

Dec. 22, 1970

TOSHIKAZU OHNISHI ETAL

3,548,615

WASHING MACHINE

Filed Oct. 30, 1968

7 Sheets-Sheet 1

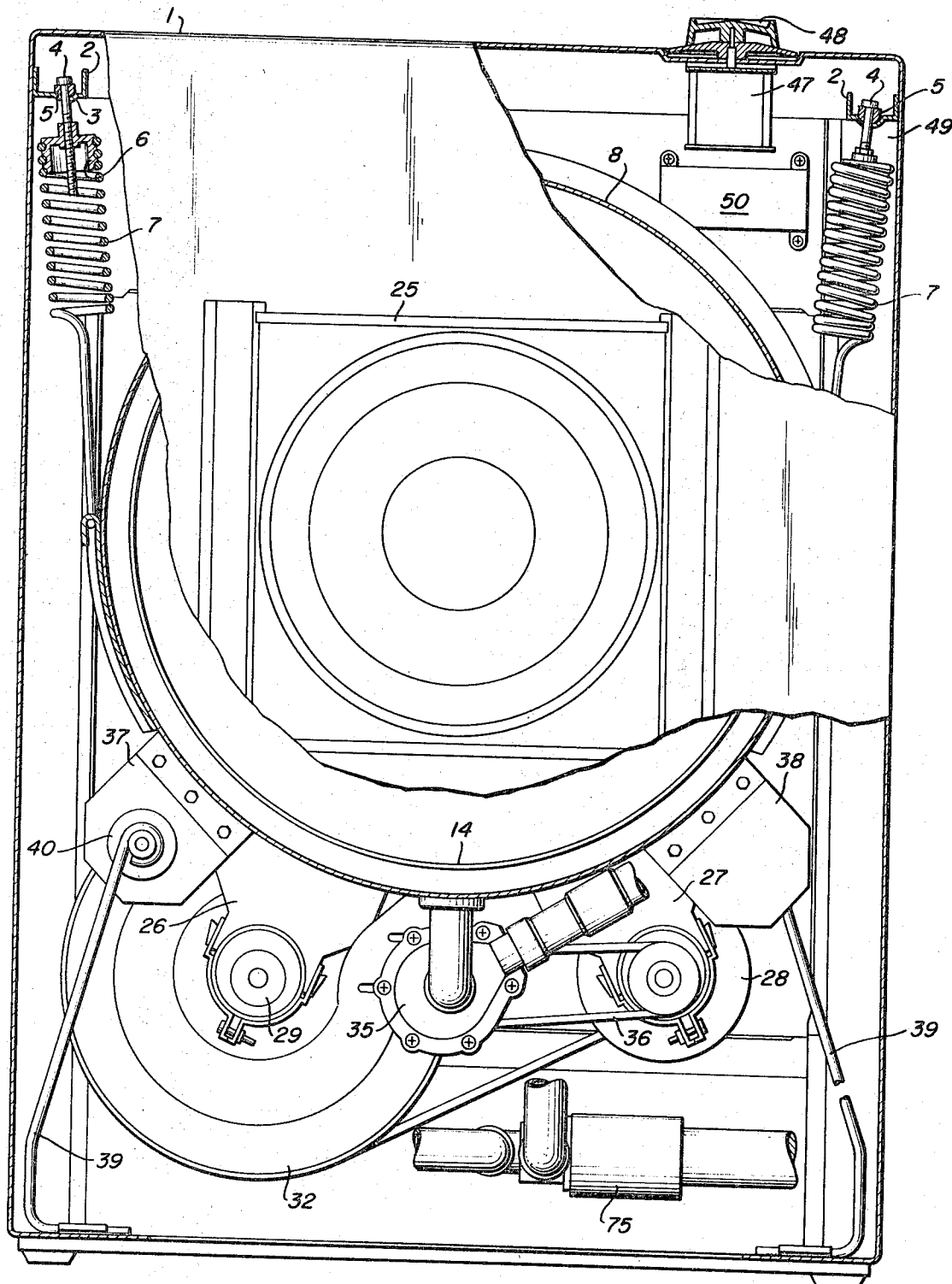


FIG. 1

INVENTORS
TOSHIKAZU OHNISHI
HIROKI UTSUMI
TORU TAZAWA
SIGETO YAMANE
KATSUMASA MATSUURA

Dec. 22, 1970

TOSHIKAZU OHNISHI ET AL

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7 Sheets-Sheet 2

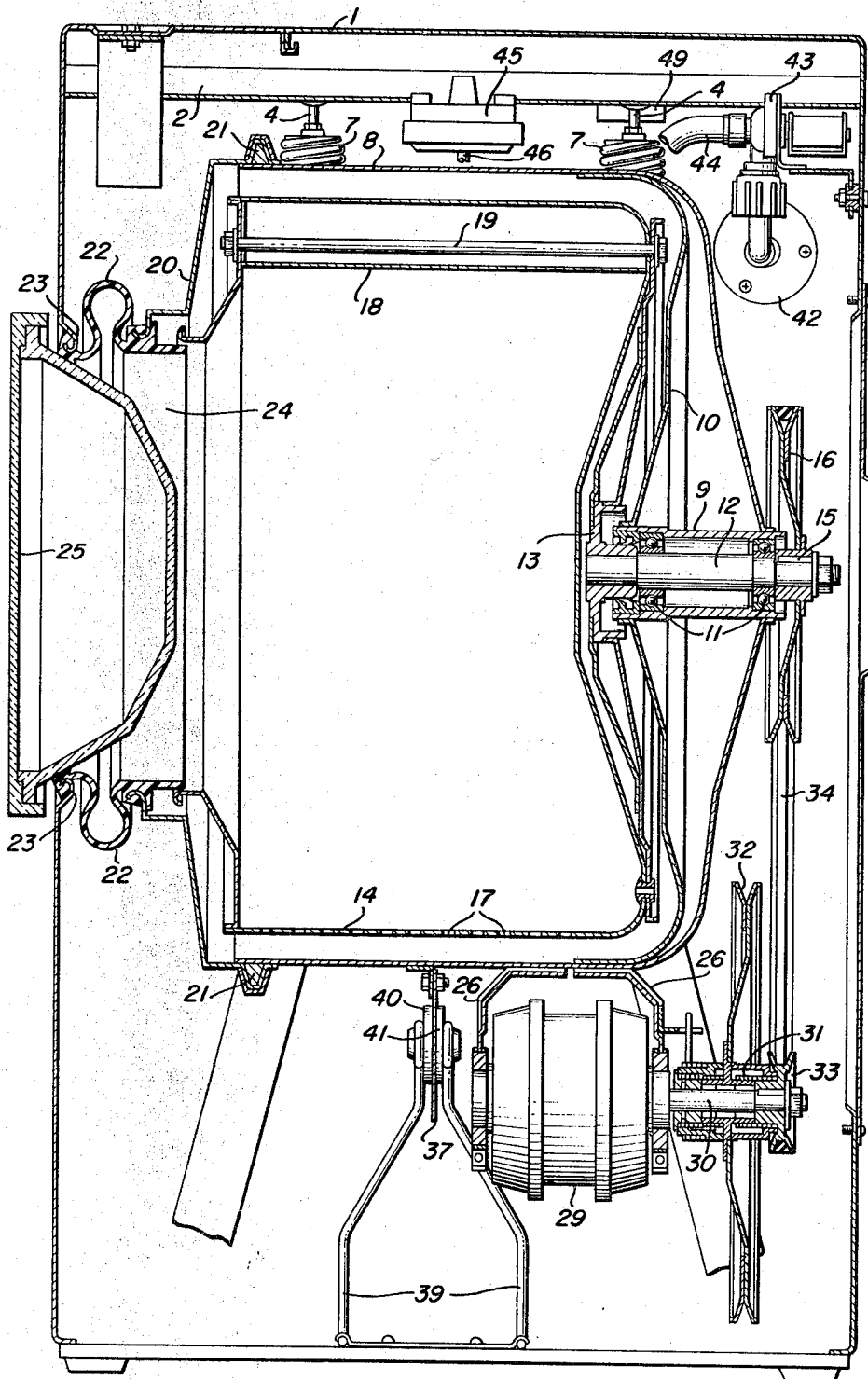


FIG. 2

INVENTORS
TOSHIKAZU OHNISHI
HIROKI UTSUMI
TORU TAZAWA
SIGETO YAMANE
KATSUMASA MATSUURA

