is a program chart for the operation of the washing machine;

FIG. **5** is a cam chart according to which a washing machine operates;

FIG. **6** is a circuit connection diagram for motor windings;

FIG. **7** is a connection diagram similar to that of FIG. **6** in which a motor is set with four-pole driving; and

FIG. **8** is a connection diagram similar to that of FIG. **6** in which a motor is set with six-pole driving.

In FIG. **1** there is shown a cylindrical water tank **2** with a bottom which is elastically suspended within a housing **1** by means of four suspension springs **3.** A basket **4** provided with a plurality of small drying holes on its circumferencial wall is disposed in the water tank **2** in coaxial relation thereto. On the upper end circumference of the basket **4** there is secured a balance ring **5** for absorbing vibrations occuring during the drying operation and on the central bottom portion thereof there is provided a pulsator **6.** A pulsator shaft **7** secured to the lower surface of the pulsator **6** passes through and extends downwardly through a hollow shaft **8** fixed to the lower bottom surface of the basket **4** with a pulley **11** secured at the lower end thereof. The hollow shaft **8** is rotatably supported within a brake housing **13** secured to the bottom portion of the water tank **2,** and a brake drum **12** is secured within the brake housing **13** to the hollow shaft **8** further extending downwardly therefrom to define a clutch boss portion **8***a* (FIG. **2**) around which a clutch spring **14** is wound. The clutch spring **14** is wound on the clutch boss portion **8***a* of the hollow shaft **8** and on the outer circumference of the boss **25** of the pulley **11** secured to the lower edge of the pulsator shaft **7,** in bridged relationship. The clutch spring **14** has a lower end **14***a* bent

back outwardly to engage with a coil collar **16** disposed at the outer circumference of the spring **14** as shown in detail in FIG. **2.** On the outer circumference of the coil collar **16** there is formed projections **16***a* (FIG. **2**) for engaging with a clutch lever **17.** The clutch spring **14** is deactuated in a state of the engagement of the projection with the clutch lever **17,** transmitting no drive power to the hollow shaft **8.**

A brake lever **15** is secured with the clutch lever **17,** and these levers are operated by the same magnet **22** (FIG. **3**). The actuation of the magnet **22** causes the brake lever **15** to be brought out of engagement with a brake shoe **13***a* and the clutch lever **17** to be brought out of engagement with the coil collar **16.** The pulley **11** is connected to a pulley of the motor **10** through a belt **9.** This construction of the clutch and break as described above is shown in detail in FIG. **2.**

A draining valve **18** is connected to the magnet **22** and adapted to be opened upon actuation thereof. Reference numeral **19** shows a draining hose, **20** an overflowing hole opened at the upper portion of the side wall of the water tank **2,** and **21** a pressure switch for controlling the level of water contained in the water tank **2.**

FIG. **3** shows an electric circuit diagram for the washing machine in which cam switches **32** to **37** are controlled by cam plates driven by a timer motor **24** in accordance with a cam chart shown in FIG. **5.** The cam switch **37,** not shown in FIG. **5,** serves as a reversing switch for alternately reversing the motor **10** in the cycle of about 30 seconds during the washing and rinsing operations for the purpose of reducing tangling conditions of the cloths and articles to be washed. There are shown a water supply valve **23** and manually operated selection switches **26, 27** serving to selectively change-over the washing and drying operations in the strong and weak modes. A relay **28** for changing the number of the pole has contacts *e, f, g, h* and *i* as shown in FIG. **6** and changes-over its contacts to a state as shown in FIG. **6** upon energization of a coil **28***a*.

A capacitor **29** is used when the motor **10** is driven with two poles and capacitors **30** and **31** are used for four-pole and six-pole driving of the motor, respectively. FIG. **6** shows a connection of the windings in the motor **10** in which windings **38** for use in the two-pole driving are comprised of main and auxiliary windings between which a capacitor **29** is connected. Windings **39** are adapted for use in both four and six pole drivings, and establish the four-pole driving when two windings are connected in parallel as shown in FIG. **7** and the six-pole driving when they are connected in series as shown in FIG. **8.** These windings **38** and **39** are inserted in corresponding slots of the motor **10.**

The four-pole and six-pole drivings of the motor require phase advancing capacitors having different capacitance, respectively, so that two capacitors **30** and **31** are provided which are connected in parallel at the four-pole driving and one capacitor **31** of which is disconnected from the circuit by means of the contact *e* (FIG. **6**) with only the other capacitor **30** operating at the six-pole driving.

FIGS. **7** and **8** show circuit diagrams at the time of energization and deenergization of the coil **28***a*, respectively, with the motor **10** driven with four poles upon the deenergization as shown in FIG. **7** and driven with six poles upon the energization as shown in FIG. **8.**

In operation, in driving the washing machine with the strong mode of the washing flow and strong mode of the drying revolution, i.e., in accordance with Program No. **1** in the operational chart of FIG. **4,** the selection switches **26** and **27** are manually connected to positions *a* and *b* (FIG. **3**), respectively. Then the timer is set to an initiating position whereupon the cam switch **32** is closed and a water supply valve **23** is actuated for water supply through a position NC of the pressure switch **21** and a position *b* of the cam switch **36.** The reversing operation of the pressure switch **21** to a position NO due to the increased level of water in the water tank **2** causes the timer motor **24** to be actuated and the motor **10** to be driven through conduction of the motor **10** through the position *b* of the cam switch **35,** a reversing cam switch **37** and the relay **28** because the cam switch **34** has already been connected to the position *b*. At this time the relay coil **28***a* remains deenergized due to the connection of the selection switch **26** to the position *a*, thereby causing the motor **10** to be connected for four-pole driving as shown in FIG. **7.** In this state, the driving force derived from the motor **10** is transmitted only to the shaft **7** of the pulsator **6** to drive the latter because the brake lever **15** and the clutch lever **17** shown in FIG. **2** are in engagement with the brake shoe **13***a* and the coil collar **16,** respectively, due to deenergization of the magnet **22.** A ratio of diameter of the pulley **11** to that of a pulley corresponding thereto and directly coupled to the motor is determined so that the pulsator **6** may be rotated at a speed of about 500 revolutions per minute.

After the completion of the washing operation in a predetermined time, the cam switch **35** is connected to the position *a* to stop the motor **10** and to render the magnet **22** conductive, thereby opening the draining valve **18** to effect a draining operation. The reduced level of water in the water tank **2** causes the pressure switch **21** to be connected to the position NC, but causes the water supplying valve **23** to remain non-operated to continue to effect the draining operation because the cam switch **36** is changed-over to the position *a*.

After a lapse of time sufficient to effect the complete drain of water in the water tank **2,** the cam switch **36** is changed-over to the position *b* to close the cam switch **33** with the water supply valve **23** opened for water supply. A predetermined amount of supply of water permits the pressure switch **21** to be connected to the position NO to actuate the timer motor **24** and the motor **10** through the position *b* of the cam switch **34,** thus effecting the rinsing operation in the same manner as in the above-mentioned washing operation.

During the rinsing step, the successive water supply is effected because the cam switch **33** is closed irrespective of the connection of the pressure switch to the position NO. The supplied water dilutes the concentration of a cleanser contained in the water tank **2** and overflows out of an overflow port **20** provided on the upper portion of the water tank **2,** thus effecting a so-called overflow rinsing operation. Following the rinsing operation of a predetermined time, the cam switch **35** is connected to the position *a* to stop the motor **10** and activate the magnet **22** with the draining valve opened to drain the water.

After the lapse of the predetermined time, the complete drain of water still remaining in the water tank is effected to change-over the cam switch **34** to the posi-

tion *a*, thus entering an intermediate drying operation. The select switch **27** has already been set to the position *b* in the drying operation, so that a current flows through the two-pole windings **38** of the motor **10** with the result of the high revolution of the motor **10.** In this state, the continuous energization of the magnet **22** is provided due to the connection of the cam switch **35** to the position *a* to open the draining valve as well as to operate the brake lever **15** and the clutch lever **17,** thus bringing the brake mechanism out of engagement to effect the unidirectional drive of the basket **4** at the high speed because the clutch spring **14** is disposed around the pulley boss **25** and the hollow shaft **8.**

The clutch spring **14** has its winding direction determined in such a way that it is urged to wind around the pulley boss **25** and the hollow shaft **8** due to the rotational drive of the motor at the drying operation in the state of disengagement of the clutch lever **17.**

The two-pole driving of the motor **10** permits the pulsator **6** as well as the basket **4** to be driven at the speed of about 1,000 revolutions per minute with the strong centrifugal drying operation.

In the drying operation, the cam switches **34** and **35** are both changed-over to the position *a*. As a result, the motor **10** is connected to the power supply through either of the positions *a* and *b* of the selection switch **27,** so that only the windings **38** for two-pole driving connected to the position *b* of the selection switch **27** is connected to the power supply in Program No. **1** with the windings completely disconnected therefrom.

Subsequent to the drying operation of the predetermined time, water supply, rinsing, draining and drying operations are effected in the same manner as in the previously described water supply, rinsing, draining and drying operations.