Dec. 22, 1970

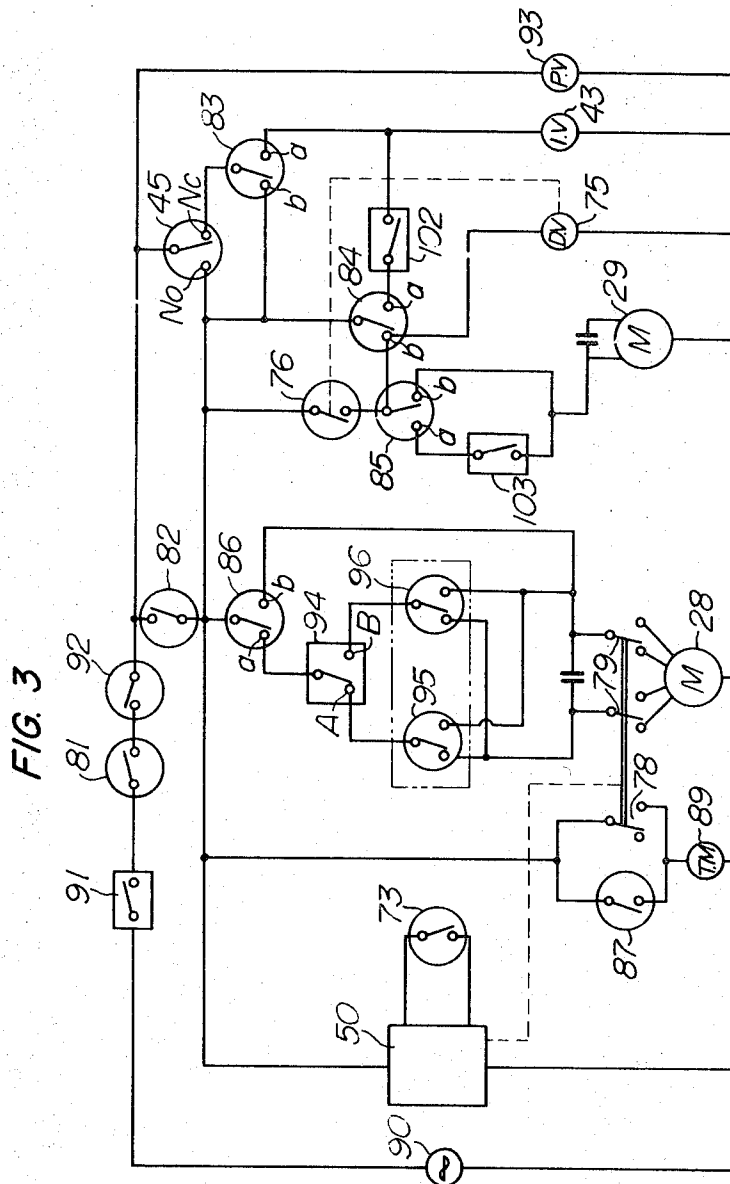
TOSHIKAZU OHNISHI ET AL

3,548,615

WASHING MACHINE

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7 Sheets-Sheet 3



INVENTORS
TOSHIKAZU OHNISHI, HIROKI
UTSUMI, TORU TAZAWA,
SIGETO YAHARA, KATSUMASA
HATSUURA
BY Gary B. Roubelli ATTORNEYS

Dec. 22, 1970

TOSHIKAZU OHNISHI ETAL

3,548,615

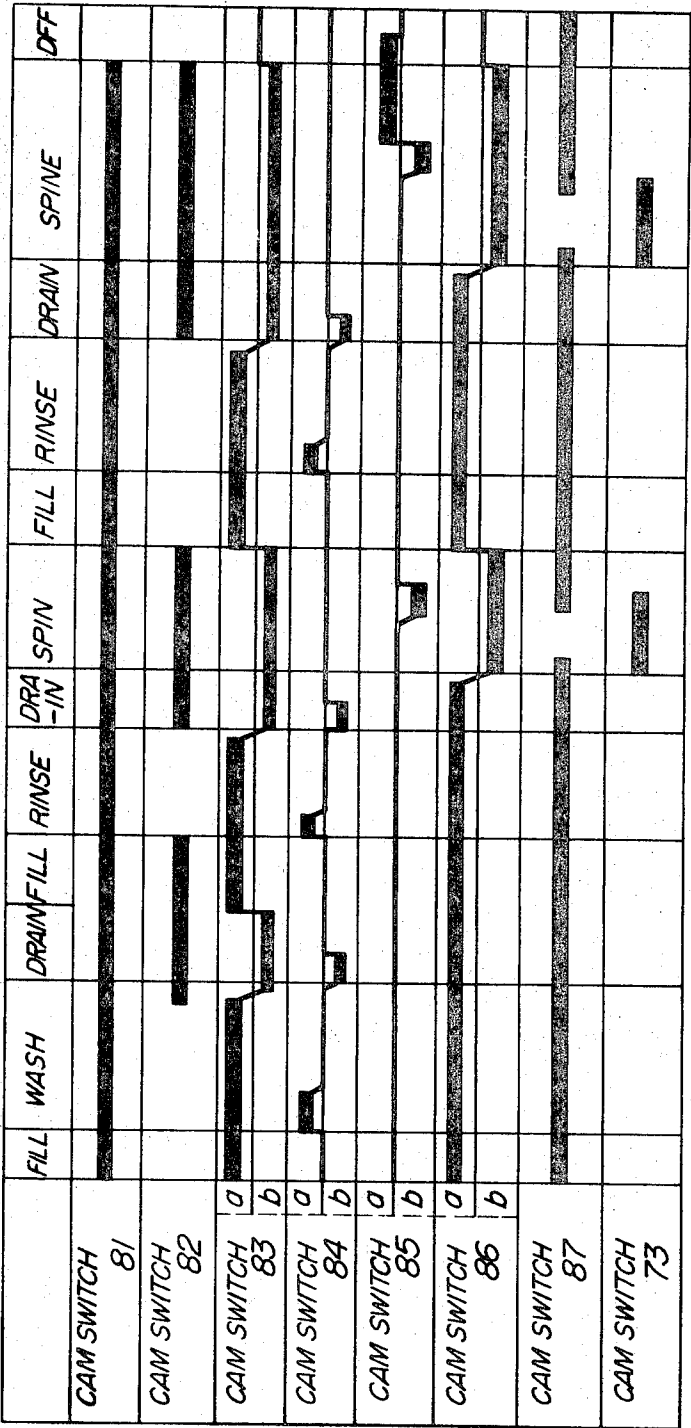
WASHING MACHINE

Filed Oct. 30, 1968

7 Sheets-Sheet 4

FIG. 4

TIMER CYCLE CHART



CONTACT CLOSED
CONTACT OPEN