Next, the selection switches **26** and **27** are set to the position *a* when the washing operation is to be effected in accordance with Program No. 2, i.e., in the strong mode of the washing water flow and in the weak mode of the drying revolution.

In this Program, the washing and rinsing operations are effected in the same manner as those according to Program No. 1 with the four-pole driving of the motor **10** and the rotation of the pulsator at the speed of about 500 revolutions per minute.

In the drying step, however, the cam switch **34** is changed-over to the position *a* to render the windings **39** of the motor **10** conductive because the selection switch has already been changed-over to the position *a*. At this time, the relay coil **28***a* remains deenergized with its relay contact returned to the original state, and the circuit as shown in FIG. **7** is established to drive the motor **10** with the four poles. As a result, the basket **4** and the pulsator **6** are rotated at the speed of about 500 revolutions per minute with the weak centrifugal drying operation as compared with that according to Program No. **1.**

The operations according to the Program No. **2** are preferably suitable for the cloths such as those made of polyester textiles which are resistant enough for the strong washing water flow but tend to crumple against a stronger dehydrating force.

The operations according to Program No. **3** in which the washing water flow is strong and the drying revolution is strong are suitable for use in washing wool products such as sweaters. In the Program No. **3,** the selection switches **26** and **27** are set to the position *b* whereupon the relay coil **28***a* is energized with the contacts *e*, *f*, *g*, *h* and *i* turned to the positions shown in FIG. **6** by solid lines to establish the circuit shown in FIG. **8** for six-pole driving of the motor **10** because the cam switches **34** and **35** are connected to the position *b* with the selection switch **26** changed-over to the position *b* in the washing and rinsing steps. Consequently, the pulsator **6** is rotated at the speed of about 300 revolutions per minute which is lower than in the washing steps according to Program Nos. **1** and **2,** thus resulting in the weaker water flow.

In the drying step, on the other hand, the two-pole driving windings **38** are energized through the position *a* of the cam switch and the position *b* of the selection switch to rotate the basket **4** at the speed of 900 to 1,000 revolutions per minute with the strong centrifugal drying.

The selection switches **26** and **27** are set to the positions *b* and *a*, respectively, in the operations according to Program No. **4** in which the motor **10** is driven with six poles at the washing and rinsing operations while with four poles at the drying operation, and which is most suitable for the products such as stockings made of nylon which require washing by weak water flow and weak drying.

The selection switches **26** and **27** can be operated independently of each other, but may be set simultaneously for improvement of the operations by utilizing a well-known piano switch in cooperation with four pushing levers each provided with a mark corresponding to the program number and by operating one of the pushing levers.

In the embodiment described above, the windings **39** of the motor **10** are selectively connected in series and in parallel for four-pole and six-pole drivings, but may be changed-over to the four-pole and eight-pole drivings wherein the pulsator is rotated in the weak washing operation half a time as low as in the strong washing operation.

Further, another embodiment can be realized in which the motor is changed in pole number to four poles, six poles or eight poles with the four-pole driving for the strong drying, the six-pole driving for the weak drying and the strong washing, and the eight-pole driving for the weak washing.

In this embodiment, a ratio of the rotational speed of the basket in the strong drying to that in the weak drying is three to two, and a ratio of the rotational speed of the pulsator in the strong washing and that in the weak washing is four to three. In both the embodiments, the maximum number of revolution at the drying is 1.3 to 4 times as great as the number of revolution at the washing.

Thus, if the maximum number of revolution at the drying is set to be 1.3 to 4 times as great as the number of revolution at the washing, then the rotational speeds respectively nearly equal to the number of revolution most suitable for the drying and that most suitable for the washing can be obtained by changing the pole number of the motor.

A ratio of the pole number to be changed to the minimum pole number ranges from 1.3 to 4, so that the motor having a torque requisite to the drying and the washing can be manufactured with ease and without making the dimension too large.

It is to be noted that the motor can be driven with two different kinds of pole number, i.e., with two and four

poles or four and eight poles in the case where it is not necessary to set the number of revolution in multiple steps at both the drying and washing operations. In this case the motor is driven with a small number of poles at the drying operation while with a large number of poles at the washing and rinsing operations.

In the case where the washing and drying operations are changed-over in the two strong and weak modes, respectively, as in the previously described embodiment, the motor may be changed in pole number in three steps wherein the strong washing operation and the weak drying operation are effected with the intermediate pole number. This permits the attainment of the expected objects with a very simplified driving mechanism. In other words, as shown in FIG. **1**, the selective switching to the drying and the washing operations is effected by transmitting the drive power from the motor **10** only to the pulsator **7** or both to the pulsator shaft **7** and the hollow shaft **8** with the result of the use of only one clutch device. This advantageously permits the use of the same driving system for both the drying and washing operations without requiring any conventional reduction mechanism such as gears for the driving system.