INVENTORS
TOSHIKAZU OHNISHI, HIROKI
UTSUNI, TORU TAZAWA, SIGETO
YAMANE, KATSUHASA MATSUURA
BY Craig & Antonelli
ATTORNEYS

Dec. 22, 1970

TOSHIKAZU OHNISHI ETAL

3,548,615

WASHING MACHINE

Filed Oct. 30, 1968

7 Sheets-Sheet 5

FIG. 5

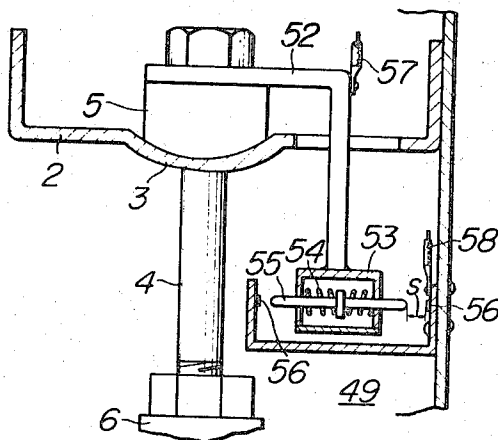


FIG. 6

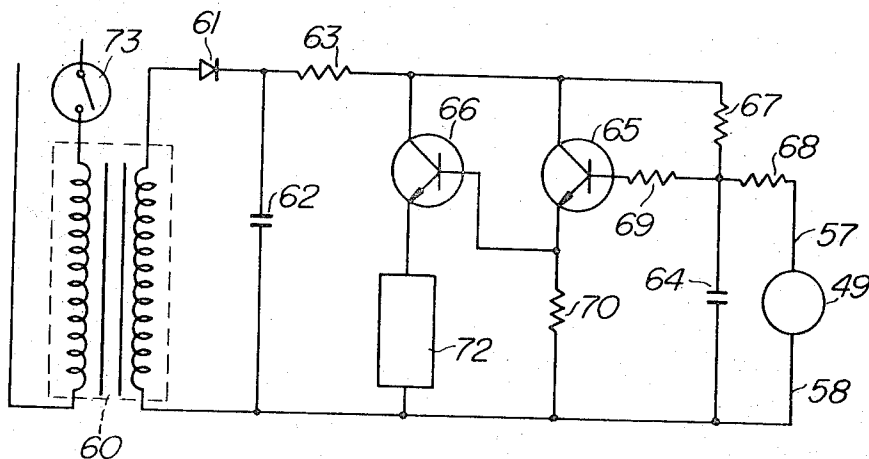
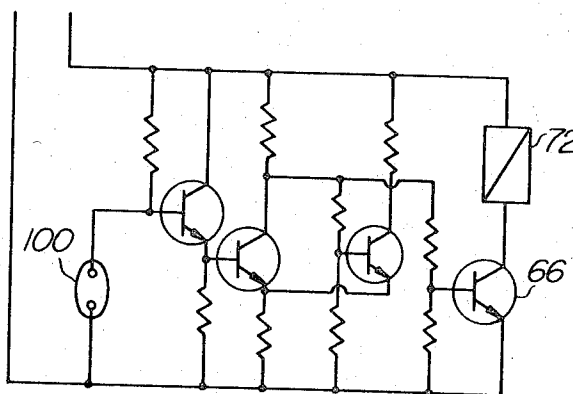


FIG. 8



INVENTOR
TOSHIKAZU OHNISHI, HIROKI
UTSUNI, TORU TAZAWA, SIGETO
BY YAMANE, KATSUNASA MATSUMURA
Craig & Rubenelli ATTORNEYS

Dec. 22, 1970

TOSHIKAZU OHNISHI ETAL

3,548,615

WASHING MACHINE

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7 Sheets-Sheet 6

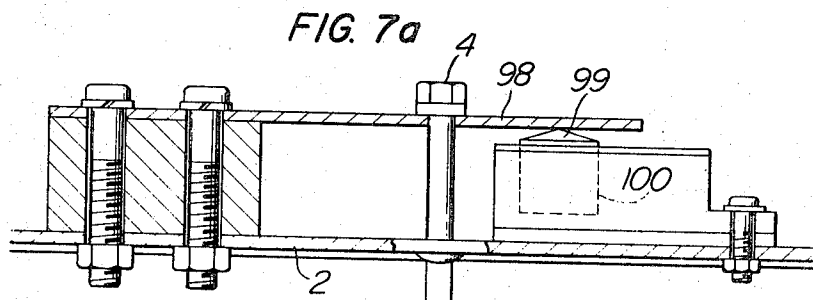
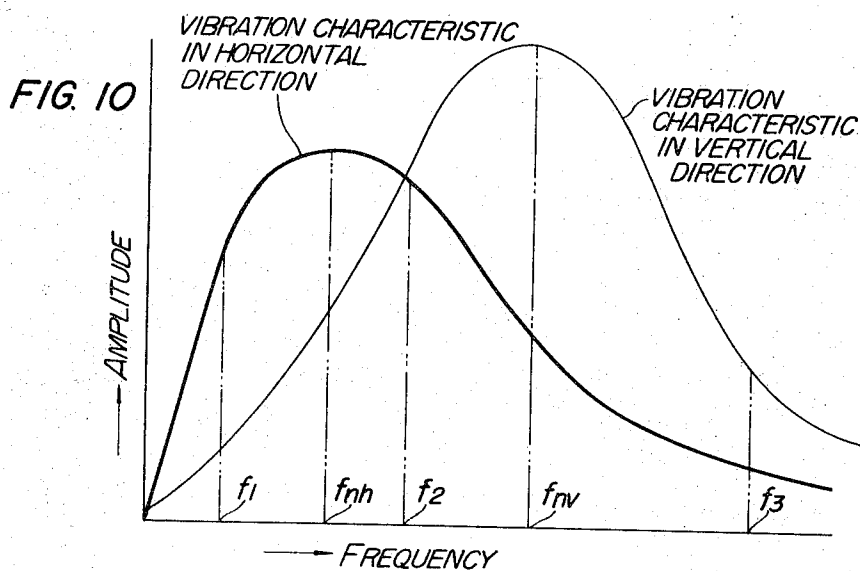
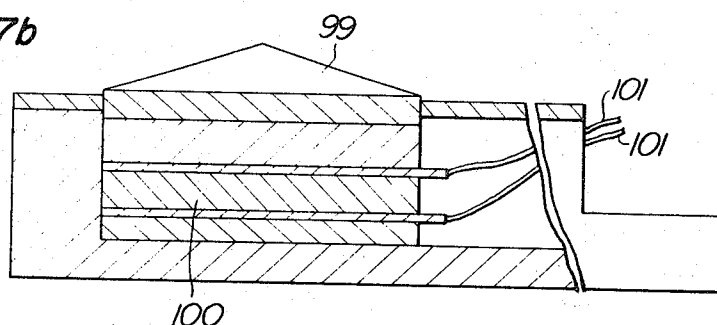


FIG. 7b



INVENTORS
TOSHIKAZU OHNISHI, HIROKI
UTSUNO, TORU TAGAWA, SUGITO
YAMANE, KATSUNAGA MATSUURA
BY
Cavigli & Antonelli
ATTORNEYS

Dec. 22, 1970

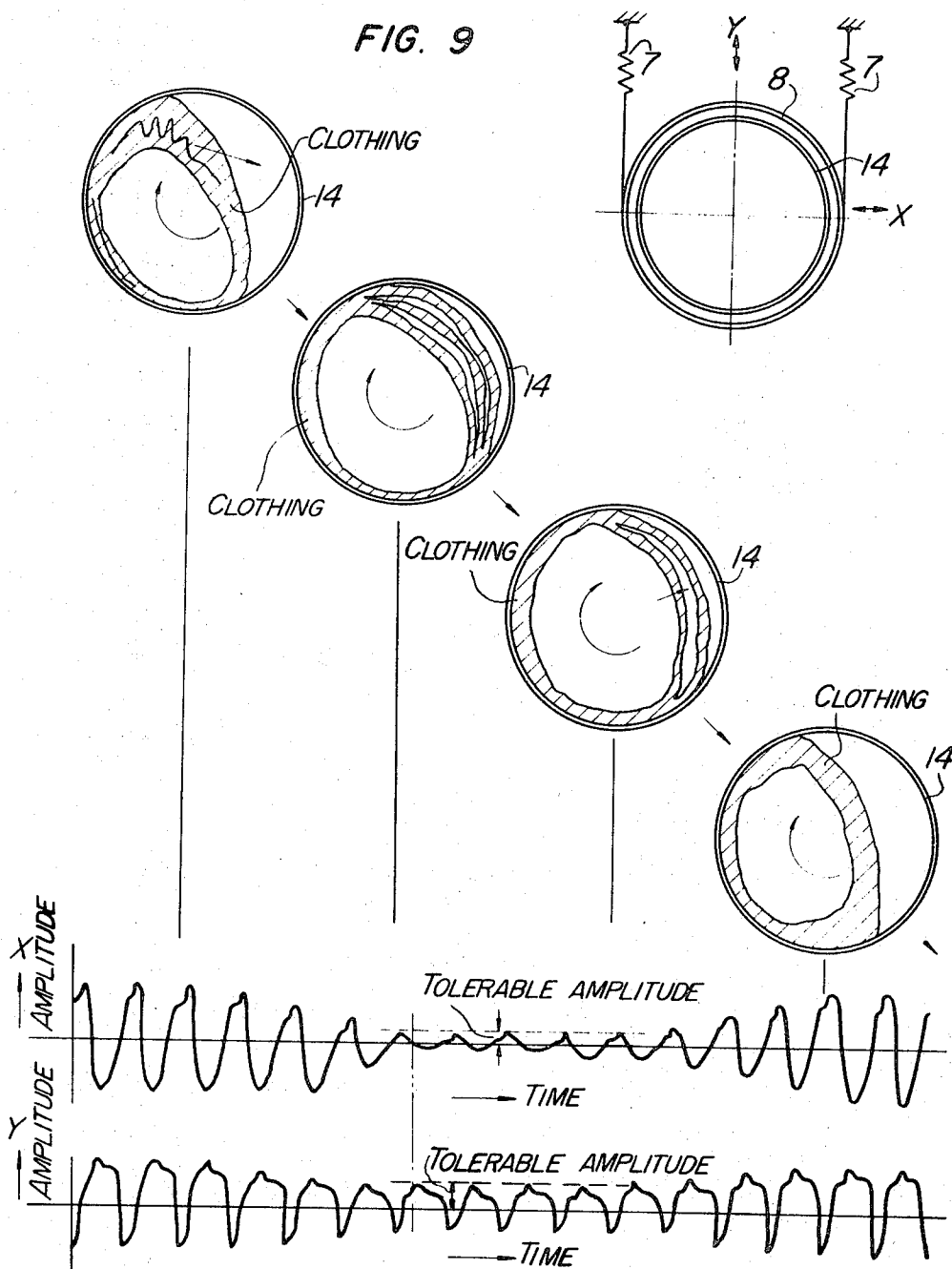
TOSHIKAZU OHNISHI ETAL
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3,548,615