According to the present invention, the rotational drive power transmitted to the pulley **11** is selectively transmitted to the pulsator **6** and the hollow shaft **8** through the clutch mechanism, so that the washing machine improves its life span and reliability remarkably with the driving system greatly simplified as compared with the conventional ones with the reduced defects.

Further, according to the present invention, the simultaneous revolution of the pulsator **6** and the basket **4** during the drying operation allows the drying operation without any disorder even if the cloths and articles to be washed are disposed on both the pulsator and the bottom of the basket in bridged relation.

The present embodiments require two kinds of windings **38** and **39** in the motor **10**, only either one of which is rendered conductive with the other disconnected from the power supply with the result of a danger of inducing a voltage on the idling winding, but short-circuited current hardly flows through the windings due to the presence of the capacitor connected in series with the resistance of the windings themselves. If the short-circuited current greatly flows through the idling winding depending upon the output from the motor, then the idling winding may be open-circuited by providing the additional selection switches **26** and **27** or contacts of the relay.

Further, in the case where the pole number is changed to two poles, four poles and eight poles, the windings can be connected by means of a relay in such a way as to always remove the idling windings.

As mentioned above, the present invention dispenses with the complicated speed changing mechanism because the motor is constructed to be changed in pole number in at least two steps wherein the motor is driven with a small number of poles at the drying operation while with a large number of poles at the washing and rinsing operations.

Further, the motor can be changed in pole number in three steps to effect the weak drying and the strong washing operations at the intermediate speed in association with the switching operation of the clutch, thereby providing the washing machine with four kinds of different programmed operations.

Further, the speed change of the motor is effected by electric control means such as relay cam switches consequently with the greatly reduced disorders and with the enhanced reliability of the devices.

What is claimed is:

1. A washing machine comprising basket means for receiving articles to be washed, said means being rotatably mounted in a water tank, pulsating means provided for said basket means, pole change motor means for driving said basket means and pulsating means, the number of poles of said motor means being adjustable to control the motor means speed in three steps, clutch means for transmitting driving power from the motor means to the basket means during drying operation of the washing machine, brake means for holding said basket means stationary during washing and rinsing operations of the washing machine, means for operating said clutch means during drying operation of the machine so as to transmit the power from said motor means to the basket means, means for releasing said brake means during drying operation, and switch means for selecting the number of poles of said motor means corresponding to a maximum number or an intermediate number during washing and rinsing operations of the machine.

2. A washing machine comprising basket means for receiving articles to be washed, said means being rotatably mounted in a water tank, pulsating means provided for said basket means, pole change motor means for driving said basket means and pulsating means, the number of poles of said motor means being adjustable to control the motor means speed in three steps, clutch means for transmitting driving power from the motor means to the basket means during drying operation of the machine, brake means for holding said basket means stationary during washing and rinsing operations of the machine, means for operating said clutch means and releasing said brake means during drying operation of the machine, and switch means for selecting the number of poles of said motor means corresponding to a minimum number or an intermediate number during drying operation of the machine.

3. A washing machine comprising basket means for receiving articles to be washed, said means being rotatably mounted in a water tank, pulsating means provided for said basket means, pole change motor means for driving said basket means and pulsating means, the number of poles of said motor means being adjustable to control the motor means speed in three steps, clutch means for transmitting driving power from the motor means to the basket means during drying operation of the machine, brake means for holding said basket means stationary during washing and rinsing operations of the machine, means for operating said clutch means and releasing said brake means during drying operation of the machine, first switch means for selecting the number of poles of said motor means corresponding to a maximum number or an intermediate number during washing and rinsing operations of the machine, and second switch means for selecting the number of poles of said motor means corresponding to a minimum number or an intermediate number during drying operation of the machine.

4. A washing machine according to claim **3**, wherein said first and second switch means are connected to contacts of cam switches changed-over during drying operation and during washing and rinsing operations of the machine.

5. A washing machine according to claim 1, wherein the pulsating means is located at a central bottom portion of the basket means, and wherein the clutch means transmits driving power from the motor means to the basket means only during drying operation of the machine.

6. A washing machine according to claim 2, wherein the pulsating means is located at a central bottom portion of the basket means, and wherein the clutch means transmits driving power from the motor means to the basket means only during drying operation of the machine.

7. A washing machine according to claim 3, wherein the pulsator means is located at a central bottom portion of the basket means, and wherein the clutch means transmits driving power from the motor means to the basket means only during drying operation of the machine.

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