Filed Oct. 30, 1968

7 Sheets-Sheet 7

FIG. 9



INVENTORS
TOSHIKAZU OHNISHI, HIROKI
UTSUMI, TORU TAGAWA, SIGEKI
YAMANE, KATSUMASA MATSUDA
BY
Craig R. Rubenelli
ATTORNEYS

1

3,548,615

WASHING MACHINE

Toshikazu Ohnishi, Hiroki Utsumi, Toru Tazawa, Sigeto Yamane, and Katsumasa Matsuura, Hitachi-shi, Japan, assignors to Hitachi, Ltd., Tokyo, Japan, a corporation of Japan

Filed Oct. 30, 1968, Ser. No. 771,919

Claims priority, application Japan, Nov. 1, 1967,

42/69,862; Nov. 10, 1967, 42/71,992

Int. Cl. D06f 37/22

U.S. Cl. 68—23.1

9 Claims

ABSTRACT OF THE DISCLOSURE

A drum-type washing machine capable of performing programmed operations ranging from a clothing operation to a spinning operation automatically, wherein a motor for driving a drum is shifted from a low rate of speed to a high rate of speed under the control of vibration detecting means provided on the drum and the drum is accelerated to a higher rate upon detecting the fact that a clothing in the drum is distributed evenly with respect to the center of rotation of said drum, whereby an excessively large vibration of the drum is prevented.

This invention relates to a drum-type washing machine and more particularly to a drum-type washing machine which is so designed that the vibration of a clothing accommodating drum is minimized while the rotating speed of said drum is being accelerated and after the rotating speed has been accelerated to the high speed rotation by changing over the rotating speed of said drum to high speed rotation when the amplitude of the drum vibration is within a tolerable range over a predetermined period of time.

In the operation of a drum-type washing machine of the type which is provided with a drum rotating about a horizontal shaft or a shaft inclined at a predetermined angle with respect to a horizontal plane and which is operated by a process comprising placing a clothing in the drum, charging a cleaning liquid in said drum, rotating the drum at a low speed for rolling the clothing therein thereby washing said clothing and rotating the drum at a high speed with a drain valve opened to effect centrifugal spinning, the drum tends to undergo an excessively large vibration while the rotating speed of said drum is being accelerated and after the rotating speed has been accelerated to the high speed rotation due to uneven distribution of the clothing in the drum.

Such vibration has not only caused a noise but also brought about the disadvantage that vibrating members are damaged by collision with stationary members, such as an outer frame. For this reason, it has been usual to repeat the steps of interrupting the acceleration of drum halfway upon occurrence of an excessive vibration, reducing the rotating speed of the drum to the low speed rotation, continuing the low speed rotation for a predetermined period and then accelerating the drum again to high speed. According to this method, however, the probability of the clothing being distributed in the drum uniformly with respect to the center of rotation while acceleration to a high speed rotation is so slim that an excessively large vibration occurs frequently in the course of acceleration and transition to a high speed rotation can be accomplished only after repeated acceleration and deceleration. Therefore, transition from the low speed rotation to the high speed spinning step cannot be attained smoothly.

There have also been proposed to suppress the vibration generated, by adding a large mass to a water tank pro-

2

vided containing the drum, but this method is quite superficial and passive.

Because in this method a technical consideration is given only as to how rationally the vibration generated can be suppressed, after accepting the vibration, resulting from uneven distribution of clothing in the drum, as an inevitable phenomenon. The suppression of a vibration generated is not a fundamental solution to the problem of eliminating the cause of vibration, while the provision of an additional mass fixedly or automatically is in no way desirable from the standpoint of structure, strength and cost.

The present invention has been achieved based on the discovery, through experiments, that the vibration of drum would be extremely small transition of the drum rotation to a high speed rotation could be attained smoothly without generating an excessively large vibration when a clothing in the drum is distributed symmetrically evenly with respect to the center of rotation of the drum in the low speed rotation of the drum and the rotation of the drum is shifted from low speed rotation to high speed rotation under such condition.

An object of the present invention is to prevent an excessively large vibration occurring while the rotating speed of said drum is being accelerated and after the rotating speed has been accelerated to the high speed rotation.

Another object of the invention is to provide highly sensitive detecting means for detecting the timing of shifting the drum from low speed rotation to high speed rotation.

Still another object of the invention is to provide a washing machine which is so constructed that an excessively large vibration sporadically occurring during acceleration of the drum from low speed rotation to high speed rotation can be damped effectively.

Still another object of the invention is to provide detecting means for detecting the timing of transition from low speed rotation to high speed rotation at low costs.

Other objects and advantages of the present invention will become apparent from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a front elevation of a drum-type washing machine according to the present invention, with a front panel broken away to show a mechanism interior of the machine;

FIG. 2 is a vertical sectional view of the washing machine;

FIG. 3 is a wiring diagram of the drum-type washing machine;

FIG. 4 is a diagram illustrating the operation program of the drum-type washing machine;

FIG. 5 is a detailed view of vibration detecting means;

FIG. 6 is a wiring diagram of the control circuit used in the drum-type washing machine;

FIG. 7a is a detailed view of another form of the vibration detecting means;

FIG. 7b is a fragmentary enlarged view of the vibration detecting means shown in FIG. 7a;

FIG. 8 is a wiring diagram of another form of the control circuit;

FIG. 9 is a diagram showing a vibration wave form of the drum; and

FIG. 10 is a vibration characteristic chart.

Referring to the drawings, a box-shaped outer frame 1 has stays 2 provided across the upper portions of the inner surface of the side walls thereof and each stay 2 has semispherical indents 3 formed therein at two places. In each of the semispherical indents 3 is slidably mounted

3

a piece 5 which has a semispherical convex surface and is connected to a bolt 4. The bolt 4 extends downwardly through the stay 2, with a spring seat 6 threadably mounted on the lower end portion thereof. A suspension coil spring 7 has the upper end thereof fitted on the spring seat 6 and the lower end thereof anchored to the side wall of a cylindrical outer tank 8, thereby suspending said outer tank.

On the back side of the outer tank 8 is provided a bearing cylinder 9 which is extending through an end wall member 10 and secured to the outer tank 8. The bearing cylinder 9 has ball bearings 11 disposed therein through which a drum shaft 12 is journaled. A washing accommodating drum 14 is fixedly connected to the inner end of the drum shaft 12 through a flange member 13, while a pulley 16 is fixedly mounted on the outer end of the drum shaft by means of a key 15.

The drum 14 has a number of apertures 17 perforated through the peripheral wall thereof for the passage of water therethrough in the process of spinning. The drum 14 also has a plurality of inwardly projecting baffles 18 secured to the inner wall surface thereof by bolts 19 extending axially across the drum.

The front end face of the outer tank 8 is covered with a front cover 20 which is secured to the outer tank through a packing 21 and said front cover 20 has an opening in the central portion thereof for throwing a clothing therethrough. The peripheral edge of the opening is connected to the peripheral edge 23 of a clothing inlet opening 24, formed in the front wall of the outer frame 1, by means of a flexible rubber bellows 22. The clothing inlet opening 24 is closed by a door 25 made of a transparent plastics.

Arms 26 and 27 are connected to the bottom of the outer tank 8 by welding and motors 28 and 29 are fixed to the lower ends of the respective arms. The driving shaft 30 of the motor 29 has a large pulley 32 loosely mounted thereon through a spring clutch 31 and said large pulley 32 is in turn operatively connected to a small pulley of the other motor 28 through a V-belt (not shown). The driving shaft 30 also has a small pulley 33 keyed thereon and a V-belt 34 is engaged around said small pulley 33 and the aforesaid pulley 16 fixedly mounted on the drum shaft 12.

The motor 28 is operatively connected to a pump 35 to drive the same, said pump 35 being connected to the bottom of the outer tank. The pump 35 is driven from the motor 28 during the process of washing operation to circulate a washing water retained in the outer tank 8.

Extending slantingly downwardly from the outer tank 8 are friction plates 37 and 38. These friction plates are each clamped between front and rear friction members 40, 41 and damp a vibration of the outer tank 8 in engagement with said friction members. The friction members 40, 41 are supported by respective supporting springs 39 fixed to the outer frame.

At the upper portion of the outer frame 1 are provided a filling flange 42 for connection to an external faucet and a filling solenoid valve 43 in communication with said filling flange. The outlet of the filling solenoid valve 43 is communicated with the upper portion of the outer tank 8 through a filling tube 44.

The filling solenoid valve 43 is operated under the control of a pressure switch 45 which is actuated by the water level in the outer tank 8 and is communicated with the bottom portion of the outer tank through a pipe 46.

Reference numeral 47 designates a timer which is so designed that once it has been set at a starting position, a programmed operation is carried out automatically by the action of a timer motor, accommodated therein, in accordance with a timer cycle chart to be described later. The operation is started by manually operating a knob 48.

Reference numeral 49 designates a vibration detector fitted to a portion of the stay 2 and the detailed structure of said vibration detector is shown in FIG. 5. Reference

4

numeral 50 designates a box in which is housed means for controlling the rate of rotation of the drum in response to a signal from the vibration detector 49. The detailed wiring of the control means 50 is shown in FIG. 6.

Now, the structure of the vibration detector 49 will be described in detail with reference to FIG. 5. The vibration detector 49 comprises a vibration transmitting rod 52 connected integrally with the piece 5 having a semispherical convex surface. The vibration transmitting rod 52 has connected to the lower end thereof an electrode box 53. In the electrode box 53 is disposed a movable contact 55 which is normally held centrally of the box under the biasing forces of return springs 54. Fixed contacts 56 are provided on the outer frame side at locations opposite to the opposite ends of the movable contact 55 respectively with a distance S therebetween. The movable contact 55 and the fixed contacts 56 are electrically connected with the control means by lead wires 57, 58 as shown in FIG. 6.

Referring to FIG. 6, a voltage from a commercial power source is dropped by a transformer 60, rectified and smoothed by a diode 61 and a condenser 62, and impressed across the movable contact and the fixed contacts through resistors 63, 67 and 68. A condenser 64 is connected in parallel to both contacts, so that a charging voltage of said condenser 64 is supplied to the base of a transistor 65 through a resistor 69.

Upon energization of the transistor 65, the base potential of a transistor 66 rises due to a voltage drop of a resistor 70, whereby said transistor 66 is energized and accordingly the exciting coil of a relay 72 is excited. The exciting coil serves as a pole changer for the motor 28 shown in the circuit diagram of FIG. 3.

A cam switch 73 is closed under the control of a timer motor 74 only when the program enters the spinning process.

Next, the operation of the drum-type washing machine constructed as described above will be described with reference to the circuit diagram of FIG. 3 and the timer cycle chart of FIG. 4.

Referring first to FIG. 3, reference numerals 73, 81, 82, 83, 84, 85, 86 and 87 designate cam switches controlled by a series of cams provided on the shaft of a timer motor 89, and the configurations of the cams of the respective cam switches are so selected that they will contact the lateral thick lines in the program chart of FIG. 4 respectively. A door switch 91 which is adapted to be closed only when the door 25 is closed, the cam switch 81 and a manual switch 92 are connected in series with a power source 90. Therefore, when the timer knob is set at the starting position, the cam switch 81 is closed first and a pilot lamp 93 is lighted indicating that the washing machine has been placed in operation. In this case, since no water is in the outer tank 8, the pressure switch is in NC position and the cam switch 83 in a position. Therefore, the filling solenoid valve 43 is energized to start filling. When the water filled in the outer tank 8 has reached a prescribed level, the pressure switch 45 is switched to NO position and the pole change motor 28 is actuated through a selective switch 94 and a reversing switch 95, since the cam switch 86 is in a position. The selective switch 94 is provided for the purpose of shifting the washing operation from strong washing operation to mild washing operation or vice versa and is operated manually. The reversing switch 95 and another reversing switch 96 are provided to change the proportion of the period of normal rotation to the period of reverse rotation of the motor 28. Thus, it will be understood that the motor 28 rotates in the normal direction and in the reverse direction repeatedly in a predetermined cycle, causing the drum 14 to rotate in the normal direction or in the reverse direction, whereby the clothing in the drum is rolled therein and thus washed. In the process of the washing operation, the timer motor 89 rotates to carry out the program, since the cam switch 87 is held in a closed position.

Upon completion of the washing process, the cam switch 82 is closed, and the cam switch 83 is brought into *b* position and the cam switch 84 into *b* position, so that a drain valve 75 is opened to drain the washing water and at the same time a microswitch 76 is closed which is operatively associated with said drain valve 75. Upon completion of the drain, the cam switch 83 is brought into *a* position to actuate the filling solenoid valve 43 and thus filling is commenced. When the water in the outer tank 8 has reached the prescribed level, the pressure switch 45 is shifted from NC position to NO position, whereby filling is interrupted. The timer motor 89 and the motor 28 continue to rotate in the period from the drain process to the filling process and therefore the drum 14 rotates continuously at the same speed as in the washing process.

Upon completion of a rinsing operation for a predetermined period, the washing machine enters the spinning process. In this case, the cam switch 73 is closed and the cam switch 87 is opened, so that the timer motor 89 is stopped and a voltage is impressed on the vibration detecting circuit shown in FIG. 6. At the same time, the cam switch 86 is brought into *b* position, so that the motor 28 starts to rotate in one direction at the same speed as in the washing process.

Here, the movement of washing in the drum will be described. Firstly, a clothing thrown into the drum settles in the bottom of the drum but when the drum starts rotating, the clothing is carried upward by the baffles and drops gravitationally from a certain height. The distribution of the clothing in the drum is not always the same, namely the clothing may be in the form of a mass at one time and may be in the form of a relatively long web at another time. When the clothing is in the form of a web and extends longitudinally along the peripheral inside surface of the drum, it is relatively distributed evenly with respect to the center of rotation of the drum.

The distribution becomes extremely uniform particularly when a relatively large quantity of clothing is placed in the drum, because the clothing is distributed along the peripheral wall of the drum in an annular shape.

However, the condition of clothing distributed evenly with respect to the center of the drum does not last long and in several to several tens seconds the clothing distribution becomes random again, with ununiform distributing. The condition of clothing distributed evenly with respect to the center of the drum appears repeatedly at relatively long periods.

It will be appreciated, therefore, that if the drum is accelerated rapidly to create in the clothing such a large centrifugal force as to keep it attached on the inside wall of the drum, under the condition wherein the distribution of the clothing with respect to the center of rotation of the drum is uniform, the amplitude of vibration of the drum in the process of acceleration and spinning will become small. The present invention is characterized in that whether the clothing in the drum is uniform distribution or not is acknowledged by detecting the amplitude at which the outer tank is vibrating, so that acceleration of the drum may be effected when the distribution of the clothing is uniform.

Namely, as shown in FIG. 5, the movable contact 55 is connected to the outer tank suspending bolt 4 through the vibration transmitting rod 52 and the fixed contacts 56 are arranged in opposed relation to said movable contact. Between the movable and fixed contacts is provided a spacing S.

With the vibration detector of the arrangement described, when the drum 4 vibrates with a vibration wave form as shown in FIG. 9 and if the amplitude of the vibration exceeds a predetermined value, the movable contact 55 is brought into contact with the fixed

contact 56 and performs an ON-OFF operation in the same cycle as the cycle in which the drum vibrates.

In this case, since the condenser 64, provided in parallel to the movable and fixed contacts, discharges the electric charge stored therein through said movable and fixed contacts, the base potential of the transistor 65 does not rise to a level to energize said transistor, so that the transistor 65 remains deenergized and the relay is held inoperative with no current flowing through the exciting coil thereof.

However, when the clothing in the drum is in a relatively uniform distribution with respect to the center of rotation of the drum, the drum vibrates at a small amplitude and therefore the movable contact 55 and the fixed contact 56 of the vibration detector are held disengaged over a certain period of time. As a result, the voltage of the condenser 65 reaches a level to energize the transistor 65 and thus the transistor 65 is energized. Upon energization of the transistor 65, a current flow through the exciting coil 72 of the relay through the following transistor 66, and a contact 79 and a contact 78 provided in series with the timer motor 89 are actuated, whereby the pole of the motor 28 is changed to drive the drum 14 at a rate twice as high as that in the washing process. At the same time, since the contact 78 is actuated, the timer motor 89 is actuated again to control the cam switches. Upon passage of a predetermined time after the pole of the motor 28 is changed, the cam switch 85 is brought into *b* position, so that the motor 29 is set in motion, and at the same time the cam switch 87 is closed and the cam switch 73 is opened. The contacts 78 and 79 of the relay are returned to the position shown and the motor 28 is shifted to low speed rotation.

Since the rotation of the motor 28 is transmitted to the driving shaft of the motor 29 through the overrunning clutch 31, slippage occurs at the clutch 31 when the motor 28 is set in motion and thus the drum 14 is driven from the motor 28.

Therefore, by employing a 4 pole-2 pole pole change motor for the motor 28 and a 2 pole motor for the motor 29 and by suitably selecting the reduction ratio from the rotary shaft of the motor 28 to the rotary shaft of the motor 29 and the reduction ratio from the rotary shaft of the motor 29 to the drum shaft 12, it is possible by the above-described operation to accelerate the rate of rotation of the drum stepwise from the rate of rotation in the washing process to the final rate of rotation in the spinning process.

Now, the vibration characteristics of the moving parts, such as the outer tank 8, the drum 14 and the motors 28, 29, resiliently suspended from the outer frame by four suspension springs 7, will be discussed.

The vibration of the mass system suspended by the springs is composed of a component in a vertical plane and a component in a horizontal plane, and the natural frequency thereof is generally higher in the vertical plane than in the horizontal plane. This is because, while the natural frequency of the vibration in a horizontal direction is determined by the distance from the semispherical concave surface 3 to the center of gravity of the resiliently supported moving part, that of the vibration in a vertical direction is determined by the mass of the resiliently suspended moving part and the spring constant of the four suspension springs. The springs are naturally required to be large in spring constant or large in rigidity because they must support the mass system. In practice, the vibration has a characteristic as shown in FIG. 10.

With such vibration characteristic, when the vibration of the drum coincides with the natural frequencies in a horizontal and a vertical directions, the amplitude of the vibration becomes large even if the vibrating force, that is, uniform distribution, is small. Thus, it will be appreciated that the period wherein the frequency of the drum coincides with the natural frequency thereof must be made as short as possible.

On the other hand, the cycle of vibration of the drum substantially coincides with the cycle of rotation of the drum. Therefore, it will be understood that a great vibration preventing effect will be attained by setting the rotating speed of the drum such that the aforesaid period wherein the frequency of the drum coincides with the natural frequency thereof in a horizontal and in a vertical direction, may be minimized.

Namely, with reference to FIG. 10, wherein reference character f_1 represents the frequency in the washing operation, f_2 the frequency at an intermediate rate of rotation in the process of acceleration from the washing operation to the spinning operation, f_3 the frequency at the final rate of rotation in the spinning operation, f_{nh} the natural frequency in a horizontal direction and f_{nv} the natural frequency in a vertical direction, the vibration of the drum can be effective by setting the rotating speed of the drum such that f_1 , f_2 and f_3 may not coincide with f_{nh} and f_{nv} as shown.

In other words, if the natural frequency f_{nh} in a horizontal direction is located between f_1 and f_2 and the natural frequency f_{nv} between f_2 and f_3 , the frequency of the drum will pass the points of these natural frequencies instantaneously during the process of acceleration and move up to a higher level before the amplitude of the drum becomes large.

The present invention will be further described with reference to another embodiment thereof. In the present invention, it is essential to detect the amplitudes of the drum 14 and the outer tank 8 as accurately as possible. Particularly, the detector is required to be accurate in operation, long in service life and low in cost.

In the embodiment shown in FIG. 7, use is made of a piezo element for drawing a vibration, propagating to the suspension springs 7, in the form of an electric signal and a relay is actuated when said electric signal is below a predetermined value over a predetermined period, whereby the pole change of the motor 28 is effected.

In FIG. 7a, pressing member 99 is disposed for engagement with the bolt 4 through a lever 98 and a piezo element 100 is interposed between the pressing member 99 and the stay 2. A lead wire 101 of the piezo element is led into the control box 50 and connected with the control circuit therein. The control circuit, in this case, is arranged as shown in FIG. 8 and operative in such a manner that the electric signal from the piezo element is amplified for comparison with a reference value and when the former is greater than the latter, that is, when the frequency of the drum is greater than a tolerance, the relay is held inoperative, whereas when the former is smaller than the latter, the relay 72 is actuated, thereby accelerating the drum.

The foregoing description has been made with reference to the case wherein the clothing in the drum is distributed substantially evenly with respect to the center of rotation of the drum during the washing operation of the drum rotating at a low speed, and such distribution of the clothing is maintained in the process of acceleration. However, it is probably, though very rarely, that the uniform distribution is disrupted in the process of acceleration. This is attributed to the fact that the washing which has been located in the proximity of the center of rotation of the drum during the low speed rotation of the drum, is not moved radially uniformly and concentrated locally during its displacement toward the peripheral wall of the drum under the influence of centrifugal force in the process of acceleration.

If ununiform distribution occurs in the process of acceleration in the manner described, the vibration of the drum becomes large abruptly and the amplitude of the vibration detected by the detector exceeds the tolerable limit, with the result that the current supply to the relay 72 is interrupted again. Therefore, the relay contact 96 is automatically returned to its original position and the drum 14 resumes the low speed rotation at which it was

driven in the washing process and maintains the same rotation until the amplitude of vibration becomes smaller than said tolerable limit. Such an excessively large vibration tends to occur in the initial stage of acceleration and will not occur under the condition wherein the clothing is completely attached to the peripheral wall of the drum. Therefore, to avoid such vibration, it is only necessary to hold the cam switch 73 in its closed position only for the period of acceleration of the drum from a low speed rotation at the time of completion of the spinning to the next intermediate rotation.

Upon completion of the spinning, filling takes place for rinsing. If, in this case, a water level selecting switch 102 is in a closed position, the filling goes on superfluously just for that period when the cam switch 84 is held in a position, even if the pressure switch 45 is switched from NC position to NO position, and accordingly, rinsing is effected with a larger amount of water than in the washing process.

Finally, spinning is performed. In this case also, the speed of rotation of the drum is shifted to a higher level by means of the amplitude of the drum as mentioned previously. The motor 29 will not be set in motion when a spinning force adjusting switch 103 is set in an open position, and the drum 14 is driven at a higher speed of rotation of the motor 28 to effect a mild spinning.

When the switch 103 is set in a closed position, on the other hand, the drum is driven from the motor 29 at the final high speed, so that a strong centrifugal spinning can be attained. It is to be understood that in shifting the drum from the rotation for washing operation to the next higher speed rotation, the speed of rotation of the drum may be changed by varying the transmission gear ratio of a speed change gear, such as a variable pulley, in addition to changing the poles of the motor.

We claim:

1. A washing machine comprising means for detecting a vibration of a clothing accommodating drum and for driving said drum at a relatively low speed rotation and a relatively high speed rotation, whereby the rotating speed of said drum is shifted to the high speed rotation when the amplitude of vibration of the drum during rotation at the low speed is held not greater than a tolerable value over a predetermined period.

2. A washing machine as defined in claim 1, wherein there is provided means for driving the clothing accommodating drum at at least two different speeds of rotation and the natural frequencies of resiliently supported parts, including said drum, are located between said speeds of rotation.

3. A washing machine comprising means for driving a clothing accommodating drum at three or more different speeds of rotation, and three different speeds of rotation being located at points outside the natural frequencies of resiliently supported parts including said drum, the speed of rotation of said drum being shifted from the lowest speed to the next higher speed only when the amplitude of said drum is held not greater than a tolerable value over a predetermined period and the subsequent shifting of the speed of rotation and said drum to higher speeds being effected automatically.

4. A washing machine as defined in claim 3, wherein a pole change for driving the drum at two different speeds of rotation and another motor for driving the drum at a higher speed of rotation than said speeds are connected to the drum through an overrunning clutch.

5. A washing machine comprising means for detecting a vibration of such parts as a drum and an outer tank resiliently suspended from an outer frame through suspension springs in the form of displacement of a vibration transmitting rod connected to said suspension spring at the joint between said suspension spring and said outer frame and means for controlling the speed of rotation of said drum in response to a signal from an electric contact mechanically operated by the displacement of said vibration transmitting rod.

9

6. A washing machine comprising a piezo element adapted to detect a change in a tension developed in a suspension spring in accordance with a vibration of a drum and means for shifting the speed of rotation of said drum from a low speed rotation to a higher speed rotation when the output of said piezo element becomes lower than a set value.

7. A washing machine as defined in claim 6, wherein said piezo element to detect the vibration of the drum is interposed between a bolt connecting the suspension spring to an outer frame and a frame.

8. A washing machine comprising means for driving a drum at at least two different speeds rotation consisting of a low speed rotation and a high speed rotation, means for detecting a vibration of said drum during the low speed rotation of the drum and in the process of acceleration of the drum from the low speed rotation to the high speed rotation, and means for accelerating the drum to the high speed rotation when the vibration of the drum detected by said vibration detecting means is below a tolerable value and returning the drum to the low speed rotation again when the amplitude of vibration of the drum becomes excessively large in the process of acceleration.

10

9. A washing machine comprising a pole change motor for driving a drum, a relay for changing the pole of said motor and vibration detecting means for detecting the amplitude of vibration of said drum and thereby controlling said relay, said relay being actuated to change the pole of said motor when said amplitude of vibration of the drum is held below a tolerable value over a predetermined period.

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WILLIAM I. PRICE, Primary Examiner

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